Optimal Portfolio Using Single Index Model and Capital Asset Pricing Model (CAPM) in Covid-19 Pandemic Era

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Abstract

To reduce the level of investment risk, investors need to be verified through the formation of a portfolio by combining several assets to minimize risk. The purpose of this study is to determine the optimal portfolio formation through the Single Index model and the Capital Asset Pricing Model (CAPM) and to determine the performance comparison of the two models using the Sharpe Index, Jensen Index, and Treynor Index. The results of this study indicate that there are 21 stocks included in the optimal portfolio using the Single Index Model and 50 stocks included in the optimal portfolio using CAPM. The evaluation of portfolio formation with the Single Index Model are using the Sharpe, Jensen, and Treynor Indices has a positive value which indicates that portfolio formation is considered good and worthy of consideration by investors to invest in the optimal portfolios. CAPM portfolio evaluation with the Sharpe and Treynor Index has a positive value, while the Jensen Index shows a negative value.

Keywords
Optimal Portfolio, Single Index Model, CAPM, Sharpe Index, Jensen Index, Treynor Index.

1. Introduction

Optimal portfolio is one way that investors can use to minimize risk with a certain rate of return Before making an investment, investors need to pay attention to several things contained in the company's financial statements including the growth of the company's total assets, revenue growth, net income, EPS, stock price, rate of return, and level of risk. This qualification is used by Harian Bisnis Indonesia in the formation of 100 Excellent Growth Company Ranks for the 2018 and 2019 periods to the stocks listed on the Indonesia Stock Exchange (IDX) (marketbisnis.com, 2021).

The occurrence of the Covid-19 pandemic has made people realize how important are savings in emergency conditions such as the Covid-19 Pandemic situation. But on the other hand, the Covid-19 pandemic is an unexpected risk in investing because the Covid-19 pandemic has hit the whole world, including Indonesia, affecting the health sector and expanding to the economic, social, educational and other sectors. It was recorded that as of December 20, 2020, the

development of daily active cases of Covid-19 in Indonesia reached 103,239 with 19,880 victims. Under these conditions, there is a policy of limiting social interaction coupled with the closure of workplaces, supermarkets, schools, and restrictions on other activities that have an impact on the distribution and production of goods, as well as investment. This condition affected the performance of the Jakarta Composite Index (JCI) which decreased by 26.55% from January 2020 to March 2020 (marketbisnis.com, 2021). According to Chasanah et al., 2020, this affects investment decisions, so it is important for investors to form an optimal portfolio during the Covid-19 pandemic in order to provide an overview for investors regarding the choice of stocks that can be invested.

Dealing with optimal portfolio, there is a few methods that can be used to form it. First, we could use the Single Index Model (Oktaviani and Wijayanto, 2016; Arnaya and Purbawangsa, 2020; Mary and Rathika, 2015). This model has been widely used as a tool in analyzing optimal portfolios because this model allows it to provide optimal returns. Another method that can be used is the Capital Asset Pricing Model (CAPM) method (Al-Afeef, 2017; Hidayati et al. 2014; Wijaya and Ferrari, 2020). The CAPM describes the relationship between risk and return on assets, and was created in parallel by WF Sharpe, J. Lintner and J. Mossin from 1964 to 1966. All of them were inspired by the model developed by H. Markowitz and J. Tobin in the early 1950s (Gavlakova and Gregova, 2013). This model links the expected return of risky assets in a balanced market condition. CAPM is a simple model that can provide an overview and predictions of a complex market (Tandelilin, 2017).

The CAPM model also explains how to determine the price of a stock by considering the risk factors contained therein (Hidayati et al. 2014). The optimal portfolio that has been formed using these two models, needs to be evaluated for performance. This is because the return aspect is not the only aspect generated through the portfolio, other factors such as the level of risk must also be taken into account. Portfolio performance measures in which there are aspects of return and risk are the Sharpe Index, Jensen Index, and Treynor Index where these indicators are used to assess the performance of the optimal portfolio (Tandelilin, 2017).

Previous research has not discussed the formation of an optimal portfolio of stocks included in the 100 Excellent Growth Company Ranks during the pandemic so this study aims to determine the optimal portfolio formation using the Single Index Model and the CAPM and to find out how the portfolio performance comparison of the two models using the Sharpe Index, Jensen Index, and Treynor Index during the Covid-2019 Pandemic.

2. Literature Review

2.1 Portfolio Formation Theory

Portfolio is a combination of investment instruments to meet certain objectives of each investor (Suhartono and Fadillah, 2009). An efficient portfolio is a portfolio that provides the largest expected return with a certain risk (Hartono, 2019). Return realization and expected return from portfolio are weighted average of individual securities returns (Hartono, 2016). Portfolio return can be calculated using the following formula:

$$R_p = \Sigma_{i=1}^{n} (W_i.R_i) \quad (2.1)$$

Portfolio expected return is obtained by calculating the weighted average expected return of each individual stock in the portfolio (Tandelilin, 2017). The portfolio expected return can be calculated using the following patter:

$$E(R_p) = \Sigma_{i=1}^{n} W_i. E(R_i) \quad (2.2)$$

2.2 Single Index Model

The Single Index Model was developed by William Sharpe by relating the calculation of security returns to the market index return (Tandelilin, 2017). Mathematically, the formula for the Single Index Model is as follows (Bodie et al. 2014):

$$R_i = \alpha_i + \beta i \, RM + ei \quad (2.3)$$

The calculation of security return in aa single index model consists of two components (Tandelilin, 2017):

1. Alpha which is denoted by α, is a component related to the uniqueness of the company, formulated as follows:

α_i = E(R_i) - βi x E(Rm) (2.4)

2. Beta which is denoted by β, is a component related to the market, formulated as follows:

$$\beta i = \frac{\sigma_{i,m}}{\sigma_m^2} \quad (2.5)$$

Beta (β) is a measure of the sensitivity of a security's return to market returns. The higher the beta value of a security, the higher the sensitivity of the security's return to market changes (Tandelilin, 2017).

2.3 Single Index Model in The Optimal Portfolio Formation

The single index model is directly used in portfolio formation by involving the calculation of expected portfolio return and portfolio risk (Hartono, 2019). The calculation of the expected portfolio return used in the Single Index Model is as follows (Bodie et al. 2014):

$E(R_p) = \alpha_p + \beta_p . E(R_m)$ (2.8)

The portfolio risk is measured by calculating the variance of securities using the following formula:

$$\sigma_p^2 = \beta_p^2 . \sigma_m^2 + (\Sigma_{i=1}^n W_i . \sigma_{ei})^2 \quad (2.6)$$

By using the calculation of portfolio alpha and portfolio beta which are the characteristics of the Single Index model, the alpha and beta calculations of the portfolio are as follows (Bodie et al. 2014):

$$\alpha_p = \Sigma_{i=1}^n W_i \alpha_i \quad (2.7)$$

$$\beta_p = \Sigma_{i=1}^n W_i \beta_i \quad (2.8)$$

In determining the optimal portfolio, the Single Index model is based on the ratio between the excess return and Beta (excess return to beta ratio). The excess of the return unit relative to the unit of risk that cannot be diversified and measured by beta will be measured by excess return to beta (ERB). ERB (Bodie et al. 2014) can be calculated using the following patter:

$$ERBi = \frac{E(Ri) - R_{BR}}{\beta_i} \quad (2.9)$$

In this case, a limiting point is needed, i.e., the cut-off point which can be determined by:

1. measuring securities and sorting from the largest ERB value to the smallest ERB value.
2. Calculating the values of Ai and Bi for each of the i-th securities. The values of Ai and Bi can be calculated using the following formula:

$$A_i = \frac{[E(Ri) - R_f]\beta_i}{\sigma_{ei^2}} \quad (2.10)$$

and

$$B_i = \frac{\beta_{i^2}}{\sigma_{ei^2}} \quad (2.11)$$

3. calculating the value of Ci, which is the value of C of the i-th security using the formula:

$$Ci = \frac{\sigma M^2 \Sigma_{j=1}^i A_j}{1 + \sigma M^2 \Sigma_{j=1}^i B_j} \quad (2.12)$$

After the optimal portfolio has been determined from various securities, the next step is to determine the proportion of funds for each selected security. The proportion of funds for security *i* can be calculated using the following formula (Bodie et al. 2014):

$$W_i = \frac{Z_i}{\Sigma_{j=1}^k z_j} \quad (2.13)$$

By calculating the Zi value first with the following formula:

$$Zi = \frac{\beta_i}{\sigma_{ei^2}} (ERBi - C^*) \quad (2.14)$$

2.4 Capital Asset Pricing Model (CAPM) Theory

Capital Asset Pricing Model (CAPM) is a calculation that shows the relationship between the expected return of a risky asset in a balanced market condition. CAPM is based on the portfolio theory put forward by Markowitz which assumes that investors will choose the optimal portfolio based on investor preferences for risk and return (Tandelilin, 2017).

2.5 Capital Asset Pricing Model (CAPM) in The Optimal Portfolio Formation

According to (Hartono, 2016), there are three variables related to CAPM, namely systematic risk (β), market return (Rm), and risk-free rate of return or risk-free return (Rf). Therefore, the formula for CAPM is as follows:

$$ER_i = R_f + \beta_i [(E(R_m) - R_f)] \quad (2.15)$$

Meanwhile, the formula of return market is as follows:

$$R_m = \frac{IHSG_t - IHSG_{t-1}}{IHSG_{t-1}} \quad (2.16)$$

Systematic risk or beta (β) is used in terms of risk that cannot be diversified. Beta (β) is a risk to CAPM and can be used to determine the risk level of a stock and shows the relationship between stock movements and the overall market. When the beta value exceeds 1 (β> 1) then the stock has a higher risk, where if there is a market change of 1% then X shares will experience a greater change of 1% or X > 1% (Fahmi, 2014).

2.6 Evaluation of Optimal Portfolio Performance

Evaluation of portfolio performance is needed to determine whether the formed portfolio has produced a good performance. In addition to the rate of return, the level of risk must also be considered in looking at the portfolio performance. Performance measures that can be used include the Sharpe Index, Jensen Index, and Treynor Index.

The Sharpe index is based on the concept of the capital market line which divides the risk premium by the standard deviation so that it can measure the risk premium for each unit of portfolio risk. The following is the calculation of portfolio performance using the Sharpe Index (Tandelilin, 2017):

$$\hat{S}_p = \frac{R_p - RF}{\sigma_{TR}} \quad (2.17)$$

The Jensen index shows the difference in the level of actual return obtained by the portfolio with the level of expected return. The following is the calculation of portfolio performance using the Jensen Index (Tandelilin, 2017):

$$\hat{J}_p = R_p - [RF + (Rm - RF)\ \beta_p] \quad (2.18)$$

Performance on the Treynor Index relates portfolio returns to the risk of the portfolio. The Treynor Index uses the assumption that the portfolio is well diversified, so that the risk that is considered relevant is systematic risk. The following is the calculation of portfolio performance using the Treynor Index (Tandelilin, 2017):

$$T_p = \frac{R_p - RF}{\beta_p} \quad (2.19)$$

3. Methods

3.1 Population and Sample

Population is a generational area including objects or subjects with certain qualities and characteristics that the researcher determines to study and then draw conclusions. Meanwhile, sample is part of the number and characteristics of the population (Sugiyono, 2012). The population in this study is a list of stocks included in the 100 Excellent Growth-Company Ranks for the period of 2019 and 2020. This study used a purposive sampling method so that the authors set the sample criteria as can be seen in the following Table 1:

Table 1. Criteria and Number of Research Samples

No	Criteria	Number of Samples
1	Shares that are consistently included in the list of 100 Growth-Company Ranks for the period of 2019 and 2020	76
2	Completeness of historical data on closing prices of shares	76
Total sample		76

Source: Processed Data (2021)

3.2 Data Analysis Technique

Based on the predetermined sample categories, data processing in this study calculated the expected return along with the risk of each stock and calculated the return and market risk. Then, the optimal portfolio formation used the two models and then the performance of the two models was compared. The data analysis process is described as follows:

1. Forming a portfolio using the Single Index model with the following stages:
- Collecting data on monthly closing prices for the period of 2019 to 2020.
- Calculating the return of each stock with and the expected return.
- Calculating stock and market return variants.
- Performing alpha and beta calculations as well as calculating Ai, Bi, and Ci.
- Calculating the value of Ci by using a formula.
- Performing the ERB calculation and determining the optimal candidate portfolio by comparing the ERB and C* values.

2. Forming an optimal portfolio using the Capital Asset Pricing Model (CAPM) with the following stages:
- Collecting monthly closing price data for the period of 2019 to 2020.
- Calculating the return of each stock.
- Calculating the market return for each index along with its systematic risk.
- Performing the expected return calculation.
- Determining the optimal portfolio candidate based on CAPM with the criteria Ri > E (Ri).
- Calculating the proportion of funds, portfolio expected return, and portfolio risk.

3. After forming an optimal portfolio using the two models, the performance of the two models were then measured using the Sharpe Index, Jensen Index, and Treynor Index with the following stages:
- Calculating the performance of both models using the Sharpe Index.
- Calculating the performance of the two models using the Jensen Index.
- Calculating the performance of the two models using the Treynor Index.

4. Data Collection

As described by Sangadji (2010) quantitative research is research whose data is expressed in the form of numbers. In this study, data collection was carried out by collecting secondary data. Supomo & Indriantoro (2002) explain that secondary data is a source of data used in a study that is sourced from intermediary media, not directly. This study uses secondary data, namely data quoted through intermediary media sourced from:

- List of stocks included in the 100 Growth-Company Ranks for the period 2019 and 2020 through the official website of the Indonesian Business Daily and the Official Magazine 100 Growth Company Ranks 2020
- Closing price obtained from the official Yahoo Finance website (finance.yahoo.com).
- Interest rate data for Bank Indonesia Certificates (SBI) for the period 2019-2020 through the official website of Bank Indonesia (www.bi.go.id/)

5. Results and Discussion

Based on the results of research on 76 stocks included in the 100 Growth-Company Ranks 2019-2020, it shows that of the 76 samples used, there are 21 stocks that are included in the optimal portfolio using Single Index Model, because the ERB value > C* with different levels of proportion. Issuers included in the formation of the optimal portfolio include BBCA, MAYA, BNLI, WIKA, ADRO, MNCN, ERAA, TOWR, BBMD, ACES, INCO, TBIG, MIKA, TINS, SSMS, DUTI, NOBU, HRUM, INDY, TPIA, ANTM.

The portfolio resulting from the formation of the Single Index Model can provide a portfolio expected return rate of 0.079 or equivalent to 7.9%. Meanwhile, the risk formed from the portfolio is 0.0083 or equivalent to 0.837%, when compared to the individual's expected return which is in the range of -0.2% – 8%. The individual's expected return has a final value that is greater than the portfolio's expected return, but the risk of the portfolio is only 0.83%. This proves that portfolio formation is one way to reduce stock risk. This also provides many choices in choosing what stocks will be used as alternatives for investors to invest.

The formation of an optimal portfolio using the CAPM model begins with determining efficient stocks with individual return rates that are greater than the level of expected return [(Ri) > E(Ri)]. Stocks that do not included into this category are called inefficient stocks. The formation of an optimal portfolio with CAPM produces 50 efficient stocks

from the 76 research samples used. The efficient stock has a higher rate of return than the expected return, and vice versa. Stocks included in the optimal portfolio include BBCA, BBRI, BTPN, BMRI, MAYA, BNLI, MEGA, DSSA, UNTR, JSMR, PNBN, BNGA, WIKA, ADRO, PGAS, MNCN, BJTM, ERAA, TOWR, MYOR, BBMD , AALI, ACES, INCO, BSDE, ADMF, TBIG, MIKA, MAPI, IMAS, PTPP, TINS, ULTJ, BFIN, SSMS, SMRA, DUTI, TBLA, BJBR, ITMG, LSIP, TSPC, JRPT, HRUM, TKIM, INDY , INKP, TPIA, ANTM, KAEF. The CAPM model also helps investors in making investment decisions that must be taken by investors, including buying efficient stocks because they are undervalued and selling inefficient stocks because they are overvalued. The result analysis can be seen in the following Table 2:

Table 2. Data Analysis Results

Indicators	Single Index Model Portfolio	CAPM Portfolio
Number of Stocks	21 stocks	50 stocks
Portfolio Expected Return	0.079 or 7.9%	-0.0019 or -0.19%
Portfolio Risk	0.0083 or 0.837%	0.0077 or 0.77 %
Sharpe Index	1.045	0.05
Jensen Index	0.047	-0.002
Treynor Index	0.019	0.003

Source: Processed Data (2021)

Evaluation of portfolio formation with the Single Index Model resulted in positive values for the Sharpe Index of 1,045, Jensen's Index of 0.1047, and Treynor's Index of 0.019. While the evaluation of portfolio formation with the CAPM resulted in a positive average value for the Sharpe Index of 0.05, Jensen's Index of -0.0019, and Treynor's index of 0.003. This shows that the performance of the Sharpe Index is ranked first because it has the largest index value. While the Treynor Index is ranked second, and the Jensen Index is ranked last because it has the lowest index value. However, the three indices can show positive results which indicate that the formation of a portfolio with the Single Index Model is considered good and worthy of consideration by investors to invest in the optimal portfolio formed when compared to the CAPM model.

6. Conclusion

In the Single Index Model, it can provide 21 stocks that are included in the optimal portfolio. Unlike the CAPM which produces 50 efficient stocks that includes in optimal portfolio. The difference in the resulting values is caused by the different approaches used in the formation of the Single Index Model and CAPM portfolios. The Single Index Model Portfolio is determined by comparing the values of ERB>C*. While the CAPM Portfolio is determined as efficient stock by comparing the value of Ri > E(Ri). For this reason, although the CAPM produces a negative expected return portfolio, the CAPM portfolio consists of a collection of efficient stocks because the value of Ri > E(Ri) is an undervalued.

The evaluation of portfolio formation performance with the Single Index Model produces positive values for the Sharpe Index, Jensen's Index, and Treynor's Index. However, the three indices can give positive results which indicate that the formation of a portfolio through the Single Index Model is considered good and feasible to be considered by investors to invest in the optimal portfolio formed by the Single Index Model.

While the evaluation of portfolio formation with the CAPM resulted in a positive average value for the Sharpe Index, Jensen's Index, and Treynor's index. The three indices can show positive results which indicate that the formation of a portfolio using the CAPM is considered good and worthy of consideration by investors to invest in the optimal portfolio formed by the CAPM model.

The results of the portfolio performance of the two models have different values. The difference in the value of each index is because each index has a different approach. The Sharpe index uses a standard deviation divisor that shows the total risk of the portfolio, while the Treynor index uses a beta divisor which only shows systematic risk.
However, the three portfolio performance measurement indices have shown positive values indicating that the formation of a portfolio with the Single Model Index and CAPM is considered good and worthy of consideration by investors to invest in an optimal portfolio. The portfolio performance index also consistently ranks at the same level which indicates that the portfolio that has been formed is an optimal portfolio (Hartono, 2019). The results of this study are supported by previous research conducted by (Sholehah et al., 2020) which states that the results of portfolio performance from the Sharpe Index, Jensen Index, and Treynor Index which have positive values indicate that the stocks included in the optimal portfolio are eligible for investment are eligible for investment even during the covid 19 pandemic era.

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