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ANALYSIS OF PORTFOLIO FORMATION ON THE LQ45 STOCKS INDEX, USING THE MARKOWITZ AND SINGLE INDEX MODELS

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ABSTRACT

In an investment, there will always be a return and risk, especially in the capital market in the form of stocks. The risk in an investment can be minimized by diversifying assets into several stocks to form a portfolio formation. Several models, such as the Single Index and Markowitz, can evaluate optimal portfolio formation. In this study we provide additional information and discourse on capital market studies and as the input for investors in making investment decisions in the form of stocks. The study shows that based on 25 companies, the Markowitz model gives 12 companies as the optimal portfolio with the largest proportion of funds owned by PT Bank Central Asia Tbk (BBCA), 82.22%. The portfolio of those 12 stocks can provide an expected return of 44.8% where its risk is about 13.77%. The Single Index model provides a formation based on 9 companies as the optimal portfolio with the largest proportion of funds owned by -again- PT Bank Central Asia Tbk (BBCA) which is 66.23%. The portfolio of these nine stocks can provide the expected return of 1.68% and its risk is 0.43%. The ratio of risk and return from each model justifies that the Single Index model gives better portfolio formation. This result should be further compared with other stock indexes, nationally and globally, and also needs to be compared with the period after the pandemic.

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1. INTRODUCTION

Investment is an activity to invest capital or money that is carried out currently with the hope of obtaining profits in the future. It is a commitment to several funds or other resources to achieve future benefits [1], [2]. The purpose of an investor investing is to get a more decent life in the future, reduce the pressure of inflation, and as an effort to save taxes [3]. Investment activities can be carried out in two ways: on financial and tangible assets. Investment in financial assets can be done in the capital market. The capital market is for various long-term financial instruments (or securities) that can be traded in debt or equity, whether issued by the government, public authorities, or private companies [4]. The capital market is not new in the investment world, including in Indonesia. As Gunawan [5] mentioned, the age of the Indonesian capital market is no longer young because this nation has been familiar with the capital market since 1912.

Stocks are capital market instruments in the form of proof of ownership of a company that makes an offer (go public) in a certain nominal or percentage [3]. Generally, two kinds of shares are issued by a company conducting a public offering (IPO), namely common and preferred stocks. The difference between these two shares is based on the rights attached to the stocks.

Tandelilin [1], [2] said that there are five stages to coming to the best investment decision, namely, determination of investment objectives, determination of investment policies, selection of portfolio strategies, and measurement, and evaluation of portfolio performance. According to [6], [7], and [8], the portfolio is a collection of financial assets in a unit that is held or created by an investor, investment company, or financial institution. Modern portfolio theory assumes that all investors are risk averse. This theory teaches how to combine stocks into a portfolio to obtain maximum profit with a particular risk or obtain a profit with minimal risk. Risk in an investment can be avoided by diversifying stocks by forming a portfolio.

Risk is often associated with deviations between the outcome received and its expected. Van Horne and Wachwics in [7], and [8], define risk as the variability of the return to the expected return. Risk is a possible difference between the expected rate of return and the return received. There are two types of risks, namely systematic and unsystematic risks.

Return is a reward for the courage of investors to take risks on the investments made. The return has two components, namely yield and capital gain (loss). Yield is the percentage of periodic cash receipts against the investment price of a certain period of investment [7], [8], while capital gain (loss) is a gain or loss due to an increase in the price of securities. Stock returns are divided into Individual Stock Realized Returns and Individual Stock Expected Returns.

Investment activities in the capital market in the form of shares are undoubtedly inseparable from the returns and risks inherent in them. An investor is required not only to think about the return that will be received in the future but also to consider the risks the investor will bear. The risk referred to in this case is the risk of loss.

The risk of loss experienced by investors can be minimized by diversifying or spreading assets. That is, investors do not only invest their funds in one stock but several stocks; this collection of several stocks is called a portfolio. Investors forming a portfolio do not just combine a few stocks but must consider two inherent elements, namely the return and the risk, to optimize them.

These two considerations can be measured by some models, for example, the Markowitz [9], [10], [11], [12], [13], [14] and the single index models [10], [14], [15], [16], [17], [18]. Both models provide information to investors in investment decisions on the capital market in the form of a stock portfolio [9], [10], [11], [12], [13], [14], [15], [16], [17], [18].

The Markowitz and the Single Index models are used to measure and calculate returns and risks in a portfolio and to determine stocks that can form an optimal portfolio. Markowitz model is the first of modern portfolio theory which was developed by Markowitz in 1950. The model forms an optimal portfolio based on the expected portfolio return and the variance of the portfolio return, which is known as Mean-Variance (M-V) based analysis. According to Markowitz, a portfolio is preferred to other portfolios if it has a higher expected return and lower variance. The Markowitz model allows investors to choose portfolios according to their characteristics, providing the smallest risk with the expected return that follows or choosing certain returns with risks that are ready to bear. It is said Markowitz model is easy to apply because the optimal portfolio is assessed at the lowest point of the efficient portfolio [19].

The Single Index model is a model which was developed by Sharpe. The model is the development of the Markowitz model. Portfolio formation using a single index model can be done by comparing the ERB (Excess Return to Beta) value of a stock with its C_i (Cut-off rate) value. The single index model is considered risk-free assets. It is based on observing the price of a stock that fluctuates in the direction of the market index.

The Indonesia Stock Exchange (IDX) publishes stock indexes that contain companies with specific criteria to overcome the difficulties experienced by investors. One of these indexes is the LQ45; the stocks listed on the LQ45 index are 45 stocks with a high liquid market capitalization, have a high trading frequency, have growth prospects and relatively good financial conditions, are not volatile, and have been objectively selected by IDX, such that in terms of risk, the LQ45 stock group has the lowest risk compared to other stocks **[5]**.

During the COVID-19 pandemic, most of the authors analyze the stock data sets of LQ45, and the period is focused on years 2019-2020, for instance **[11]**, **[13]**, **[14]**, **[17]**, **[18]**.

In this paper, the authors are interested in analyzing the portfolio formation in LQ45 index stocks by using both the Markowitz and Single Index models before the pandemic period, which is in the year 2014-2018. The use of these two models is intended to compare the results of each model, which is expected to provide transparent information for investors in investment decisions in the future. These two periods are important to be modeled such that we can compare the results from before and during the pandemic. Moreover, in the future, we subsequently can analyze the data set after the pandemic.

2. RESEARCH METHODS

2.1. Research Design

We estimate the optimal portfolio stocks, and compute their return and risk, by using the Single Index and Markowitz models, based on the LQ45 stocks data. We choose the best model based on the highest return, smallest risk, and ratio of risk and return [20]. We use the Excel and R software during the computation. The ratio between the risk and expected return

2.2. Data Sources and Data Collection Techniques

We collected the data from the IDX website www.idx.co.id, which is the LQ45 stock data from 2014 to 2018. In IDX, within a year, there were two announcements regarding changes in the stocks in the LQ45 index, namely August to January and February to July. This announcement means that there are stocks that leave or enter the LQ45. The samples in this study are stocks that have always consistently existed in the LQ45 list from 2014 to 2018. There are 25 stocks fulfilling this criterion, which can be seen in **Table 1.**

Table 1. LQ45 Stock in the Study

No	Stocks	No	Stocks	No	Stocks
1	ADHI	10	GGRM	19	PTPP
2	ADRO	11	ICBP	20	SMGR
3	AKRA	12	INDF	21	TLKM
4	ASIA	13	INTP	22	UNTR
5	BBCA	14	JSMR	23	UNVR
6	BBNI	15	KLBF	24	WIKA
7	BBRI	16	MNCN	25	WSKT
8	BMRI	17	PGAS		
9	BSDE	18	PTBA		

2.3. Data Analysis

2.3.1. Markowitz Model

As we already know, the portfolio return is a weighted average of all single security returns, but portfolio risk is not a weighted average of all single security risks. Portfolio risk may be less than the weighted average risk of each single security. The concept of portfolio risk was first formally introduced by Harry M. Markowitz in the 1950s, and then he won the Nobel Prize in economics in 1990 for his work. He pointed out that, in general, risk may be reduced by combining several single securities into a portfolio. The main requirement to reduce risk in the portfolio is that the returns for each security are not positively and perfectly correlated.

The Markowitz model shows that the variance of portfolio returns on financial securities depends not only on how risky the individual assets in the portfolio are but also on the risk relationship to the securities [21]. This model believes that the addition of stocks continuously in one portfolio at a certain point will further reduce the benefits of diversification and increase the risk level [1], [2].

Suppose P_t and P_{t-1} are, respectively, the stock price at the time t and $t-1$, and n is the year of the stock data set. Calculation of the optimal portfolio in the Markowitz model can be done in several stages [11], [12], [13], [14], [22], as follows:

a. Calculate the realized return of individual stocks

$$R_{it} = \frac{P_t - P_{t-1}}{P_{t-1}} \tag{1}$$

b. Calculate the expected return of individual stocks

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

c. Calculate the standard deviation of individual stock σ_i and variance σ_i^2

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

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

d. Calculate the covariance of individual stock i and j

$$\sigma_{ij} = \sum_{t=1}^{n} \frac{(R_{it} - E(R_i))\,((R_{jt} - E(R_j))}{n-1} \tag{5}$$

e. Calculate the correlation coefficient (ρ) between the stocks of each company. Let X and Y, respectively, be the rate of return from stock A and stock B. Then the value of the correlation

$$\rho = \frac{n\sum XY - \sum X \sum Y}{\sqrt{[n\sum X^2 - (X)^2][n\sum Y^2 - (\sum Y)^2]}} \tag{6}$$

f. Calculate the portfolio returns

$$E(R_p) = \sum_{i,j=1}^{n} W_i \cdot E(R_i) + W_j \cdot E(R_j) \tag{7}$$

g. Calculate the portfolio risk $\sigma_p = \sqrt{\sum_{i,j=1}^{n} W_i W_j \sigma_{ij}}$ and ${\sigma_p}^2 = \sum_{i,j=1}^{n} W_i W_j \sigma_{ij}$

$$\sigma_p = \sqrt{\sum_{i,j=1}^{n} W_i W_j \sigma_{ij}} \tag{8}$$

$${\sigma_p}^2 = \sum_{i,j=1}^{n} W_i W_j \sigma_{ij} \tag{9}$$

2.3.2. Single Index Model (SIM)

An optimal portfolio stock can also be achieved by implementing the single index model [5], [6]. Analysis of portfolio formation using the single index model begins by calculating the individual returns of each stock included in the sample and market returns. After that, it is continued by calculating the expected return of each stock and the expected return of the market.

Suppose P_t and P_{t-1} are, respectively, the stock price at the time t and $t-1$, I_t and I_{t-1} are, respectively, the LQ45 market at the time t and $t-1$, n is the number of data, and T is the number of times. The Single Index Model is processed as follows [5], [6], [17], [18], [21].

a. Calculate the stock return R_{it} and the market return R_{mt}

$$R_{it} = \frac{P_{it} - P_{it-1}}{P_{it-1}} \tag{10}$$

$$R_{mt} = \frac{I_{mt} - I_{mt-1}}{I_{mt-1}} \tag{11}$$

b. Calculate the expected stock return $E(R_i)$ and the expected market return $E(R_m)$

$$E(R_i) = \frac{\sum_{t=1}^{T} R_{it}}{T} \tag{12}$$

$$E(R_m) = \frac{\sum_{t=1}^{T} R_{mt}}{T} \tag{13}$$

c. Calculate the stock risk σ_i^2 and market risk σ_m^2

$$\sigma_i^2 = \frac{\sum_{t=1}^{T}[R_{it} - E(R_i)]^2}{T} \tag{14}$$

$$\sigma_m^2 = \frac{\sum_{t=1}^{T}[R_{mt} - E(R_m)]^2}{T} \tag{15}$$

d. Calculate the beta and alpha of stock, respectively are $\beta_i = \frac{\sigma_i^2}{\sigma_m^2}$ and $\alpha_i = E(R_i) - \beta_i E(R_m)$

$$\beta_i = \frac{\sigma_i^2}{\sigma_m^2} \tag{16}$$

$$\alpha_i = E(R_i) - \beta_i E(R_m) \tag{17}$$

e. Calculate the variance of residual σ_{ei}^2

$$\sigma_{ei}^2 = \frac{1}{T}\sum_{t=1}^{T}[R_{it} - (\alpha_i + \beta_i R_{mt})] \tag{18}$$

f. Calculate the excess return to beta (ERB)

$$ERB_i = \frac{E(R_i) - R_{fr}}{\beta_i} \tag{19}$$

g. Specify the cut-off point
The cut-off point (C*) is the largest C_i value [7], [8]. The value of C* determines which stock limit points are included as optimal portfolio candidates. The optimal portfolio consists of stocks with an ERB value greater than or equal to the C_i value.

$$C_i = \frac{\sigma_m^2 \sum_{j=1}^{i} A_j}{1 + \sigma_m^2 \sum_{j=1}^{i} B_j} \tag{20}$$

where $A_j = \frac{[E(R_j) - R_{fr}]\beta_j}{\sigma_{ej}^2}$ and $B_j = \frac{\beta_j^2}{\sigma_{ej}^2}$

h. Determine the optimal portfolio candidate with the criteria if the stock ERB > C^*.

i. Calculate the proportion of funds for each stock W_i

$$W_i = \frac{Z_i}{\sum_{i=1}^{n} Z_i} \tag{21}$$

where $Z_i = \frac{\beta_i^2}{\sigma_{ei}^2}(ERB_i - C^*)$.

j. Counting beta and alpha for portfolio
$\beta_p = \sum_{i=1}^{n} \beta_i W_i$ and $\alpha_p = \sum_{i=1}^{n} \alpha_i W_i$

k. Calculate the portfolio return R_p, portfolio expected return $E(R_p)$ and portfolio risk σ_p

$$R_p = E(R_i)W_i$$

$$E(R_p) = \alpha_p + \beta_p\, E(R_m) \tag{22}$$

$$\sigma_p = \sqrt{\beta_p^2 \sigma_m^2 + \sum_{i=1}^{n} W_i^2 \sigma_{ei}^2} \tag{23}$$

3. RESULTS AND DISCUSSION

3.1. Markowitz Model

3.1.1 Stock Performance from the Rate of Return and Risk

The calculation of stock performance can be seen from the return given and the risks contained in it. Return is divided into two, namely realized return and expected return. The realized return is the average return received by investors based on historical data, while the expected return is the return expected by investors. The results of the calculation of the returns and risks are presented in **Table 2**.

Table 2 shows that the company with the most significant realized return is PT Bukit Asam Tbk, with a PTBA stock code of 4.3264 and an expected return of 0.0733. This shows that the return received by investors in the last five years is 433%, and the expected return is 7.33%, with a risk level of 27.84%.

Table 2. Individual Stock Returns and Risks

No	Stock	R_i	$E(R_i)$	σ_i^2
1	ADHI	0.1782	0.0030	0.0134
2	ADRO	0.6568	0.0111	0.0111
3	AKRA	0.3354	0.0057	0.0067
4	ASII	0.3174	0.0054	0.0040
5	BBCA	1.0910	0.0185	0.0024
6	BBNI	0.8880	0.0151	0.0064
7	BBRI	0.8733	0.0148	0.0047
8	BMRI	1.0926	0.0185	0.0213
9	BSDE	0.0403	0.0007	0.0062
10	GGRM	0.6785	0.0115	0.0040
11	ICBP	1.2944	0.0219	0.0264
12	INDF	0.2065	0.0035	0.0045
13	INTP	0.1317	0.0022	0.0095
14	JSMR	0.0723	0.0012	0.0054
15	KLBF	0.1967	0.0033	0.0032
16	MNCN	-0.5636	-0.0096	0.0184
17	PGAS	-0.1710	-0.0029	0.0170
18	PTBA	4.3264	0.0733	0.2784
19	PTPP	0.9920	0.0168	0.0154
20	SMGR	0.0528	0.0009	0.0078
21	TLKM	0.6188	0.0105	0.0033
22	UNTR	0.4719	0.0080	0.0058
23	UNVR	0.6459	0.0109	0.0029
24	WIKA	0.3527	0.0060	0.0143
25	WSKT	1.4641	0.0248	0.0122

The portfolio in this case does not directly combine one stock with another stock and does not only consider the return and risk aspects but also considers the covariance and correlation coefficient of the stock. Covariance is a calculation that describes the movement between stocks, which is combined to determine the effect between stocks. The correlation coefficient is a calculation describing the risk movement between stocks.

3.1.2 The Proportion of Stock Funds that Make Up the Optimal Portfolio

The proportion of stock funds determines how much money will be invested in each stock that produces the optimal portfolio. The proportion of these funds can be seen in **Table 3**.

Table 3. Proportion of Temporary Funds

Stock	W_i	Stock	W_i
ADHI	-1.14%	JSMR	-35.20%
ADRO	-4.85%	KLBF	-42.00%
AKRA	-7.02%	MNCN	-14.26%
ASIA	-8.97%	PGAS	-6.38%
BBCA	82.22%	PTBA	1.68%
BBNI	-12.06%	PTPP	20.59%
BBRI	23.37%	SMGR	8.51%
BMRI	-2.61%	TLKM	37.15%
BSDE	-24.63%	UNTR	26.14%
GGRM	19.10%	UNVR	27.21%
ICBP	5.65%	WIKA	-11.44%
INDF	1.81%	WSKT	26.33%
INTP	-9.22%		

Table 3 shows that several stocks form a negative proportion, meaning that these shares do not qualify as candidates for the optimal portfolio. Therefore, the shares with a negative proportion value must be eliminated. The stocks that make up the optimal portfolio are presented in **Table 4.**

Table 4. Proportion of Optimal Portfolio Funds

No	Stock	W_i
1	BBCA	82.22%
2	TLKM	37.15%
3	UNVR	27.21%
4	WSKT	26.33%
5	UNTR	26.14%
6	BBRI	23.37%
7	PTPP	20.59%
8	GGRM	19.10%
9	SMGR	8.51%
10	ICBP	5.65%
11	INDF	1.81%
12	PTBA	1.68%

Table 4 shows that the most significant proportion of funds is owned by PT Bank Central Asia Tbk (BBCA) at 82.22% with an individual risk of 0.0024 and portfolio risk of 0.1377. This means that the individual risk owned by the stock has been successfully diversified to become smaller. The expected return of the portfolio is 0.4480. It means that the optimal portfolio stock performance increases in generating returns.

The Markowitz model on the data set has provided 12 stocks in the optimal portfolio, which are BBCA, TLKM, UNVR, WSKT, UNTR, BBRI, PTPP, GGRM, SMGR, ICBP, INDF, and PTBA. The fund proportion that can be invested into that optimal portfolio for each stock is 82.22%, 37.5%, 27.21%, 26.33%, 26.14%, 23.37%, 20.59%, 19.10%, 8.51%, 5.65%, 1.81%, and 1.68%. The optimal portfolio is expected to have a return of 44.8% per month, and the risk is 13.77%.

3.2 Single Index Model

3.2.1 Calculating expected return and stock and market risk

Of the twenty-five data sets studied, the stock that provides the highest level of expected return is PTBA stock, which is 0.0733, while the stock that provides the lowest expected return is MNCN stock, which is -0.0096. From the calculation of individual stock variance, the stock with the largest variance is PTBA stock of 0.2784, while the stock with the lowest variance is BBCA of 0.0024.

In this study, two stocks have a negative expected return: MNCN and PGAS. The investors will avoid these two stocks because rational investors will choose stocks with a positive expected return and the lowest risk, but this also depends on the risk preferences of each investor.

Based on the calculations made on the market return, it is found that the expected market return is 0.0064 per month, and the standard deviation is 0.0308. Meanwhile, the market risk covered is 0.0009; see **Tables 5** and **6**. **Table 6** also shows that the expected market return has a positive value, which proves that investment in the capital market provides a return or profit for investors.

Table 5. Expected Return and Market Variance

No	Stock	$E(R_i)$	σ_i^2	No	Stock	$E(R_i)$	σ_i^2
1	ADHI	0.0030	0.0134	14	JSMR	0.0012	0.0054
2	ADRO	0.0111	0.0111	15	KLBF	0.0033	0.0032
3	AKRA	0.0057	0.0067	16	MNCN	-0.0096	0.0184
4	ASII	0.0054	0.0040	17	PGAS	-0.0029	0.0170
5	BBC	0.0185	0.0024	18	PTBA	0.0733	0.2784
6	BBNI	0.0151	0.0064	19	PTPP	0.0168	0.0154
7	BBRI	0.0148	0.0047	20	SMGR	0.0009	0.0078
8	BMRI	0.0185	0.0213	21	TLKM	0.0105	0.0033
9	BSDE	0.0007	0.0062	22	UNTR	0.0080	0.0058
10	GGRM	0.0115	0.0040	23	UNVR	0.0109	0.0029
11	ICBP	0.0219	0.0264	24	WIKA	0.0060	0.0143
12	INDF	0.0035	0.0045	25	WSKT	0.0248	0.0122
13	INTP	0.0022	0.0095				

Table 6. Expected Return of the Market

$E(R_m)$	0.0064
σ_m^2	0.0009
σ_m	0.0308

3.2.2 Calculating Excess Return to Beta

In calculating excess return to beta (ERB), the residual error variance (σ_{ei}^2), alpha, and beta values are needed. Stock residual variance error is a unique or unsystematic risk, namely, a risk that diversification can eliminate. Unsystematic risk only exists in the company concerned; hence, this risk can be diversified.

The alpha values obtained are varied; some companies have negative and positive alpha values. As we already understand, alpha is the value of the expected stock return independent of market returns. A change in market return in the form of an increase or decrease will not affect individual stock returns. Alpha is part of the individual stock returns unaffected by market changes.

Beta is the unique risk of the stock, which is the sensitivity of stock returns to market returns. Positive beta indicates that stock returns will also increase if market returns increase. An increase in market returns will increase LQ45 index stock returns. Conversely, if beta is negative, the increase in market return will be followed by a decrease in stock returns.

Based on the calculations in **Table 7**, the company with the highest beta is MNCN of 2.0823. This means that if there is an increase in market return of one unit, it will be followed by an increase in MNCN stock return of 2.0823 units or 208%.

To obtain candidate portfolios from the LQ45 index company shares, the excess return to beta (ERB) calculation is carried out. ERB is the excess of return over risk-free return on other assets and shows the relationship between return and risk, which is a determinant of investment. Based on the ERB calculation, the highest ERB value is ICBP of 0.0857, and the lowest ERB value is PTBA of -0.2558. Remember that the optimal portfolio stocks must have a high ERB value.

Table 7. ERB Computation

Stock	β_i	α_i	σ_{ei}^2	R_f	ERB_i
ADHI	1.7044	-0.0078	0.0134	0.0026	0.0003
ADRO	1.4518	0.0019	0.0111	0.0026	0.0059
AKRA	0.7207	0.0011	0.0067	0.0026	0.0043

Stock	β_i	α_i	σ_{ei}^2	R_f	ERB_i
ASII	1.5396	-0.0044	0.0040	0.0026	0.0018
BBC	1.0811	0.0116	0.0024	0.0026	0.0147
BBNI	1.8657	0.0032	0.0064	0.0026	0.0067
BBRI	1.6203	0.0045	0.0047	0.0026	0.0076
BMRI	0.8157	0.0133	0.0213	0.0026	0.0196
BSDE	1.6306	-0.0097	0.0062	0.0026	-0.0012
GGRM	0.6966	0.0071	0.0040	0.0026	0.0128
ICBP	0.2262	0.0205	0.0264	0.0026	0.0857
INDF	1.1580	-0.0039	0.0045	0.0026	0.0008
INTP	1.6676	-0.0084	0.0095	0.0026	-0.0002
JSMR	1.2585	-0.0068	0.0054	0.0026	-0.0011
KLBF	1.1518	-0.0040	0.0032	0.0026	0.0007
MNCN	2.0823	-0.0228	0.0184	0.0026	-0.0058
PGAS	1.9163	-0.0151	0.0170	0.0026	-0.0028
PTBA	-0.2768	0.0751	0.2784	0.0026	-0.2556
PTPP	1.8173	0.0052	0.0154	0.0026	0.0078
SMGR	1.5919	-0.0092	0.0078	0.0026	-0.0010
TLKM	0.5814	0.0068	0.0033	0.0026	0.0136
UNTR	0.7925	0.0030	0.0058	0.0026	0.0069
UNVR	0.7378	0.0063	0.0029	0.0026	0.0114
WIKA	1.8884	-0.0060	0.0143	0.0026	0.0018
WSKT	1.6136	0.0145	0.0122	0.0026	0.0138

3.2.3 Determine the Cut-Off Point(C*)

The cut-off point (C*) in this study is 0.0074. The ERB value must be compared with the cut-off point value to obtain the optimal stock portfolio candidate. After stocks are sorted by ERB value from highest to lowest, then we have nine stocks to be included in the optimal stock portfolio. The stocks are ICBP, BMRI, BBCA, WSKT, TLKM, GGRM, UNVR, PTPP, and BBRI. Therefore, the other 16 stocks are not included in the optimal portfolio.

3.2.4 Calculating the Proportion of Each Share

The next step is calculating each share's proportion of funds (W_i). To obtain the value of W_i, it is necessary to calculate the weighted scale of each share (Z_i). **Table 8** shows the result of calculating each share's weighted scale and the proportion of funds.

Table 8. Fund Proportion

No	Stock	Z_i	W_i
1	ICBP	5.7670	0.25%
2	BMRI	17.8747	0.78%
3	BBC	1522.3973	66.23%
4	WSKT	112.6456	4.90%
5	TLKM	191.4318	8.33%
6	GGRM	168.4643	7.33%
7	UNVR	250.6526	10.90%
8	PTPP	6.6577	0.29%
9	BBRI	22.7524	0.99%
Total		2298.6436	100.00%

Table 8 shows that the most significant proportion of funds is in BBCA company shares, 66.23%, while the lowest is ICBP shares at 0.25%. Stocks with the highest proportion of funds are investment alternatives that rational investors will choose.

3.2.5 Calculating Expected Return and Portfolio Risk

The expected return portfolio is the rate of return expected by investors on the funds invested in the optimal portfolio. The next step is to calculate the portfolio's expected return after knowing the proportion of

funds for the selected stocks in forming the optimal portfolio. Before calculating the portfolio's expected return, calculate the portfolio alpha and beta portfolio. The portfolio's alpha is obtained from the weighted average of each stock's alpha, while the portfolio's beta is obtained from the weighted average of the beta of each stock. The following table is the result of the portfolio alpha and beta calculation.

Table 9 shows that the portfolio return calculated from the nine LQ45 index company stocks selected to form the optimal portfolio is 0.0168, and the obtained variance or portfolio risk is 0.0043. This return will influence investors' decisions to invest in LQ45 index company stocks because they have a higher expected return than the market's expected return or risk-free return.

Table 9. Expected Return and Portfolio Risk

No	Stock	α_p	β_p	σ^2_{ep}
1	ICBP	0.00005	0.00057	0.00007
2	BMRI	0.00010	0.00634	0.00017
3	BBC	0.00769	0.71605	0.00158
4	WSKT	0.00071	0.07907	0.00060
5	TLKM	0.00057	0.04842	0.00028
6	GGRM	0.00052	0.05106	0.00029
7	UNVR	0.00068	0.08045	0.00032
8	PTPP	0.00002	0.00526	0.00004
9	BBRI	0.00004	0.01604	0.00005
	Total	0.01038	1.00326	0.00339
	$E(R_p)$	0.0168		
	σ^2_p	0.0043		

The single index model on the data set provides nine stocks in the optimal portfolio: BBCA, UNVR, TLKM, GGRM, WSKT, BBRI, BMRI, PTPP, and ICBP. The fund proportion that can be invested into that optimal portfolio for each stock is 66.23%, 10.90%, 8.33%, 7.33%, 4.90%, 0.99%, 0.78%, 0.29%, and 0.25%. The optimal portfolio is expected to have a return of 1.68% per month, and the risk is 0.43%.

In comparison to the pandemic, the Markowitz model gives the results that the optimal portfolio consisted of BBCA (Bank Central Asia Tbk.) with a weight of 78.09% and BRPT (Barito Pacific Tbk.) with a weight of 21.91%, which produced an expected return of 2.35% and a standard deviation of 7.01%, see **[11]**. Results from **[14]** conclude that the Markowitz model gives a higher return than the single index model.

On the other hand **[17]** reveal that during the Covid-19 pandemic, Aneka Tambang Tbk (ANTM) shares 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%. Those optimum portfolios, single index model-based, can generate the expected return of 7.85% with a risk of 1.24 %.

The results from **[18]** concluded that the optimal portfolio, based on the Single Index Model, generates a higher return than the individual stocks. The optimal portfolio formation is Erajaya Swasembada Tbk (ERAA), Indah Kiat Pulp & Paper Tbk (INKP), Aneka Tambang (Persero) Tbk (ANTM), Pabrik Kertas Tjiwi Kimia Tbk (TKIM), PP (Persero) Tbk (PTPP), Vale Indonesia Tbk (INCO), and Bank Tabungan Negara (Persero) Tbk (BBTN) with the respective proportions of 0.3065, 0.217, 0.216795, 0.108794, 0.058829, 0.064533, and 0.027549. The optimal portfolio has an expected return of 0.1101, while the risk that must be faced from the optimal portfolio is 0.2095.

For the LQ-45 stocks index, before the pandemic covid -19, the best approach to create the optimal portfolio formation is the Single Index model, which gives higher expected returns. In the meantime, during the COVID-19 pandemic, the Markowitz approach performs better in some research than the single Index model.

4. CONCLUSIONS

Our study on 25 data samples of LQ45 stocks suggested that the two models, the Markowitz, and the single index models, have different optimal portfolio formations. The single index and Markowitz models

respectively obtained 9 and 12 stocks that would be the optimal portfolio group. All companies in the single index model are also in the Markowitz model.

Both models show that the most significant proportion is owned by PT Bank Central Asia Tbk (BBCA), with the proportion of funds in the Markowitz model is 82.22% and in the single index model is 66.23%.

The optimal portfolio formation for the Markowitz model, respectively, gives a portfolio expected return and risk are 44.8% and 13.77%. On the other hand, the optimal portfolio formation for single index models, respectively, gives a portfolio expected return and risk of 1.68% and 0.43%. The ratio between the risk and expected return for Markowitz and single index models are respectively 0.31 and 0.26. The single index model has the lowest ratio.

Based on these findings, it is advised that to form an optimal portfolio, the investor uses the single index model since it can produce stocks with an inevitable expected return, the lowest risk, and the lowest ratio of the risk and expected return.

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