

# Optimal Portfolio Analysis using the Single Index Model

## The Case of LQ45 Stock Index Before and During Covid-19

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### Abstract

*This study aims to determine the formation of the optimal portfolio using the single-index model and find out whether there are differences between the optimal portfolio and the non-optimal portfolio of stock. Further, it also finds out the percentage of the proportion of funds and the expected returns and risks for each stock making up the optimal portfolio before the Covid-19 period from February 2019 to January 2020 and during the Covid-19 period from February 2020 to January 2021). The study applied a descriptive quantitative approach. Of 45 stocks listed in the LQ45 Index, the study takes as many as 28 stocks as samples, which is then analyzed using Single Index Model. We found that there are three stocks making up the optimal portfolio before the Covid-19 period. Those stocks are Media Nusantara Citra Tbk (MNCN) with the proportion of funds 18.55%, Bank Central Asia Tbk (BBCA) with 69.83%, and Bank Rakyat Indonesia (Persero) Tbk (BBRI) with 11.63%. The expected return of this stock group is 0.023669025 or 2.37% and it's a portfolio risk of 0.000721873 or 0.07%. Meanwhile, during the Covid-19 period, there were four stocks that formed the optimal portfolio, namely Aneka Tambang Tbk (ANTM) shares with the fund proportion of 38.41%, Indah Kiat Pulp & Paper Tbk (INKP) with 27.30%, Bukit Asam Tbk (PTBA) with 25.18%, and United Tractors Tbk (UNTR) with 9.11%. The expected return is 0.078544263 or 7.85% with a portfolio risk of 0.012364093 or 1.24%.*

**Keywords :** *optimal portfolio; single-index model; LQ45 Index*

### INTRODUCTION

Investment is essentially the placement of a number of funds at this time to be transferred to productive assets for a certain period of time in the hope of obtaining future profits (Halim, 2005:4). Investment seen from the form, is divided into two, namely real investment (investment in tangible assets) and financial investment (investment in securities). Financial investment in the money market provides short-term financing, while the capital market provides long-term financing. Instruments traded in the money market can be in the form of Bank Indonesia Certificates (SBI), Money Market Securities (SBPU), certificates of deposit, and so on. The instruments traded in the capital market are stocks, bonds, derivative instruments and other instruments.

The most popular investment in the capital market is stocks. Shares are securities that show ownership of a company. Investments in the form of shares actually have a high risk in accordance with the investment principle, namely low risk low return, high risk high return. The goal of investors in investing is to maximize returns, without forgetting the investment risk factors that must be faced. Return is one of the factors that motivate investors to invest and is also a reward for the courage of investors to take risks on their investments. Investment return consists of two components, namely yield and capital gain (loss). However, in addition to taking into account

returns, investors also need to consider the level of risk of an investment as the basis for making investment decisions. Risk is the possible difference between the actual return received and the expected return. The greater the possibility of the difference, the greater the risk of the investment (Tandelilin, 2010:102-103).

To reduce investment risk, investors need to diversify. Diversification (portfolio) can mean that investors need to form a portfolio through the selection of a combination of a number of assets in such a way that risk can be minimized without reducing the expected return. Reducing risk without reducing return is the goal of investors in investing. In the 1950s Henry Markowitz introduced the diversification theory which became known as the Markowitz diversification model. Where the formation of a portfolio by considering the covariance and negative correlation coefficient between assets in order to reduce portfolio risk. Markowitz's very important advice in portfolio diversification is *"don't put all the eggs in one basket"*, because if the basket falls, all the eggs in the basket will break. In the context of investment, this teaching can be interpreted as *"don't invest all the funds we have in just one asset, because if that asset fails, all the funds we have invested will disappear"*.

In the 1950s, Markowitz developed a portfolio selection model that incorporated the principle of diversification. The determination of the optimal portfolio is known as the determination of the optimal portfolio of the Markowitz model (Goetzmann et al., 2014). Further developed by William Sharpe by creating a Single Index Model to simplify the calculation of the Markowitz model. Jogiyanto (2013:339) explains that the single index model is based on the observation that the price of a security fluctuates in the direction of the market price index. Stocks in general will experience an increase in price if the stock price index rises, and vice versa the price of most stocks will decrease if the stock price index falls. The analysis model of portfolio formation is very helpful for investors in investing their capital in order to obtain the best combination of profit and risk. Anggraeni and Mispiananti (2020) state that the single index model can provide investors with an overview to be used as a reference in investing.

Optimal portfolio analysis with a single index model requires a number of calculation procedures through a number of data as input about the portfolio structure. Analysis of securities is carried out by comparing the excess return to beta (ERB) of each stock with its Cut-off point (C\*). The excess return to beta (ERB) is the excess return over the risk-free rate of return on other assets and the cut-off point (C\*) itself is nothing but the largest value of the various candidate stocks obtained from the comparison between the market return variance and the return sensitivity. individual stocks to stock variance error. Stocks that have an ERB greater than C\* are used as portfolio candidates, and vice versa, ie C\* is greater than ERB are not included in the portfolio (Jogiyanto, 2013).

At the beginning of 2020, the world was shocked by the outbreak of the Covid-19 virus (coronavirus disease 2019) or often called the Corona virus which then on March 9, 2020 the WHO (World Health Organization or World Health Organization) officially declared this virus a pandemic because has spread widely and attacked many countries in the world, one of them is Indonesia. In Indonesia, the COVID-19 pandemic has been confirmed since early March 2020 with 2 positive cases. As of February 20, 2021, the number of COVID-19 cases in Indonesia is 1,271,353 positive; 1,078,840 recovered; and as many as 34,316 who died (accessed via [www.covid19.co.id](http://www.covid19.co.id)). The Covid-19 outbreak has not significantly affected the movement of the stock market in Indonesia. The decline in stock indexes in the capital market during Covid-19 from the analysis results turned out to be strongly correlated so that several policies were needed from the Financial Services Authority (OJK) and the Indonesia Stock Exchange, such as the trading halt (policy to stop trading) for 30 minutes if the JCI was Composite Stock Price Index) fell by 5 percent which was announced on March 10, 2020 (accessed via <https://market.bisnis.com/>).

This negative signal for the Covid-19 outbreak will of course also have an impact on the LQ45 Index, which continues to fluctuate and tends to experience a significant decline compared to before and during Covid-19. The period before Covid-19 is from February 2019 to January 2020 and

the Covid-19 period is from February 2020 to January 2021.

The movement of the LQ45 Index where in February 2019 the closing price was IDR. 1,006.10 and decreased in the same month in 2020 by IDR. 879.53 or -12.58%. In March 2019 it was IDR. 1,019.04 then in 2020 it decreased by IDR. 691.13 or -32.18%. In April 2019 it was IDR 1,019.33, down in 2020 it was IDR 713.64 or -29.99%. In May 2019 it was IDR 982.88, down in 2020 it was IDR 725.83 or -26.15. And in June 2019 it was IDR 1,013.96, down in 2020 it was IDR 756.20 or -25.42%. Entering the beginning of the second semester in July 2019 the closing price of the LQ45 Index of IDR 1,022.43 fell again in the same month of 2020 by IDR 803.01 or -21,46%. In August 2019 it was IDR. 995.76, down IDR. 824.19 or -17.23% in 2020. And in September 2019 it was IDR. 968.15 and then it was down IDR. 737.15 or -23.86% in 2020. In October 2019 it was IDR. 984.84, down in 2020 to IDR. 790.50 or -19.73%. Furthermore, in November, although there was a decrease but not as much as the previous months, in 2019 it was IDR. 956.82 and in 2020 it was IDR. 883.06 or -7.71%. Then at the end of the 2019 period in December, it was IDR. 1,014.47, down by IDR. 934.89 in 2020 or -7.84%. Meanwhile, at the beginning of the 2021 period, the closing price of the LQ45 index still decreased by IDR. 911.98 or -5.20% compared to the beginning of the 2020 period before the Covid-19 outbreak of IDR. 961.98..

## **LITERATURE REVIEW**

### **Investment**

Investment is a commitment to a number of funds or other sources of funds carried out at this time, with the aim of obtaining a number of benefits in the future. An investor buys a number of shares today with the hope of profiting from an increase in the share price or a number of dividends in the future, in return for the time and risk associated with the investment (Tandelilin, 2010:4). Meanwhile, Jogiyanto (2013) investment is a delay in current consumption to be used in efficient production for a certain period of time.

Investment is a form of delaying consumption from the present to the future, which includes the risk of uncertainty, for which compensation is needed for the delay, which is commonly known as the gain from investment or gain. In general, investments can be categorized into two major groups, namely:

- 1) Real Investment, investment in real form such as investment in property, commercial investment, and others.
- 2) Financial Investment, investment in financial products such as investments in fixed forms, among others, deposits and bonds or in non-fixed forms such as stock investments or the like.

### **Return**

The goal of investors in investing is to maximize returns, without forgetting the investment risk factors that must be faced. Return is one of the factors that motivate investors to invest and is also a reward for the courage of investors to take risks on their investments. The sources of investment return consist of two main components, namely yield and capital gain (loss). Yield is a component of return that reflects the cash flow or income obtained periodically from an investment. If we invest in a bond, for example, the yield is shown from the bond interest paid. Likewise, if you buy shares, the yield is indicated by the amount of dividends we get. Meanwhile, capital gain (loss) as the second component of return is an increase (decrease) in the price of a securities (either stocks or long-term debt securities), which can provide gains (losses) for investors. In other words, capital gain (loss) can also be interpreted as a change in security prices (Tandelilin, 2010:102).

In the context of investment management, return is the return obtained from investment, the return is divided into two. First, the return that has occurred (actual return) which is calculated based on history. Second, the expected return will be obtained by investors in the future (Halim, 2014).

### **Risk**

Investors do not only need to calculate the return for each investment. The risk of investment also needs to be taken into account. Return and risk are two inseparable things, because the consideration of an investment is a trade-off of these two factors. Return and risk have a positive relationship, the greater the risk that must be borne, the greater the return that must be compensated (Jogiyanto, 2013). According to Tandelilin (2010:102) risk is the possible difference between the actual return received and the expected return. The greater the possible difference, the greater the risk of the investment. According to Reilly and Brown (2003), risk is the uncertainty of the investment that will be obtained against the expected return. While Koch et al. (2008), risk is defined as the possibility of permanent capital loss or capital damage.

Kamarudin (2004) in the context of the portfolio, risk is divided into two, namely:

1) Systematic Risk (Systematic Risk)

Risk that cannot be eliminated by diversifying, because fluctuations in this risk are influenced by macro factors that can affect the market as a whole, for example, changes in interest rates, foreign exchange rates, and government policies. So that it is general in nature and applies to all relevant shares and stock exchanges. This risk is also called undiversable risk.

2) Unsystematic Risk (Unsystematic Risk)

This is a risk that can be done by diversifying, because this risk is only in a particular company or industry. The amount of this risk fluctuation varies from one stock to another. Because of this difference, each stock has a different level of sensitivity to market changes. For example, the asset structure factor, the level of liquidity, and so on. This risk is called diversifiable risk.

The relationship between the level of risk and the expected return is a unidirectional and linear relationship. This means that the greater the risk of an asset, the greater the expected return on that asset (higher risk, high potential return), and vice versa (Tandelilin, 2010:11).

### **Optimal Portfolio**

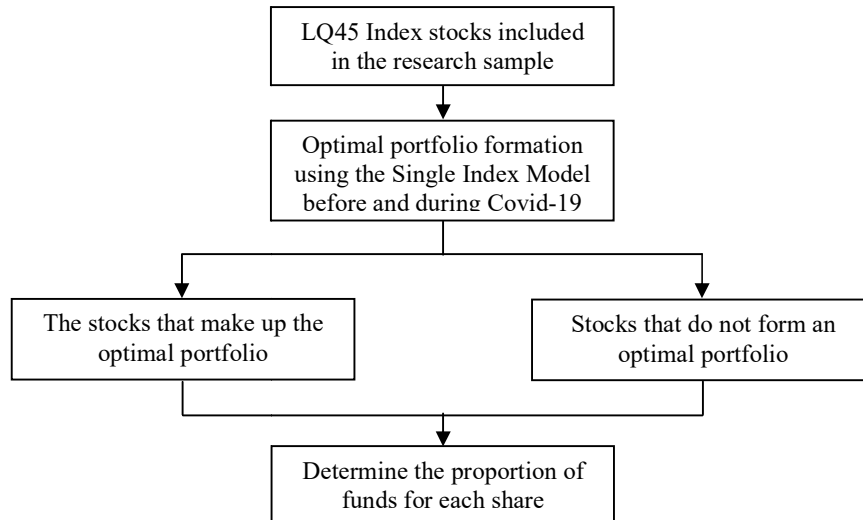
According to Jones (2002), "Portfolio is the securities held by an investor taken as a unit." This means that the portfolio is a number of securities that are maintained by investors in one unit (Fahmi & Hadi). According to Bodie and Marcus (2013), an efficient portfolio is: "All the portfolios that lie on the minimum-variance frontier from the global minimum variance portfolio and upward provide the best risk-return combinations and thus are candidates for the optimal portfolio. The part of the frontier that lies above the global minimum-variance portfolio, therefore, is called the efficient frontier of risky assets."

This means that all portfolios that are above the minimum variance boundary line from the global portfolio minimum variance limit and above which provide a good combination of risk and return and are optimal portfolios. Therefore, the portfolio contained in the minimum line of global portfolio variance is also called the efficient boundary line of risky assets. According to Tandelilin (2003), the optimal portfolio is "a portfolio that is chosen by an investor from the many choices available in an efficient portfolio collection."

### **Single Index Model**

The single index model was developed by William Sharpe, an economist in the United States in 1963 (Dileep & Rao., 2013). This model can be used to simplify calculations on the Markowitz model. The single index model is based on the observation that the price of a security fluctuates in the direction of the market price index (Kamal, 2012). Stocks in general will experience an increase in price if the stock price index rises, and vice versa the price of most stocks will decrease if the stock price index falls. This suggests that the returns from securities may be correlated because of the general reaction (common response) to changes in market value (Jogiyanto, 2013:339).

**Conceptual Model**



**Figure 1.** Research Stages

The hypothesis proposed is that there is a difference between stocks that form an optimal portfolio and stocks that do not form an optimal portfolio on LQ45 index stocks before and during the Covid-19 period.

**RESEARCH METHOD**

**Location and Research Design**

This study uses a quantitative descriptive research design that aims to provide a detailed description of determining the optimal stock portfolio. With the object of research on companies listed on the Indonesia Stock Exchange which consists of 45 stocks included in the LQ45 Index.

**Population, Samples, and Sampling Technique**

The population in this study are stocks included in the LQ45 index from February 2019 to January 2021, totaling 45 companies. The sampling technique in this research is purposive sampling. Purposive sampling is a sampling technique based on certain objectives and considerations. The considerations used include: 1) The company's shares have always remained in the LQ45 index during the research period, namely before Covid-19 from February 2019 to January 2020 and during the Covid-19 period from February 2020 to January 2020, 2021. 2) No stock split or stock split during the research period. 3) Does not include new shares going public or IPO (Initial Public Offering). Based on the consideration of these criteria, the sample in this study amounted to 28 company shares.

**Data Collection Method**

This secondary data was collected using the documentation method, namely by recording or documenting data related to the research object of the companies included in the LQ45 index during the study period.

**Data Analysis Method**

In this study, to form an optimal portfolio of LQ45 index stocks, the analytical method used is the Single Index Model. Mathematically, the single index model is as follows:

$$R_i = \alpha_i + \beta_i R_m + e_i \dots\dots\dots (1)$$

$R_i$  indicates the return of security  $i$ ,  $R_m$  indicates the return of the market index,  $\alpha_i$  is the part of the return of security  $i$  that is not affected by market performance, while  $\beta_i$  is a measure of the

sensitivity of the return of security  $i$  to changes in market returns, and  $e_i$  is the residual error.

In data processing techniques, data collection is carried out, data analysis is then processed using a computer with Microsoft Excel. The stages carried out in this research are:

1. Collect company stock data

Collecting sample data during the study period, namely closing stock data (closing price), LQ45 index data and BI 7 day repo rate data every month.

2. Calculate the return (return) and the expected return (expected return) of each stock.

$$R_i = \frac{P_t - P_{t-1}}{P_{t-1}} \text{ and } E(R_i) = \frac{\sum_{t=1}^n R_{it}}{n}$$

3. Calculate the expected return from each market.

$$R_{Mt} = \frac{LQ45_t - LQ45_{t-1}}{LQ45_{t-1}} \text{ and } E(R_M) = \frac{\sum_{t=1}^n R_{Mt}}{n}$$

4. Calculating the variance of returns from stocks and markets.

$$\sigma_i^2 = \frac{\sum_{t=1}^n [R_i - E(R_i)]^2}{n-1} \text{ and } \sigma_m^2 = \frac{\sum_{t=1}^n [R_m - E(R_m)]^2}{n-1}$$

5. Calculating the standard deviation of stocks and markets.

$$\sigma_i = \sqrt{\sigma_i^2} \text{ and } \sigma_m = \sqrt{\sigma_m^2}$$

6. Calculate the beta and alpha of each stock.

$$\beta_i = \frac{\sigma_{iM}}{\sigma_M^2} \text{ and } \alpha_i = E(R_i) - \beta_i \cdot E(R_m)$$

7. Calculate the residual error variance.

$$\sigma_{ei^2} = \frac{1}{t} \sum_{t=1}^i [R_{it} - (\alpha_i + \beta_i \cdot R_{mt})]^2$$

8. Determine the "optimal portfolio based on a single index model:

- a. Calculating the excess return to beta (ERB) value of each stock.

$$.ERB_i = \frac{E(R_i) - R_{BR}}{\beta_i}$$

- b. Sorting stock levels according to the value of excess return to beta (ERB) from the highest to the lowest.

- c. Calculating cut off rate ( $C_i$ )

The calculation of  $C_i$  can be done by first calculating the values of  $A_i$  and  $B_i$  for each of the  $i$ th securities.

$$A_i = \frac{[E(R_i) - R_{BR}] \cdot \beta_i}{\sigma_{ei^2}} \text{ and } B_i = \frac{\beta_i^2}{\sigma_{ei^2}}$$

After getting the values of  $A_i$  and  $B_i$  then look for the value of  $C_i$ .

$$.C_i = \frac{\sigma_m^2 \cdot \sum_{j=1}^i A_j}{1 + \sigma_m^2 \cdot \sum_{j=1}^i B_j}$$

Determine the candidate portfolio with criteria  $ERB > C^*$ .

- d. Determine the proportion ( $W_i$ ) of each stock in the optimal portfolio.

$$Z_i = \frac{\beta_i}{\sigma_{ei^2}} (ERB_i - C^*) \text{ With the value of } Z_i \text{ is equal to: } W_i = \frac{Z_i}{\sum_{j=1}^N Z_j}$$

- e. Calculating the expected return of portfolio  $E(R_p)$  and portfolio risk ( $\sigma_p^2$ )

$$E(R_p) = \alpha_p + \beta_p \cdot E(R_m)$$

The alpha and beta of the portfolio can be found by the formula:

$$\alpha_p = \sum_{i=1}^n W_i \cdot \alpha_i \text{ and } \beta_p = \sum_{i=1}^n W_i \cdot \beta_i$$

while risk uses the following formula:

$$\sigma_p^2 = \beta_p^2 \cdot \sigma_m^2 + \left[ \sum_{i=1}^n W_i^2 \cdot \sigma_{ei^2} \right]$$

## EMPIRICAL RESULTS

**Table 1.** Return Realization and Expected Return of Stocks

No	Stock Code	Before Covid-19		Covid-19 Period	
		$R_i$	$E(R_i)$	$R_i$	$E(R_i)$
1	ADRO	0,00271	0,00023	0,14683	0,01224
2	AKRA	-0,34813	-0,02901	0,00228	0,00019
3	ANTM	-0,18189	-0,01516	1,50868	0,12572
4	ASII	-0,22916	-0,01910	0,12920	0,01077
5	BBCA	0,15747	0,01312	0,10093	0,00841
6	BBNI	-0,17478	-0,01457	0,00019	0,00002
7	BBRI	0,19852	0,01654	0,06427	0,00536
8	BBTN	-0,31355	-0,02613	0,27841	0,02320
9	BMRI	0,06094	0,00508	0,03225	0,00269
10	GGRM	-0,32024	-0,02669	-0,33595	-0,02800
11	HMSP	-0,54444	-0,04537	-0,29029	-0,02419
12	ICBP	0,08588	0,00716	-0,15524	-0,01294
13	INKP	-0,51782	-0,04315	0,88920	0,07410
14	INTP	-0,08863	-0,00739	-0,09356	-0,00780
15	ITMG	-0,55626	-0,04635	0,54280	0,04523
16	JSMR	-0,02803	-0,00234	0,18255	0,01521
17	KLBF	-0,06395	-0,00533	0,07715	0,00643
18	MNCN	0,81414	0,06785	-0,27568	-0,02297
19	PGAS	-0,32801	-0,02733	0,22436	0,01870
20	PTBA	-0,49965	-0,04164	0,36067	0,03006
21	PTPP	-0,38173	-0,03181	0,68475	0,05706
22	SCMA	-0,16742	-0,01395	0,62926	0,05244
23	SMGR	0,00330	0,00028	0,01841	0,00153
24	SRIL	-0,38240	-0,03187	0,13237	0,01103
25	TLKM	-0,00319	-0,00027	-0,09595	-0,00800
26	UNTR	-0,20452	-0,01704	0,32315	0,02693
27	UNVR	-0,18502	-0,01542	-0,08407	-0,00701
28	WIKA	0,07964	0,00664	0,35628	0,02969

Source: Data processed, 2021

**Table 2.** Market Return ( $R_M$ ) and Expected Market Return  $E(R_M)$

Month	Before Covid-19		Covid-19 Period	
	LQ45 Index	$R_M$	LQ45 Index	$R_M$
February	1006,10	-0,03164	879,53	-0,08570
March	1019,04	0,01286	691,13	-0,21421
April	1019,33	0,00029	713,64	0,03257
May	982,88	-0,03576	725,83	0,01708
June	1013,96	0,03163	756,20	0,04184
July	1022,43	0,00835	803,01	0,06191
August	995,76	-0,02608	824,19	0,02637
September	968,15	-0,02773	737,15	-0,10560
October	984,84	0,01725	790,50	0,07237
November	956,82	-0,02846	883,06	0,11709
December	1014,47	0,06025	934,89	0,05869
January	961,98	-0,05175	911,98	-0,02450
$\Sigma R_M$		-0,07080		-0,00209
$E(R_M)$		-0,00590		-0,00017

Source: Data processed, 2021

**Table 3.** Standard Deviation and Market Return Variance

No	Stock Code	Before Covid-19		Covid-19 Period	
		$\sigma_i$	$\sigma_i^2$	$\sigma_i$	$\sigma_i^2$
1	ADRO	0,12505	0,01564	0,12555	0,01576
2	AKRA	0,10507	0,01104	0,14174	0,02009
3	ANTM	0,12912	0,01667	0,26403	0,06971
4	ASII	0,06451	0,00416	0,15157	0,02297
5	BBCA	0,02889	0,00083	0,08240	0,00679
6	BBNI	0,07508	0,00564	0,18525	0,03432
7	BBRI	0,05287	0,00280	0,12560	0,01578
8	BBTN	0,08506	0,00724	0,28159	0,07929
9	BMRI	0,05364	0,00288	0,13999	0,01960
10	GGRM	0,08591	0,00738	0,09156	0,00838
11	HMSP	0,06062	0,00367	0,13257	0,01757
12	ICBP	0,05721	0,00327	0,08846	0,00783
13	INKP	0,13999	0,01960	0,20120	0,04048
14	INTP	0,08208	0,00674	0,10286	0,01058
15	ITMG	0,13167	0,01734	0,22360	0,05000
16	JSMR	0,07486	0,00560	0,19102	0,03649
17	KLBF	0,07339	0,00539	0,08060	0,00650
18	MNCN	0,17141	0,02938	0,15855	0,02514
19	PGAS	0,09355	0,00875	0,25207	0,06354
20	PTBA	0,10186	0,01038	0,10612	0,01126
21	PTPP	0,14092	0,01986	0,27274	0,07439
22	SCMA	0,10302	0,01061	0,19233	0,03699
23	SMGR	0,08857	0,00784	0,15407	0,02374
24	SRIL	0,06918	0,00479	0,17187	0,02954
25	TLKM	0,04075	0,00166	0,10176	0,01036
26	UNTR	0,07805	0,00609	0,13615	0,01854
27	UNVR	0,05241	0,00275	0,07264	0,00528
28	WIKA	0,11022	0,01215	0,22403	0,05019
$\sigma_m$		<b>0,03298</b>		<b>0,09293</b>	
$\sigma_m^2$		<b>0,00109</b>		<b>0,00864</b>	

Source: Data processed, 2021

**Table 4.** Risk Free Return

Month	BI 7 Day Repo Rate	
	Before Covid-19	Covid-19 Period
February	6,00%	4,75%
March	6,00%	4,50%
April	6,00%	4,50%
May	6,00%	4,50%
June	6,00%	4,25%
July	5,75%	4,00%
August	5,50%	4,00%
September	5,25%	4,00%
October	5,00%	4,00%
November	5,00%	3,75%
December	5,00%	3,75%
January	5,00%	3,75%
<b>Average</b>	<b>5,54%</b>	<b>4,15%</b>
<b>RF/Month</b>	<b>0,00462</b>	<b>0,00345</b>

Source: [www.bi.co.id](http://www.bi.co.id), accessed 2021

The calculation results show the average BI 7 Day Repo Rate per year for the period before Covid-19 is 5.54% or 0.00462 per month. Meanwhile, during the Covid-19 period, the average BI 7 Day Repo Rate per year was 4.15% or 0.00345 per month. This illustrates that if an investor invests in SBI, the profit expected by investors in the pre-Covid-19 period is 0.046% per month, while in the Covid-19 period it is 0.035% per month with 0% risk.

**Table 5. Beta ( $\beta$ ) and Alpha ( $\alpha$ ) Before and During Covid-19**

No	Stock Code	Before Covid-19		Covid-19 Period	
		$\beta_i$	$\alpha_i$	$\beta_i$	$\alpha_i$
1	ADRO	2,51142	0,01504	0,62556	0,01234
2	AKRA	1,79457	-0,01842	1,19600	0,00040
3	ANTM	1,87754	-0,00408	1,82112	0,12604
4	ASII	1,30747	-0,01138	1,14923	0,01097
5	BBCA	0,65594	0,01699	0,67563	0,00853
6	BBNI	1,57991	-0,00524	1,61453	0,00030
7	BBRI	1,14514	0,02330	1,08294	0,00554
8	BBTN	0,72799	-0,02183	2,05316	0,02356
9	BMRI	1,20390	0,01218	1,22089	0,00290
10	GGRM	0,75818	-0,02221	0,73913	-0,02787
11	HMSP	0,84882	-0,04036	0,82062	-0,02405
12	ICBP	-0,20051	0,00597	0,14293	-0,01291
13	INKP	1,83713	-0,03231	1,18517	0,07431
14	INTP	1,13281	-0,00070	0,83190	-0,00765
15	ITMG	2,49058	-0,03166	1,33089	0,04547
16	JSMR	1,12209	0,00428	1,40467	0,01546
17	KLBF	1,01178	0,00064	0,26814	0,00648
18	MNCN	1,20539	0,07496	1,39748	-0,02273
19	PGAS	1,80335	-0,01670	2,17063	0,01908
20	PTBA	2,07790	-0,02938	0,50830	0,03014
21	PTPP	3,40414	-0,01173	2,50753	0,05750
22	SCMA	1,59998	-0,00451	1,53397	0,05271
23	SMGR	1,37250	0,00837	1,20691	0,00175
24	SRIL	0,88925	-0,02662	1,30582	0,01126
25	TLKM	0,39959	0,00209	0,69639	-0,00787
26	UNTR	1,17645	-0,01010	0,49827	0,02702
27	UNVR	0,17673	-0,01438	0,01022	-0,00700
28	WIKA	2,31478	0,02029	2,02026	0,03004

Source: Data processed, 2021

**Table 6. Residual Error Variance**

No	Stock Code	$\sigma_{ei}^2$	
		Before Covid-19	Covid-19 Period
1	ADRO	0,00878	0,01238
2	AKRA	0,00754	0,00773
3	ANTM	0,01284	0,04107
4	ASII	0,00230	0,01157
5	BBCA	0,00037	0,00285
6	BBNI	0,00292	0,01181
7	BBRI	0,00137	0,00565
8	BBTN	0,00666	0,04288
9	BMRI	0,00130	0,00672
10	GGRM	0,00676	0,00367
11	HMSP	0,00289	0,01176
12	ICBP	0,00323	0,00765
13	INKP	0,01593	0,02835
14	INTP	0,00534	0,00460
15	ITMG	0,01059	0,03470
16	JSMR	0,00423	0,01945
17	KLBF	0,00427	0,00588
18	MNCN	0,02780	0,00827
19	PGAS	0,00521	0,02285
20	PTBA	0,00568	0,00903
21	PTPP	0,00726	0,02008
22	SCMA	0,00783	0,01667
23	SMGR	0,00580	0,01116
24	SRIL	0,00393	0,01481
25	TLKM	0,00149	0,00617
26	UNTR	0,00459	0,01639
27	UNVR	0,00271	0,00528
28	WIKA	0,00632	0,01494

Source: Data processed, 2021

*Determination of Optimal Portfolio Using Single Index Model*

**Table 7.** Excess Return to Beta (ERB)

No	Stock Code	ERB <sub>i</sub>	
		Before Covid-19	Covid-19 Period
1	ADRO	-0,00175	0,01404
2	AKRA	-0,01874	-0,00273
3	ANTM	-0,01053	0,06714
4	ASII	-0,01814	0,00636
5	BBCA	0,01296	0,00733
6	BBNI	-0,01214	-0,00213
7	BBRI	0,01041	0,00176
8	BBTN	-0,04224	0,00962
9	BMRI	0,00038	-0,00063
10	GGRM	-0,04129	-0,04255
11	HMSP	-0,05889	-0,03369
12	ICBP	-0,01266	-0,11468
13	INKP	-0,02600	0,05961
14	INTP	-0,01060	-0,01353
15	ITMG	-0,02047	0,03139
16	JSMR	-0,00620	0,00837
17	KLBF	-0,00983	0,01109
18	MNCN	0,05245	-0,01891
19	PGAS	-0,01772	0,00702
20	PTBA	-0,02226	0,05233
21	PTPP	-0,01070	0,02138
22	SCMA	-0,01161	0,03193
23	SMGR	-0,00316	-0,00159
24	SRIL	-0,04103	0,00580
25	TLKM	-0,01222	-0,01644
26	UNTR	-0,01841	0,04711
27	UNVR	-0,11337	-1,02381
28	WIKA	0,00087	0,01299

Source: Data processed, 2021

**Table 8.** Excess Return to Beta (ERB) by Order Before Covid-19

No	Stock Code	ERB <sub>i</sub>
1	MNCN	0,05245
2	BBCA	0,01296
3	BBRI	0,01041
4	WIKA	0,00087
5	BMRI	0,00038
6	ADRO	-0,00175
7	SMGR	-0,00316
8	JSMR	-0,00620
9	KLBF	-0,00983
10	ANTM	-0,01053
11	INTP	-0,01060
12	PTPP	-0,01070
13	SCMA	-0,01161
14	BBNI	-0,01214
15	TLKM	-0,01222
16	ICBP	-0,01266
17	PGAS	-0,01772
18	ASII	-0,01814
19	UNTR	-0,01841
20	AKRA	-0,01874
21	ITMG	-0,02047
22	PTBA	-0,02226
23	INKP	-0,02600
24	SRIL	-0,04103
25	GGRM	-0,04129
26	BBTN	-0,04224
27	HMSP	-0,05889
28	UNVR	-0,11337

Source: Data processed, 2021

**Table 9.** Excess Return to Beta (ERB) by Order During Covid-19

No	Stock Code	ERB <sub>i</sub>
1	ANTM	0,06714
2	INKP	0,05961
3	PTBA	0,05233
4	UNTR	0,04711
5	SCMA	0,03193
6	ITMG	0,03139
7	PTPP	0,02138
8	ADRO	0,01404
9	WIKA	0,01299
10	KLBF	0,01109
11	BBTN	0,00962
12	JSMR	0,00837
13	BBCA	0,00733
14	PGAS	0,00702
15	ASII	0,00636
16	SRIL	0,00580
17	BBRI	0,00176
18	BMRI	-0,00063
19	SMGR	-0,00159
20	BBNI	-0,00213
21	AKRA	-0,00273
22	INTP	-0,01353
23	TLKM	-0,01644
24	MNCN	-0,01891
25	HMSP	-0,03369
26	GGRM	-0,04255
27	ICBP	-0,11468
28	UNVR	-1,02381

Source: Data processed, 2021

**Table 10.** ERB<sub>i</sub>, A<sub>i</sub>, B<sub>i</sub>, C<sub>i</sub> and C\* Before Covid-19

No	Stock Code	ERB <sub>i</sub>	A <sub>i</sub>	B <sub>i</sub>	C <sub>i</sub>	C*
1	MNCN	0,05245	2,74149	52,26482	0,00282	-
2	BBCA	0,01296	15,21863	1173,83300	0,00837	-
3	BBRI	0,01041	9,97252	957,64040	0,00900	0,00900
4	WIKA	0,00087	0,73912	847,58477	0,00726	-
5	BMRI	0,00038	0,42573	1113,63449	0,00575	-
6	ADRO	-0,00175	-1,25674	718,55896	0,00481	-
7	SMGR	-0,00316	-1,02850	325,03731	0,00439	-
8	JSMR	-0,00620	-1,84251	297,32018	0,00390	-
9	KLBF	-0,00983	-2,35540	239,58710	0,00340	-
10	ANTM	-0,01053	-2,89237	274,60227	0,00285	-
11	INTP	-0,01060	-2,54617	240,27570	0,00240	-
12	PTPP	-0,01070	-17,08974	1596,95557	0,00001	-
13	SCMA	-0,01161	-3,79515	326,98562	-0,00041	-
14	BBNI	-0,01214	-10,37130	854,17391	-0,00142	-
15	TLKM	-0,01222	-1,31233	107,37948	-0,00153	-
16	ICBP	-0,01266	-0,15763	12,45210	-0,00155	-
17	PGAS	-0,01772	-11,05028	623,66852	-0,00249	-
18	ASII	-0,01814	-13,46478	742,35538	-0,00351	-
19	UNTR	-0,01841	-5,55528	301,70712	-0,00389	-
20	AKRA	-0,01874	-8,00711	427,29480	-0,00441	-
21	ITMG	-0,02047	-11,98802	585,74494	-0,00515	-
22	PTBA	-0,02226	-16,92045	760,10378	-0,00611	-
23	INKP	-0,02600	-5,50995	211,90173	-0,00642	-
24	SRIL	-0,04103	-8,26441	201,43010	-0,00692	-
25	GGRM	-0,04129	-3,51365	85,09752	-0,00713	-
26	BBTN	-0,04224	-3,36111	79,57991	-0,00733	-
27	HMSP	-0,05889	-14,67781	249,23517	-0,00823	-
28	UNVR	-0,11337	-1,30513	11,51171	-0,00831	-

Source: Data processed, 2021

**Table 11.** ERB<sub>i</sub>, A<sub>i</sub>, B<sub>i</sub>, C<sub>i</sub> and C\* During Covid-19

No	Stock Code	ERB <sub>i</sub>	A <sub>i</sub>	B <sub>i</sub>	C <sub>i</sub>	C*
1	ANTM	0,06714	5,42193	80,75659	0,02759	-
2	INKP	0,05961	2,95346	49,54875	0,03403	-
3	PTBA	0,05233	1,49741	28,61323	0,03594	-
4	UNTR	0,04711	0,71349	15,14440	0,03652	0,03652
5	SCMA	0,03193	4,50771	141,16317	0,03502	-
6	ITMG	0,03139	1,60245	51,04730	0,03464	-
7	PTPP	0,02138	6,69361	313,09775	0,02942	-
8	ADRO	0,01404	0,44364	31,60542	0,02883	-
9	WIKA	0,01299	3,54790	273,20817	0,02489	-
10	KLBF	0,01109	0,13575	12,23686	0,02474	-
11	BBTN	0,00962	0,94540	98,30050	0,02351	-
12	JSMR	0,00837	0,84915	101,45004	0,02234	-
13	BBCA	0,00733	1,17564	160,28532	0,02071	-
14	PGAS	0,00702	1,44811	206,22746	0,01903	-
15	ASII	0,00636	0,72641	114,17151	0,01822	-
16	SRIL	0,00580	0,66793	115,12585	0,01747	-
17	BBRI	0,00176	0,36446	207,65959	0,01593	-
18	BMRI	-0,00063	-0,13932	221,68680	0,01436	-
19	SMGR	-0,00159	-0,20774	130,56577	0,01351	-
20	BBNI	-0,00213	-0,47035	220,81225	0,01223	-
21	AKRA	-0,00273	-0,50478	184,93710	0,01127	-
22	INTP	-0,01353	-2,03318	150,32763	0,01003	-
23	TLKM	-0,01644	-1,29305	78,63633	0,00936	-
24	MNCN	-0,01891	-4,46463	236,08409	0,00736	-
25	HMSA	-0,03369	-1,92953	57,27579	0,00667	-
26	GGRM	-0,04255	-6,34161	149,03418	0,00460	-
27	ICBP	-0,11468	-0,30629	2,67080	0,00451	-
28	UNVR	-1,02381	-0,02026	0,01979	0,00451	-

Source: Data processed, 2021

#### Determination of Optimal Portfolio Candidates

Based on table 10 above, it can be seen that the Cut-Off Point (C\*) value for the period before Covid-19 occurred in the shares of Bank Rakyat Indonesia (Persero) Tbk (BBRI) of 0.00900 which is the last limit value where the ERB value is greater than C<sub>i</sub> value. So that included as candidates for the optimal portfolio as many as 3 stocks, namely Media Nusantara Citra Tbk (MNCN), Bank Central Asia Tbk (BBCA), and Bank Rakyat Indonesia (Persero) Tbk (BBRI).

Meanwhile, for the Covid-19 period as shown in table 11 above, it is known that the Cut-Off Point (C\*) value is located in United Tractors Tbk (UNTR) shares of 0.03652 which is the last limit value where the ERB value is greater than the C<sub>i</sub> value. . So the stock candidates that make up the optimal portfolio are 4 stocks, namely Aneka Tambang Tbk (ANTM), Indah Kiat Pulp & Paper Tbk (INKP), Bukit Asam Tbk (PTBA) and United Tractors Tbk (UNTR).

#### Stock Proportion in the Optimal Portfolio Category

**Table 12.** Stock Proportion Before Covid-19

No	Stock Code	Z <sub>i</sub>	W <sub>i</sub>	Percentage
1	MNCN	1,884071525	0,185461403	18,55%
2	BBCA	7,09348755	0,698258072	69,83%
3	BBRI	1,181274501	0,116280525	11,63%
<b>Total</b>		<b>10,15883358</b>	<b>1</b>	<b>100%</b>

Source: Data processed, 2021

**Table 13.** Stock Proportion of each share during Covid-19

No	Stock Code	$Z_i$	$W_i$	Percentage
1	ANTM	1,35762	0,384114	38,41%
2	INKP	0,965053	0,273044	27,30%
3	PTBA	0,88991	0,251784	25,18%
4	UNTR	0,321836	0,091058	9,11%
<b>Total</b>		<b>3,534418665</b>	<b>1</b>	<b>100%</b>

Source: Data processed, 2021

**Table 14.** The Beta and Alpha Values Before and During Covid-19

	Before Covid-19	Covid-19 Period
$\alpha_p$	0,028475571	0,078753126
$\beta_p$	0,814723546	1,196475633

Source: Data processed, 2021

In table 5.16 the beta value of the portfolio before the Covid-19 occurred was 0.814723546. That is, if there is an increase (decrease) in market return by 10%, the portfolio will experience an increase (decrease) in return of 8.147%. Meanwhile, during the Covid-19 period, the beta portfolio value was 1.196475633. Which means, if there is an increase (decrease) in market return by 10%, the portfolio will experience an increase (decrease) in return by 11.965%. Then the alpha portfolio value before Covid-19 was 0.028475571, which means this value indicates that the portfolio return that is not influenced by the market is 2.85%. Meanwhile, during the Covid-19 period, the alpha portfolio value was 0.078753126, which means that the portfolio return that is not influenced by the market is 7.88%.

**Table 15.** The Value of  $E(R_p)$  and  $\sigma_p^2$

	Before Covid-19	Covid-19 Period
$E(R_p)$	0,023669025	0,078544263
$\sigma_p^2$	0,000721873	0,012364093

Source: Data processed, 2021

Based on the calculations above, the optimal portfolio formed before the pandemic is able to provide an expected return of 0.023669025 or 2.37% with a portfolio risk of 0.000721873 or 0.07%. This will affect the investor's decision to invest in stocks that are included in the optimal portfolio because it has a higher expected return than the market's expected return of -0.00590 and the risk contained in this stock portfolio is smaller than the risk of individual stocks, where the risk of individual stocks from the range of 0.00083 to 0.02938.

Meanwhile, the optimal portfolio formed during the Covid-19 pandemic is able to provide an expected return of 0.078544263 or 7.85% with a portfolio risk of 0.012364093 or 1.24%. This will affect investors' decisions to invest in stocks that are included in the optimal portfolio because in addition to having a higher expected return than the market's expected return of -0.00017 but also having a portfolio risk that is smaller than the risk of individual stocks, where the risk of individual stocks from the range of 0.005276 to 0.079292.

When viewed from the expected return and risk values between periods, investors will choose to invest during the pandemic with an expected return of 7.85% and a portfolio risk of 1.24% compared to before the pandemic where the expected return is only 2.37% with a portfolio risk of 0.07%.

## CONCLUSION

The analysis of optimal portfolio formation with the Single Index Model for the period before Covid-19 occurred can produce 3 stocks and during the Covid-19 period there were 4 stocks as candidates for the optimal portfolio composing of the 28 company stocks that were used as research samples. Stocks that are included in the optimal portfolio candidates for the period before Covid-19 are Media Nusantara Citra Tbk (MNCN) shares with a proportion of 18.55% of funds, Bank Central Asia Tbk (BBCA) 69.83%, and Bank Rakyat Indonesia (Persero) Tbk (BBRI) 11.63%. The expected return that investors will get if they invest before Covid-19 is 0.023669025 or 2.37% with a portfolio risk of

0.000721873 or 0.07%. While during the Covid-19 pandemic, Aneka Tambang Tbk (ANTM) shares with a proportion of 38.41% of funds, Indah Kiat Pulp & Paper Tbk (INKP) 27.30%, Bukit Asam Tbk (PTBA) 25.18% and United Tractors Tbk (UNTR) 9.11%. And if investors make investments during the Covid-19 pandemic, they can generate expected returns from the optimal portfolio formed of 0.078544263 or 7.85% with the risk that will be borne by investors on their investments of 0.012364093 or 1.24 %.

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