EFFICIENT FRONTIER ANALYSIS FOR PORTFOLIO INVESTMENT IN MALAYSIA STOCK MARKET

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ABSTRACT: *Modern portfolio theory is a theory of finance that attempts to maximize portfolio expected return for a given amount of risk, or minimize the risk for a given level of expected return. The objective of this study is to develop efficient frontier for portfolio investment consists of two stocks form Kuala Lumpur Stock Exchange (KLSE). Daily share price is collected from Thomson Reuters DataStream. The methodology implemented in this study is statistical normality diagnostics checking, correlation analysis of two stock and mathematical modeling for Markowitz theory to achieve a global minimum of investment risk. The result shows expected portfolio return is 0.54 percentages at global minimum portfolio risk, 2.34 percentages. The findings of this study will help investors to select optimum investment weightage that minimize portfolio risk for a given amount of expected return.*

Keywords: Investment, Markowitz theory, Efficient frontier, Portfolio risk, Portfolio return.

1. INTRODUCTION

Investment is the complex process involving decision making regarding the possible expected rate of return. Investment analysis comprises several key analytical techniques, namely the discounted cash flow model, portfolio theory and risk analysis that are essentially structured frameworks, which enable a more precise and certain evaluation of an investment [1]. Therefore, investment analysis is very important in order to increase a return and reduce a risk.

Diversification of investment is one of the techniques to maximize a return. Investors can reduce risk even more substantially if they hold an internationally diversified fund as globally diversified portfolios would dominate domestic-only ones on the efficient frontier [2]. Therefore, the diversity of investment is looking like one of the methods that investors can implement in order to maximize the expected rate of return.

One of the most famous theories that explained the diversification of investment is portfolio theory. This theory was introduced by Harry Markowitz in 1952. This theory explained how investors can maximize the expected rate of return and minimize the risk by diversifying their investment. Therefore, investors should choose a good combination of the portfolio in order to maximize the expected rate of return. This theory implies that the investors place all his funds in the security with the greatest discounted value [3].

In recent year, investing in the portfolio investment is looking like one of the opportunities to increase the expected rate of return. Investors are looking at the portfolio investment that can generate a high return. Moreover, the current economic condition such as oil and gas crisis [4], crypto currency investment booms [5] also give a significant impact on the performance of the stock market over the world. These situations give opportunities to investors to invest in many portfolio investments. Therefore, investors will be faced with the high probability either to get a high return or high risk. This is because investment in the crypto currency is involved with the high risk and high speculation. Therefore, investors must have good information regarding portfolio investment.

Thus, this paper investigated the performance of portfolio selection using Modern Portfolio Theory (Markowitz Theory) in order to analyze an expected rate of return that investors want to earn. In Modern Portfolio Theory, stock portfolio model is optimized by minimizing the risk of the portfolio as measured by the variance of stock prices; subject to a given portfolio return [6].

2. LITERATURE REVIEW

Portfolio theory is the theory based on the principle of maximizes the expected rate of return and minimize the risk. Investors are looking at the investment that can generate a high return. Many researchers have examined the performance of portfolio investment [7-11]. Study regarding the benefits of further diversifying a global portfolio of financial assets with New Zealand farm real estate and found that the risk reduction benefits of diversifying with farm real estate are larger than the risk enhancement benefits [12].

Diversification is one of an alternative that investors can choose to increase the expected rate of return. A study that focus on diversification concluded that investors seeking diversification have two alternatives: creating a random portfolio by investing directly in the market or investing in an index fund [13]. Venture capitalists that diversify across portfolio company stage of development have greater success in bringing companies public and exiting their investments via acquisition [14]. However, industry specialization has no significant impact on venture fund success rates.

Besides the study focus on portfolio investment in real estate, a study regarding the conditionally expected return on size-based portfolios in an emerging market found that the conditional expected returns of large-cap stocks should be priced by global variables. Mid- and small-cap stocks are influenced by domestic variables rather than global variables, and the returns are priced by local residual risks. Investors realize that investing in the stock market will provide good returns and provide a major contribution for economic development in Malaysia [15].

Study on the performance of Malaysian portfolio investment found that the mean returns of the local funds appear to exceed those of the international funds. Nevertheless, when the returns are risk-adjusted using the Sharpe measure, the internationally diversified funds performed equally well as the domestic funds [16]. Companies with large portfolio

holdings can influence the stock prices of property companies with smaller portfolio holdings [17].

3. RESEARCH METHODOLOGY

The objective of this study is to develop portfolio investment with global minimum investment risk. This study implemented a diversification method that proposed by Markowitz that known as Markowitz portfolio theory [18].

3.1. Data calculation for the return of share price

This study collected daily share price from Thomson Reuters Datastream. Then, this study calculated the average monthly price. Next, this study calculated the return for share price using Equation (1).

$$\mathrm{Re}_{i,n} = \left(\frac{SP_{n+1} - SP_n}{SP_n} \right) \times 100\% \quad \text{..... (1)}$$

where,

$\mathrm{Re}_{i,n}$ = return for stock *i* at period *n*,

SP_n = monthly share price for stock *i* at period *n*,

SP_{n+1} = monthly share price for stock *i* at period *n+1*.

3.2. Mathematical derivation for statistical data normality test

This study evaluates the normality of data distribution using numerical statistical test. This section describes the mathematical derivation for the normality test that developed by Shapiro-Wilk [19].

The Sapiro-Wilk normality test states the null hypothesis that a sample $\left(x_1, x_2, x_3, ..., x_n\right)$ come from a normally distributed population. Then, the Shapiro-Wilk normality test represented by Equation (2).

$$W = \frac{\left(\sum_{i=1}^{n} a_i x_{(i)} \right)^2}{\sum_{i=1}^{n} \left(x_i - \bar{x} \right)^2} \quad \text{.....(2)}$$

where,

$x_{(i)}$ is the *i*th order statistic; $x_{(1)}$ is the smallest number in the sample,

$\bar{x} = \frac{\left(x_1 + x_2 + x_3 + ... + x_n \right)}{n}$ is the sample mean,

a_i is constant derived by Equation (3):

$$\left(a_1, a_2, a_3, ..., a_n\right) = \frac{m^T V^{-1}}{\left(m^T V^{-1} V^{-1} m \right)^{0.5}} \quad \text{.....(3)}$$

where,

$$m = \left(m_1, m_2, m_3, ..., m_n\right)^T \quad \text{.....(4)}$$

In Equation (4), $m_1, m_2, m_3, ..., m_n$ are the expected value of the order statistics of independent and identically distributed random variables sampled from the standard normal distribution. Then, V is covariance matrix of order statistics.

3.3. Mathematical derivation for Pearson correlation analysis

The correlation between two variables or stocks is validated using Pearson correlation analysis. The type of data in Pearson correlation analysis should be interval or ratio.

Pearson correlation coefficient between the two variables (stocks) is defined as the covariance of the two variables divided by the product of their standard deviations [20]. Pearson correlation coefficient is represented as ρ in Equation (5) for the population.

$$\rho_{X,Y} = \frac{\mathrm{cov}\left(X, Y\right)}{\sigma_X \sigma_Y} = \frac{E\left[\left(X - \mu_X\right)\left(Y - \mu_Y\right)\right]}{\sigma_X \sigma_Y} \quad \text{.....(5)}$$

where

cov is covariance,

σ_X is standard deviation of X,

σ_Y is standard deviation of Y,

μ_X is mean of X, μ_Y is mean of Y,

The sample of Pearson correlation coefficient is represented as r in Equation (6).

$$r_{XY} = \frac{\sum_{i=1}^{n} \left(X_i - \bar{X} \right)\left(Y_i - \bar{Y} \right)}{\sqrt{\sum_{i=1}^{n} \left(X_i - \bar{X} \right)^2} \sqrt{\sum_{i=1}^{n} \left(Y_i - \bar{Y} \right)^2}} \quad \text{.....(6)}$$

3.3. Mathematical modeling for Modern Portfolio Theory (Markowitz Portfolio Theory)

Modern portfolio theory is a theory of finance that attempts to maximize portfolio expected return for a given amount of risk or minimize risk for a given level of expected return [21].

The Markowitz portfolio theory is based on two assumptions:

(a)Investors are risk-averse and thus have a preference for expected return and dislike for risk.

The expected return for a portfolio consisting of two stock is represented by Equation (7).

$$E\left(r_P\right) = w_A E\left(r_A\right) + w_B E\left(r_B\right) \quad \text{.....(7)}$$

where

$E\left(r_P\right)$ is expected return for portfolio,

$E\left(r_A\right)$ is expected return for stock A,

$E\left(r_B\right)$ is expected return for stock B,

w_A is stock A weigthage, and w_B is stock B weigthage.

The variance of the rate of return for two type of stocks in a portfolio is described in Equation (8).

$$\sigma_P^2 = \left(w_A \sigma_A\right)^2 + \left(w_B \sigma_B\right)^2 + 2\left(w_A \sigma_A\right)\left(w_B \sigma_B\right)\rho_{AB} \quad \text{.(8)}$$

where,

σ_A is sock A standard deviation, σ_B is sock B standard deviation, and ρ_{AB} is correlation coefficient between stock A and B.

4. RESULTS AND DISCUSSION

The objective of this study is to determine the optimum weightage of investment in achieving a higher return with minimizing the investment risk. The investment risk is minimizing using a combination of stocks in Markowitz theory. Therefore, this study performed statistical diagnostics for stock selection to find mean, standard deviation and correlation. These three parameters implemented in Markowitz equation to find weightage that can reduce portfolio risk in efficient frontier method.

4.1. Data Selection

This study selected two shares for developing a portfolio analysis. The selected companies are Astro Malaysia Holdings Berhad and Nestle Malaysia Berhad. Both of these companies listed in the main market of Kuala Lumpur Stock Exchange (KLSE), Malaysia.

The data of share price for this study are collected daily from Thomson Reuters Datastream. Then, this study calculated the average of share price for monthly. The observation is involved 45 months starting from August 2014 until April 2018.

Figure 1 shows the dynamic behavior of the share price for Astro Malaysia Holdings Berhad. The value of share price in the first observation (August 2014) is MYR 3.307. Meanwhile, the value of share price in the 45th observation (April 2018) is MYR 1.195. There is decrement of 42 percentages in the share price.

Figure 2 shows the share price behavior of Nestle Malaysia Berhad. The value of share price for the first observation is MYR 67.821. Next, the value of the share price in 45th observation is MYR 174.086. The result shows there is an increment of 116.9 percentages.

4.2. Statistical normality analysis for share price return of Astro Malaysia Holdings Berhad

Next, this study calculated the return of share price for Astro Malaysia Holdings Berhad. Then, the statistical normality test performed to evaluate the characteristics of data distribution in detecting the normal distribution of data and outliers.

Figure 3 shows the data distribution of return for the share price of Astro Malaysia Holdings Berhad. Mean of the data distribution is -1.13 percentages. The standard deviation of the data distribution is 4.47 percentages. Figure 3 shows there are two data points that deviate largely from the x-axis.

Next, the normality of data distribution is validated using graphical and numerical statistical method. Figure 4 shows the histogram for data distribution of share price return for Astro Malaysia Holding Berhad. Then, Figure 5 shows the normal probability plot for the return of share price for Astro Malaysia Berhad. Both of the figures show the data distribution is followed by normal distribution line.

The numerical test for normality data distribution was performed using the Shapiro-Wilk normality test. Table 1 shows the normality test for the return of share price for Astro Malaysia Holdings Berhad. The probability value is 0.140 that is larger than 0.05. The finding indicates that this study failed to reject the null hypothesis of normality test. Therefore, the data distribution of return is followed normal data distribution.

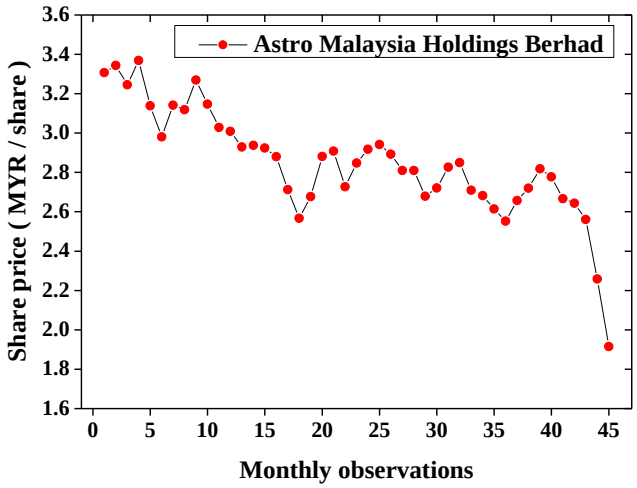

Figure 1: Share price behavior for Astro Malaysia Holdings Berhad

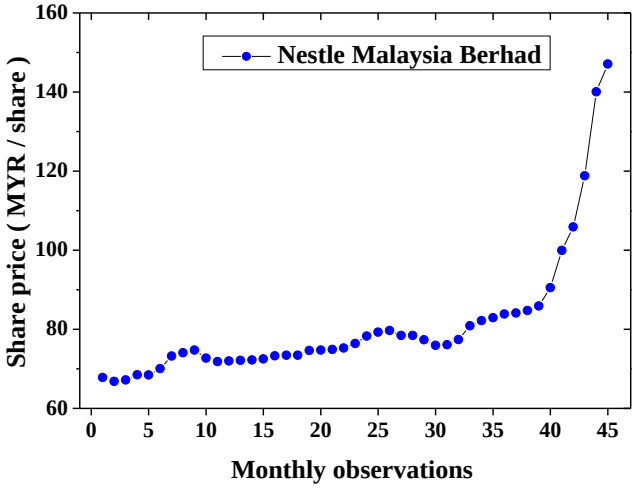

Figure 2: Share price behavior for Nestle Malaysia Berhad

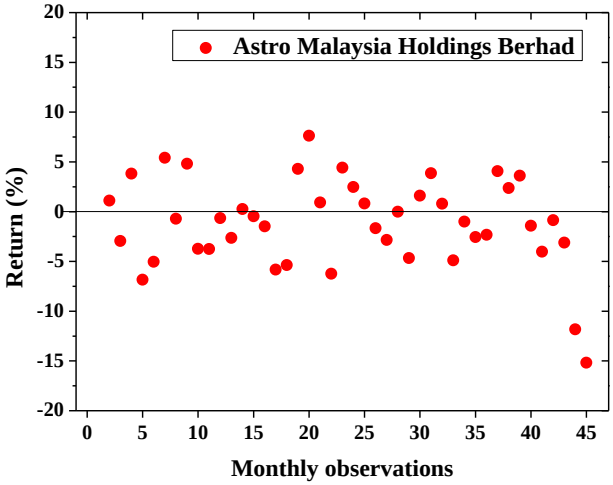

Figure 3: Data distribution of return for the share price of Astro Malaysia Holdings Berhad

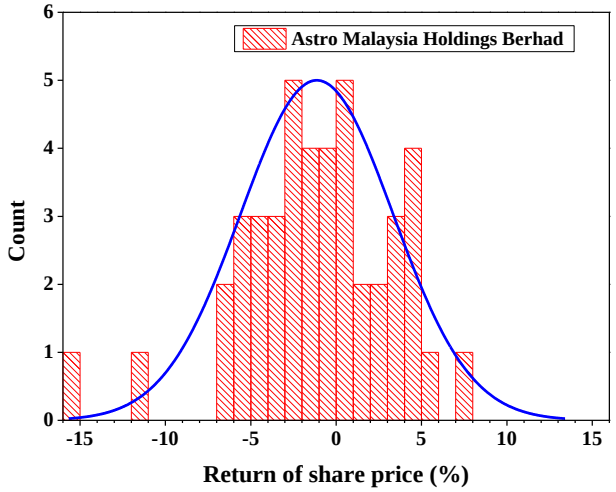

Figure 4: Data distribution of return for the share price of Astro Malaysia Holdings Berhad

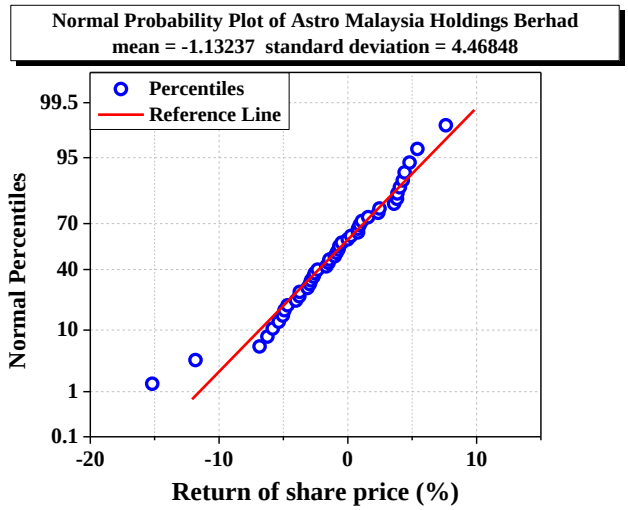

Figure 5: Normal probability plot of return for share price of Astro Malaysia Holdings Berhad

Table 1: Normality test for the return of share price for Astro Malaysia Holdings Berhad

Normality test	Shapiro Wilk test		
Parameter	Statistic	Degree of freedom	Probability value
Value	0.961	44	0.140

4.3. Statistical normality analysis for share price return of Nestle Malaysia Holdings Berhad

Next, this study calculated the return of share price for Nestle Malaysia Berhad. Then, the statistical normality test performed to evaluate the characteristics of data distribution in detecting the normal distribution of data and outliers.

Figure 6 shows the data distribution of return for the share price of Astro Malaysia Holdings Berhad. Mean of the data distribution is 1.84 percentages. The standard deviation of the data distribution is 3.78 percentages. Figure 3 shows there are three data points that deviated largely from the x-axis.

Next, the normality of data distribution is validated using graphical and numerical statistical method. Figure 7 shows the histogram for data distribution of share price return for Astro Malaysia Holding Berhad. The histogram shows there is 3 point of outliers exist in the data. Then, Figure 8 shows the normal probability plot for return of share price for Astro Malaysia Berhad. In this normal probability plot, there are data points that deviated largely from normal distribution line. Both of the figures show the data distribution is followed by normal distribution line.

The numerical test for normality data distribution was performed using the Shapiro-Wilk normality test. Table 2 shows the normality test for the return of share price for Nestle Malaysia Berhad. The probability value is 0.000 that is less than 0.05. The finding indicates that this study rejects the null hypothesis of normality test. Therefore, the data distribution of return deviates from normal data distribution. The distribution of data is non-normal distribution because of the existence of outliers.

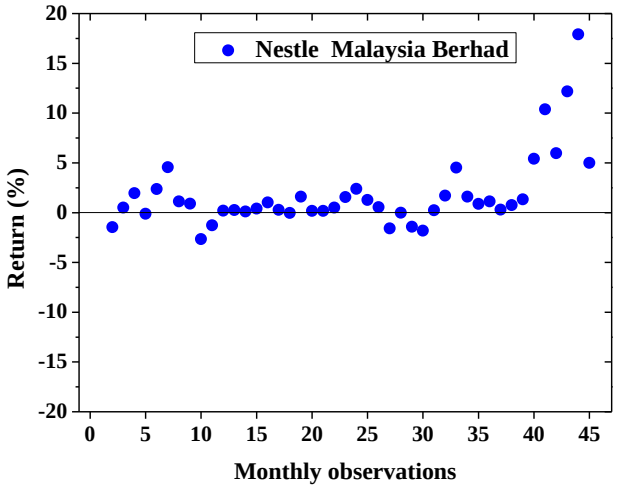

Figure 6: Data distribution of return for the share price of Astro Malaysia Holdings Berhad

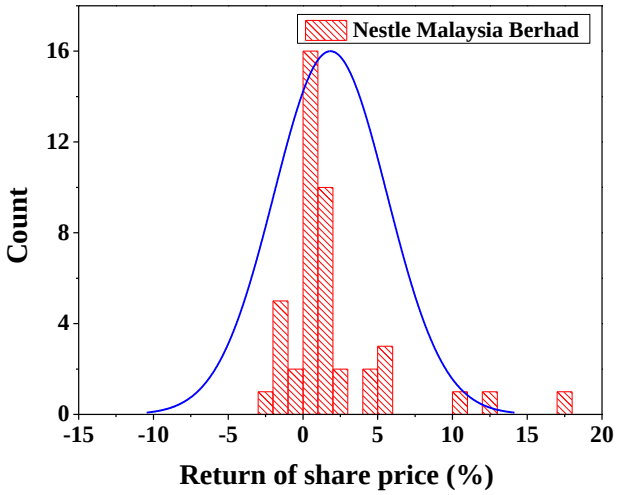

Figure 7: Data distribution of return for the share price of Astro Malaysia Holdings Berhad

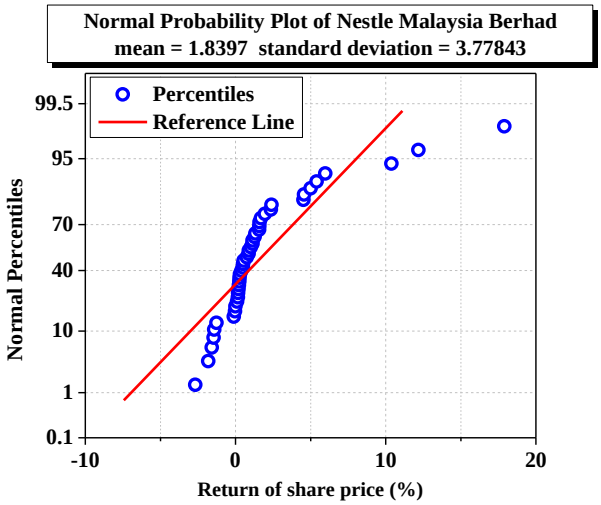

Figure 8: Normal probability plot of return for the share price of Nestle Malaysia Berhad

Table 1: Normality test for the return of share price for Nestle Malaysia Berhad

Normality test	Shapiro Wilk test		
Parameter	Statistic	Degree of freedom	Probability value
Value	0.715	44	0.000

4.3. Statistical correlation analysis for share price return between Astro Malaysia Holdings Berhad and Nestle Holdings Berhad

The correlation is performed using the graphical method and numerical statistical method to evaluate the association relationship between the rate of return for Astro and Nestle.

Figure 9 shows the scatter plot correlation of return of share price for Astro Malaysia Holdings Berhad and Nestle Malaysia Berhad. The x-axis represents is returned price for Astro Malaysia Holdings Berhad. The y-axis is the return price for Nestle Malaysia Berhad. The graphical test shows there is a pattern of an association relationship between these two variables.

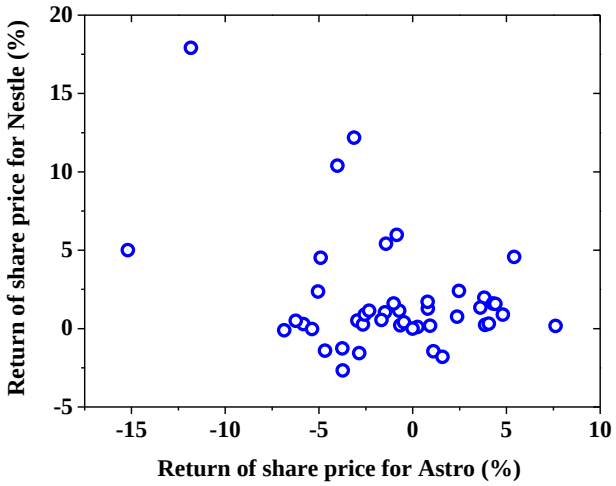

Figure 9: Scatter plot of return for share price for Astro Malaysia Holdings Berhad (x-axis) and Nestle Malaysia Berhad (y-axis)

Next, this study performed a statistical numerical test to evaluate the correlation level for the rate of return of share price between Astro Malaysia Holdings Berhad and Nestle Malaysia Berhad. The probability value is 0.023 which is smaller than 0.05. Therefore, this study rejected the null hypothesis. It is concluded that there is a significant correlation of share price return between Astro Malaysia Holdings Berhad and Nestle Malaysia Berhad.

In addition, the value of the Pearson correlation coefficient is -0.342. This value indicates there is a significantly weak negative correlation of share price return between Astro Malaysia Holdings Berhad and Nestle Malaysia Berhad...

Table 3: Statistical Correlation test of share price return for Astro Malaysia Holdings Berhad and Nestle Malaysia Berhad

Parameter	Value
Pearson correlation, ρ	- 0.342
Probability value	0.023
Number of data	44

4.4. Analysis of portfolio diversification theory to achieve low risk (Markowitz model).

The main objective of this study is to develop a combination of shares in portfolio investment that can reduce standard deviation (risk) of a particular investment. This section is combining shares of Astro Malaysia Holdings Berhad and Nestle Malaysia Berhad.

Figure 10 shows a scatter plot of portfolio return with corresponding to portfolio risk. The portfolio risk is considered as a standard deviation that derived from the portfolio investment. The first point of the calculation started with 100 percentage of weightage in Nestle stock and zero percentage in Astro stock. Then, this study reduced investment weightage in Nestle stock. In the same time, this study increased investment weightage in Astro stock. Finally, the investment weightage of Astro stock become 100 percentages. Meanwhile, Nestle stock is zero percentage.

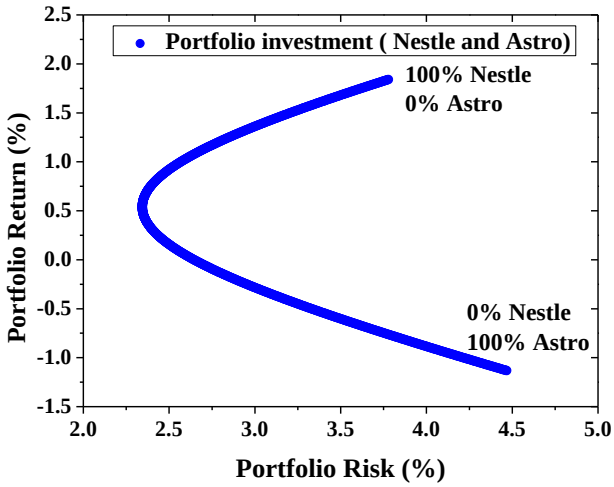

Figure 10: Scatter plot of portfolio return and portfolio risk

4.5. Development of efficient frontier for investment in the Markowitz model.

This study developed the calculation in Markowitz theory to find the efficient frontier of the investment for a combination of two stocks listed in Kuala Lumpur Stock Exchange. In the same, this study calculated the weightage that contributes the lowest portfolio risk that contributes high return.

Figure 11 shows an efficient frontier line for portfolio investment of two stocks namely Astro and Nestle. Each point on the line represents an optimal combination of securities that maximizes the return for any given level of risk (standard deviation).The global minimum portfolio risk is when the combination of investment is 56.2 percentages in Nestle and 43.8 percentages in Astro. The expected portfolio return is 0.54 percentages at global minimum portfolio risk.

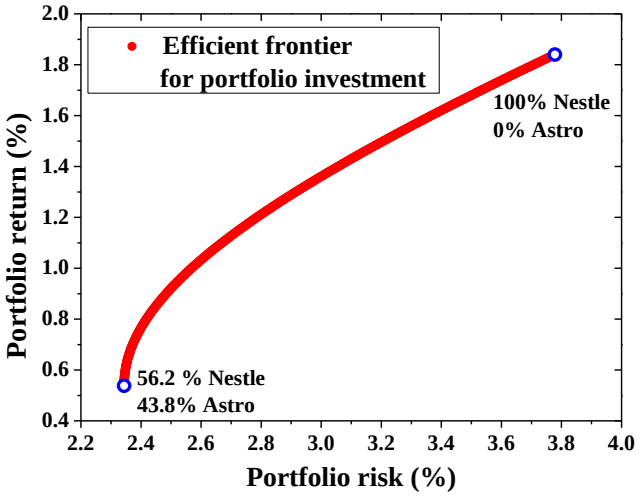

Figure 11: Efficient frontier line for portfolio investment of Astro Malaysia Holdings Berhad and Nestle Malaysia Berhad

5. CONCLUSIONS

The main objective of this study is to develop an efficient frontier line for investment portfolio consist of two stocks namely Astro Malaysia Holdings Berhad and Nestle Malaysia Berhad. Each point on the efficient frontier line represents an optimal combination of securities that maximizes the return for any given level of risk (standard deviation). The main finding of this study is:

(a) There is a significant correlation of share price return between Astro Malaysia Holdings Berhad and Nestle Malaysia Berhad. The value of the Pearson correlation is -0.342. This value indicates there is a significantly weak negative correlation.

(b) The global minimum portfolio risk is when the combination of investment is 56.2 percentages in Nestle and 43.8 percentages in Astro. The expected portfolio return is 0.54 percentages at global minimum portfolio risk.

The findings from this study will help investors to understand regarding portfolio selection in reducing their investment risk to prevent lost and at the same time retaining their expected rate of return.

Further research of this study can be extended to the implementation of the portfolio with more stocks to further reducing the investment risk.

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