Optimization of the Mean-Variance Investment Portfolio of Some Stocks under Market Sentiment and the ARMAX-GARCH Model

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Abstract

Stock returns are assumed to follow the model of the time series. To determine stock returns is done by using the log-return model. It is assumed that the stock price was affected by market sentiment, so in this paper the mean stock returns is estimated using a model Autoregressive Moving Average exogenous (ARMAX) which is inserted exogenous variables such as indicator of market sentiment. While volatility is estimated using a model Generalized Autoregressive Conditional Heteroscedastic (GARCH). In this paper discussed about the mean and variance portfolio optimization several Sharia stocks where its prediction of stock return model is using ARMAX-GARCH models where the optimization is done is to use the method of Lagrange Multiplier. Numerical results obtained by using the data several Sharia stocks in Indonesia where the expected results are obtained proportion appropriate investment for shares of sharia in Indonesia.

Keywords: Return, Risk, Optimization, Portfolio, ARMAX, GARCH, Lagrange Multiplier.

1. Introduction

Investment is basically invest some capital into some form of instrument (asset), can be either fixed assets or financial assets [1], [2], [3]. Investing in financial assets can generally be done by buying shares in the stock market [4], [5]. By investing stocks, investors will faced the risk which the magnitude of the problem along with the magnitude of the expected return [6], [7]. Generally, the greater the expected return, the greater the risk to be faced [8], [9]. The risk of investment is described by rise and fall changes of stock price at any time, which can be measured by the value of variance [10].

The strategy is often used by investors to the face the risks of investing is by conduct an investment portfolio [11], [12]. Essentially, establishment of an investment portfolio is by allocates capital in a few selected stocks, or often referred to diversify investments [13]. The purpose of the establishment of the investment portfolio is to get a certain return with minimum risk levels, or to get maximum returns with limited risk [14]. To achieve these objectives, the investor is deemed necessary to conduct analysis of optimal portfolio selection. Analysis of portfolio selection can be done with optimum investment portfolio optimization techniques [15].
Some research are done related to portfolio optimization which formed mean-variance, some are explained follow. Soeryana et al (2018) [16] discuss about return prediction of sharia stock market of some company in Indonesia. ARMAX-GARCH method will be used, where variable X in ARMAX is an indicator of market sentiment. Qur’anitasari, et al (2019) [17], done the research about analysis of performance of portfolio stock LQ45 using Sharpe, Treynor and Jensen. Delong and Gerrard (2007) [18], investigate about portfolio Mean-Variance selection for some non-life insurance company by one of the stochastic technique, that is control theory.

Soeryana et al. (2018) [16] investigate about mean-variance portfolio optimization using mean-variance using model ARMA-GARCH of some sharia stocks in Indonesia, with Lagrange Multiplier as method. In this paper optimization of mean-variance model will be analyzed, and the variance assumed to be constant. In this paper, stock price is affected by indicator of market sentiment. In this paper, so that the non-constant mean analyzed by Autoregressive Moving Average Exogen (ARMAX), while non-constant volatility analyzed by Generalized Autoregressive Conditional Heteroscedastic model (GARCH). As numerical illustration, some sharia stock are analyzed which is sold in stock market in Indonesia. The purpose of this research is to obtain the proportion of investment capital allocation in some sharia stocks, which can provide a maximum return with a certain level of risk.

2. Mathematical Models

In this section, some model will be discussed which are used for calculation of modeling, includes sharia stock market, Return, ARMA model, ARMAX model and GARCH model.

2.1 Sharia Stock return

Suppose that $P_t$ is sharia stock price at time $t$, and $r_t$ Sharia stock return at time $t$. The value of $r_t$ can be calculated by the following equation.

$$r_t = \ln \left( \frac{P_t}{P_{t-1}} \right),$$

where $t = 1, ..., T$ with $T$ the number of stock price data observed [19], [8].

2.2 Indicator Market Sentiment

The changes of stock prices usually affected by market sentiment. Therefore, investor should have a knowledge to recognize the existence of market sentiment. In this paper, an indicator is proposed to detect an affection of the market sentiment which defined as follows,

$$I = \begin{cases} +1; & P_t > \mu + K\sigma \\ 0; & \mu - K\sigma < P_t < \mu + K\sigma \\ -1; & P_t < \mu - K\sigma \end{cases}$$

(2)

This indicator of market sentiment of (2) then will be used as exogen variable in ARMA process into ARMAX. Where $\mu$ is mean, $\sigma$ is standard deviation and $K$ positive constant. Value +1 identified that there is influence a positive sentiment, 0 identified that there is no influence, and -1 identified there is a negative sentiment.

2.3 ARMA Model

Autoregressive moving average model (ARMA) is the combination of AR and MA model. The autoregressive moving average model with order $p$ and $q$ written as ARMA $(p, q)$, with the following equation

$$r_t = \phi_1 r_{t-1} + \ldots + \phi_p r_{t-p} + \alpha_t + \theta_1 \alpha_{t-1} + \ldots + \theta_q \alpha_{t-q}$$

(3)
where the residual \( \{ a_t \} \) are normal distributed and white noise with mean 0 and variance \( \sigma^2 \), while \( p \) and \( q \) are non-negative integer number. Sequence of \( \{ r_t \} \) is an ARMA \( (p, q) \) model with mean \( \mu_t \), if \( \{ r_t - \mu_t \} \) is ARMA \( (p, q) \) model. (Gujarati, 2004 [20]; Shewhart et al., 2004 [21]).

Procedure of modeling mean are include: model identification, estimation ARMA model, diagnostic test and prediction [19].

### 2.4 ARMAX Model

One of the time series model which extended from ARMA time series model is ARMAX model, that is, ARMA model with exogen variable. In this model, some factors which affect the dependent variable \( r \) in \( t \)-th time not only by variable \( X \) in time \( t \) but also another independent variable in \( t \)-th time. Generally, ARMAX \( (p, q) \) model has the following form,

\[
    r_t = \phi_1 r_{t-1} + \ldots + \phi_p r_{t-p} + \alpha_t + \theta_1 a_{t-1} + \ldots + \theta_q a_{t-q} + \delta_1 X_{it} + \ldots + \delta_s X_{it} \quad \text{(4)}
\]

Where \( r_t \) Sariah stock return in time \( t \), \( \phi_p \) is a \( p \)-th parameter of autoregressive, \( \alpha_t \) residual value at \( t \), \( \theta_q \) is a \( q \)-th parameter of moving average, \( \delta_i \) the \( i \)-th parameter of exogen, \( X_{it} \) the \( i \)-th variabel exogen in time \( t \).

In this model \( r_t \) and \( X_{it} \), \( i = 1, 2, \ldots, k \) are time series data which assumed to be stationer. While if \( \{ r_t \} \) not statoner (contain trend) and \( \{ X_{it} \} \), \( i = 1, 2, \ldots, k \) stationer, ARMAX model can be used by adding component of integrated difference model into \( r_t \). While if \( r_t \) stationer but \( \{ X_{it} \} \), \( i = 1, 2, \ldots, k \) not stationer, the model can be used directly. But if \( r_t \) and \( \{ X_{it} \} \), \( i = 1, 2, \ldots, k \) both are not stationer but integrated, the correction model can be used. While if \( r_t \) and \( \{ X_{it} \} \), \( i = 1, 2, \ldots, k \) both are not integrated, we can do modeling respect to deferens of \( r_t \) or \( \{ X_{it} \} \), \( i = 1, 2, \ldots, k \). Procedures on modeling ARMAX generally similar with ARMA, but in the estimation model, the component of another independent variables are added into the model.

### 2.5 GARCH Model

Volatility models in time series data in general can be analyzed using GARCH models. Suppose \( \{ r_{it} \} \) is Sharia stock returns \( i \) at time \( t \) is stationary, the residuals of the mean model for Sharia stock \( i \) at time \( t \) is \( a_{it} = r_{it} - \mu_{it} \). Residual sequence \( \{ a_{it} \} \) follow the model GARCH \( (g, s) \) when for each has the following equation:

\[
    a_{it} = \sigma_{it} \varepsilon_{it} \quad , \quad \sigma_{it}^2 = \alpha_{i0} + \sum_{k=1}^{g} \alpha_{ik} a_{it-k}^2 + \sum_{j=1}^{s} \beta_{ij} \sigma_{it-j}^2 + \varepsilon_{it} \quad , \quad \text{(5)}
\]

with \( \{ \varepsilon_{it} \} \) is a sequence of residual volatility models, namely the sequence of random variables are independent and identically distributed (IID) with mean 0 and variance 1. Parameter coefficients satisfy the property that \( \alpha_{i0} > 0 \), \( \alpha_{ik} \geq 0 \), \( \beta_{ij} \geq 0 \), and

\[
    \sum_{k=1}^{\max(g,s)} \alpha_{ik} + \beta_{ij} < 1 .
\]

Volatility modeling process steps include: (i) The estimated mean model, (ii) Test of ARCH effects, (iii) Identification of the model, (iv) The estimated volatility models, (v) Test of diagnosis, and (vi) Prediction [19].
2.6 Portfolio Optimization Model

Suppose $r_i t$ Sharia stock return $i$ at time $t$, where $i = 1, \ldots, N$ with $N$ the number of stocks that were analyzed, and $t = 1, \ldots, T$ with $T$ the number of Sharia stock price data observed. Suppose also $w' = (w_1, \ldots, w_N)$ weight vector, $r' = (r_1 t, \ldots, r_N t)$ vector stock returns, and $e' = (1, \ldots, 1)$ unit vector. Portfolio return can be expressed as $r_p = w' r$ with $w' e = 1$ (Panjer et al., 1998) [13]. Suppose $\mu' = (\mu_1 t, \ldots, \mu_N t)$, expectations of portfolio $\mu_p$ can be expressed as:

$$\mu_p = E[r_p] = w' \mu.$$  

(6)

Suppose given covariance matrix $\Sigma = (\sigma_{ij})_{i,j=1,\ldots,N}$, where $\sigma_{ij} = \text{Cov}(r_i t, r_j t)$. Variance of the portfolio return can be expressed as follows:

$$\sigma_p^2 = w' \Sigma w.$$  

(7)

**Definition 1.** (Panjer et al., 1998) [13]

A portfolio $p$ called (Mean-variance) efficient if there is no portfolio $p$ with $\mu_p \geq \mu_p^*$ and $\sigma_p^2 < \sigma_p^*$.  

To get efficient portfolio, typically using an objective function to maximize

$$2 \tau \mu_p - \sigma_p^2, \tau \geq 0$$

where the parameters of the investor's risk tolerance. Means, for investors with risk tolerance $\tau (\tau \geq 0)$ need to resolve the problem of portfolio

$$\text{Maximize } \{2 \tau w' \mu - w' \Sigma w \}$$  

(8)

with the condition $w' e = 1$.

Please note that the completion of (9), for all $\tau \in [0, \infty)$ form a complete set of efficient portfolios. Set of all points in the diagram-($\mu_p, \sigma_p^2$) related to efficient portfolio so-called surface efficient (efficient frontier).

Equation (9) is the optimization problem of quadratic convex [13]. Lagrange multiplier function of the portfolio optimization problem is given by

$$L(w, \lambda) = 2 \tau w' \mu - w' \Sigma w + \lambda (w' e - 1).$$  

(9)

Based on the Kuhn-Tucker theorem, the optimality condition of equation (10) is $\frac{\partial L}{\partial w} = 0$ and $\frac{\partial L}{\partial \lambda} = 0$. Completed two conditions of optimality mentioned equation, the equation would be the optimal portfolio weights as follows:

$$w^* = \frac{1}{e' \Sigma^{-1} e} \Sigma^{-1} e + \tau \{\Sigma^{-1} \mu - \frac{e' \Sigma^{-1} \mu}{e' \Sigma^{-1} e} \Sigma^{-1} e\}.$$  

(10)

Furthermore, with substituting $w^*$ into equation (6) and (7), respectively obtained the values of the expectation and variance of the portfolio. As a numerical illustration, will be analyzed some Sharia stocks as the following.

3. Result and Discussion

In this section will discuss the application of the method and the results of the analysis stage of the observation that includes sharia stocks data, the calculation of sharia
stock returns, ARMA model, ARMAX model, GARCH model, and prediction of the mean and variance values, the process of optimization.

3.1 Data Analysis

The data used in this study is secondary data, in the form of time series data (time series) of some of the daily sharia stock price, which includes sharia stocks: TLKM, LPKR, ITMG, and AKRA. Sharia stock price data, the data used is the closing Sharia stock price, starting from January 1, 2014 until June 30, 2019 were downloaded from www.finance.yahoo.com. Stock prices data will then be processed by using statistical software of Eviews-6 and Maple.

3.2 Sharia Stock Return

Sharia stock returns of four firms in this study was calculated using (1). Figure-1 indicates the four analyzed Sharia stock chart returns

Based on unit root test with ADF test method of TLKM, LPKR, ITMG, and AKRA return, it is obtain, respectively $t_{stat} = -28.41472, -33.24196, -30.21782, -34.28439$ which wholly have $Prob = 0.0000$. If the level of significance are specified to be $\alpha = 0.05$, and $t_{table} = -3.413121$ is known, it is clear that $Prob < \alpha$, It is clear that the value of the statistic test for all ADF of analyzed sharia stocks are located in the rejection region, or said to be stationer.

3.4 ARMAX Model Estimation

ARMAX model is the model with additional exogen variable into ARMA($p, q$) model, that is the market sentiment refer to equation (2). Constanta $K$ which is used for return data TLKM, LPKR, ITMG, and AKRA for market sentiment $I$ in (2) respectively are 1 and 0.5.

First Identification and estimation are done by see the mean model through ACF and PACF sample. By looking the ACF and PACF, then the prediction of the best model for return TLKM, LPKR, ITMG, and AKRA are ARMAX(2,3), ARMAX(1,0), ARMA(1,0) and ARMA(1,0). Both of the significance test for parameter as well as the model identified that the mean model for sharia stocks are significant. Third, the diagnostic test for these models are done used residual corellogram and Ljung-Box hypothesis test. The results shown that residuals are white-noise. The formula of mean model for four sharia stock are given in the following section.

3.5 GARCH Model Estimation

First, carried out the detection elements of autoregressive conditional heteroscedasticity (ARCH) to the residual $a_t$, using the ARCH-LM test statistic. Statistical value of the results obtained $\chi^2$ (obs*R-Square) each of sharia stock returns TLKM, LPKR, ITMG, and AKRA respectively are: 146.7170, 37.81395, 40.55526, and 45.34655 with probability of each are 0.0000 or smaller, which means that there are elements of ARCH.
Second, the identification and estimation of volatility models. This study used models of generalized autoregressive conditional heteroscedasticity (GARCH) which refers to equation (6). Based on squared residuals correlogram $a_t^2$, the ACF and PACF graphs of each, selected models of volatility that might be tentative. Volatility model estimation each of sharia stock return performed simultaneously (synchronously) with mean models. After going through tests of significance for parameters and significance tests for models, all equations written below have been significant. The result, obtained the best model are respectively:

- Sharia stock TLKM follow the model ARMAX(2,3)-GARCH(1,0) with formula:
  \[ r_t = 0.002949x - 0.116872r_{t-2} - 0.065967a_{t-3} + a_t \]
  \[ \sigma_t^2 = 0.000315 + 0.325750a_{t-1}^2 + \epsilon_t \]

- Sharia stock LPKR follow the model ARMAX(1,0)-GARCH(1,0) with formula:
  \[ r_t = 0.002752x + 0.066909r_{t-1} + a_t \]
  \[ \sigma_t^2 = 0.000441 + 0.135753a_{t-1}^2 + \epsilon_t \]

- Sharia stock ITMG follow the model ARMA(1,0)-GARCH(1,1) with formula:
  \[ r_t = 0.132914r_{t-1} + a_t \]
  \[ \sigma_t^2 = 2 \times 10^{-5} + 0.065166a_{t-1}^2 + 0.924703\sigma_{t-1}^2 + \epsilon_t \]

- Sharia stock AKRA follow the model ARMA(1,0)-GARCH(1,1) with formula:
  \[ r_t = 0.087493a_{t-1} + a_t \]
  \[ \sigma_t^2 = 1.31 \times 10^{-5} + 0.039025a_{t-1}^2 + 0.943024\sigma_{t-1}^2 + \epsilon_t \]

Based on the ARCH-LM test statistics, the residuals of the models for Sharia stock TLKM, LPKR, ITMG, and AKRA there is no element of ARCH, and also has white noise. Mean and volatility models are then used to calculate the values $\hat{\mu}_t = \hat{r}_t(l)$ and $\hat{\sigma}_t^2 = \sigma_l^2(l)$ recursively.

### 3.6 Prediction of Mean and Variance

Estimation of Mean-Variance Model of four sharia stock which have been given then will be used to show the one step ahead value of mean –variance prediction. The prediction value are given in following Table 1.

**Table 1.** Predictive Values of Mean and Variance One Period Ahead For Each Sharia Stocks

<table>
<thead>
<tr>
<th>Sharia Stocks</th>
<th>Model of Mean-Volatility</th>
<th>Mean ($\hat{\mu}_t$)</th>
<th>Variance ($\hat{\sigma}_t^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLKM</td>
<td>ARMAX(2,3)-GARCH(1,0)</td>
<td>0.0346101</td>
<td>0.00315032</td>
</tr>
<tr>
<td>LPKR</td>
<td>ARMAX(1,0)-GARCH(1,0)</td>
<td>0.0650742</td>
<td>0.00466013</td>
</tr>
<tr>
<td>ITMG</td>
<td>ARMA(1,0)-GARCH(1,1)</td>
<td>0.0289532</td>
<td>0.00122352</td>
</tr>
<tr>
<td>AKRA</td>
<td>ARMA(1,0)-GARCH(1,1)</td>
<td>0.0736614</td>
<td>0.00531278</td>
</tr>
</tbody>
</table>

### 3.7 Portfolio Optimization and Analysis Process

In this section, the portfolio optimization are done referring to equation (9), where the data which is used are shown in Table 1. By using values of mean in Table 2, column $\hat{\mu}_t$, used to form the mean vector $\mathbf{\hat{\mu}} = (0.0346101 \ 0.0650742 \ 0.0289532 \ 0.0736614)$, with amount of the Sharia stock that were analyzed were $\mathbf{e}^T = (1 \ 1 \ 1 \ 1)$.

Furthermore, by using the values of variance in Table 2, column $\hat{\sigma}_t^2$, and together with the values of the covariance between Sharia stocks, those are used to form the covariance matrix $\Sigma$ and the inverse matrix $\Sigma^{-1}$ as follows.
And
\[
\Sigma^{-1} = \begin{pmatrix}
322.0723 & -11.1095 & -49.3434 & -7.9689 \\
-11.0643 & 224.1869 & -86.3134 & -1.8851 \\
-49.3469 & -86.5954 & 873.5511 & -49.6143 \\
-8.0222 & -0.8115 & -50.0300 & 191.6482
\end{pmatrix}
\]

Optimization done in order to determine the composition of the portfolio weights, and thus the portfolio weight vector is determined by using equation (10). The weight vector calculation process, the values of risk tolerance \( \tau \) determined by the simulation begins value \( \tau = 0.000 \) with an increase of 0.005. If it is assumed that short sales are not allowed, then the simulation is stopped when it has resulted at least there is one negative value in a portfolio weight. The results of portfolio weights calculation are given in Table-2.

<table>
<thead>
<tr>
<th>( \tau )</th>
<th>TLKM</th>
<th>LPKR</th>
<th>IMTG</th>
<th>AKRA</th>
<th>( w^T \sigma )</th>
<th>Mean</th>
<th>Variance</th>
<th>( \mu_p - \sigma_p^2 )</th>
<th>( \mu_p / \sigma_p^2 )</th>
<th>Maximum</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.000</td>
<td>0.2115</td>
<td>0.1042</td>
<td>0.5736</td>
<td>0.1107</td>
<td>1</td>
<td>0.0388617</td>
<td>0.00083</td>
<td>0.038</td>
<td>46.61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.005</td>
<td>0.2042</td>
<td>0.1377</td>
<td>0.5114</td>
<td>0.1466</td>
<td>1</td>
<td>0.0416377</td>
<td>0.00085</td>
<td>0.041</td>
<td>49.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.010</td>
<td>0.1970</td>
<td>0.1713</td>
<td>0.4492</td>
<td>0.1825</td>
<td>1</td>
<td>0.0444137</td>
<td>0.00089</td>
<td>0.044</td>
<td>49.94</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.015</td>
<td>0.1898</td>
<td>0.2049</td>
<td>0.3870</td>
<td>0.2184</td>
<td>1</td>
<td>0.0471897</td>
<td>0.00096</td>
<td>0.046</td>
<td>49.22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.020</td>
<td>0.1825</td>
<td>0.2384</td>
<td>0.3248</td>
<td>0.2543</td>
<td>1</td>
<td>0.0499657</td>
<td>0.00106</td>
<td>0.049</td>
<td>47.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.025</td>
<td>0.1753</td>
<td>0.2720</td>
<td>0.2626</td>
<td>0.2902</td>
<td>1</td>
<td>0.0527417</td>
<td>0.00118</td>
<td>0.052</td>
<td>44.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.030</td>
<td>0.1680</td>
<td>0.3056</td>
<td>0.2004</td>
<td>0.3260</td>
<td>1</td>
<td>0.0555177</td>
<td>0.00133</td>
<td>0.054</td>
<td>41.63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.035</td>
<td>0.1608</td>
<td>0.3391</td>
<td>0.1382</td>
<td>0.3619</td>
<td>1</td>
<td>0.0582937</td>
<td>0.00151</td>
<td>0.057</td>
<td>38.51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.040</td>
<td>0.1535</td>
<td>0.3727</td>
<td>0.0760</td>
<td>0.3978</td>
<td>1</td>
<td>0.0610697</td>
<td>0.00172</td>
<td>0.059</td>
<td>35.46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.045</td>
<td>0.1463</td>
<td>0.4063</td>
<td>0.0137</td>
<td>0.4337</td>
<td>1</td>
<td>0.0638457</td>
<td>0.00196</td>
<td>0.062</td>
<td>32.61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.046</td>
<td>0.1448</td>
<td>0.4130</td>
<td>0.0013</td>
<td>0.4409</td>
<td>1</td>
<td>0.0644009</td>
<td>0.00201</td>
<td>0.062</td>
<td>32.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.047</td>
<td>0.1434</td>
<td>0.4197</td>
<td>-0.0111</td>
<td>0.4481</td>
<td>1</td>
<td>0.0649561</td>
<td>0.00206</td>
<td>0.063</td>
<td>31.53</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The weight composition of the maximum portfolio is 0.1970, 0.1713, 0.4492 and 0.1825. This gives a reference to investors who invest in TLKM, LPKR, IMTG and AKRA sharia stocks, to achieve the maximum portfolio value the composition of portfolio weights is as mentioned above. Likewise, for optimal portfolio, it can be seen from the large ratio of analysis results. From the analysis based on Table 2, it can be seen that the composition of optimal portfolio weights 0.1970, 0.1713, 0.4492 and 0.1825 also occurs when the portfolio ratio is 49.94 is the largest. The ratio provides an understanding that the composition provides a greater mean value relative to the level of risk that must be faced. This gives a reference to investors when investing in TLKM, LPKR, IMTG and AKRA Sharia stocks to get optimal results, when the risk tolerance level is 0.010.
4. Conclusion

In this paper the Mean-Variance portfolio optimization on some sharia stocks are analyzed by using non constant mean and volatility models approaches, where the Sharia stocks are traded in the Sharia capital market in Indonesia. The analysis showed that some of Sharia stocks which analyzed are follow the ARMAX-GARCH models. Whereas, Based on the numerical results of portfolio optimization, the optimum is achieved when the composition of the portfolio investment weights in sharia stocks of TLKM, LPKR, ITMG and AKRA, respectively are: 0.1970, 0.1713, 0.4492 and 0.1825. The composition of the portfolio weights thereby will produces a portfolio with mean value of 0.0644009 and the value of risk, measured as the variance of 0.00201.

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