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Optimal Portfolio Comparison Based on Markowitz and Single Index Model Using IDX BUMN20 Stocks during Covid-19

Ricky Albert Husni [1]; Tumpal Samosir [2]; Siji Jati Sindhuarta [3]

[1] dr.r1cky_ah@yahoo.com, Faculty of Economic and Business, Mercu Buana University, Indonesia
[2] tumpalsamosir5@gmail.com, Faculty of Economic and Business, Mercu Buana University, Indonesia
[3] siji.sindhuarta01@gmail.com, Faculty of Economic and Business, Mercu Buana University, Indonesia

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Abstract

The study aims to compare between an optimal portfolio of stocks formed with the Markowitz model and those formed with the Single Index model during the Covid-19 pandemic. This study's goal is to determine which model will give a higher expected return or lower portfolio risk. Samples used are the stocks member of index IDX BUMN20 which never leave the index, never had changes in shares amount in major and minor reviews, also didn't do stock split along the period of January 2020 – January 2022. The study method used is a quantitative method with a cross-sectional approach. The results show that both higher expected returns and lower portfolio risk are given by the Single Index model. This demonstrates that the optimal portfolio formed with the Single Index model is better than those formed with the Markowitz model.

INTRODUCTION

Even though the Covid-19 pandemic swept through Indonesia that causes lots of restrictions on social activities, investors are still eager and willing to invest in the stock market. Many investors took advantage of the transaction ease of digital-based investing platforms, thus raising the number of domestic investors rapidly. Therefore, the year 2020 is also said to be the year of rising domestic investors (Sidik, 2021). Based on KSEI data, there is an increase of 417,366 new investors or 28% by the year 2020 (Imung, 2020). And, also derived from KSEI data, the total of investors reached 8,100,000 people in February 2022 (Dirgantara, 2022) compared to 5,088,093 in April 2021 (Sidik, 2021). Looking at these data, enthusiasm for domestic investors is increasing. The stock market is perceived as a profitable place for investing following the level of expected return and risk. That's why investors need to make the right decision because the future of investment is full of uncertainty.

In other words, investments can't be separated from the level of expected return and risk, the higher the expected return is, the investors should also embrace a higher risk. To reduce these risks, one of the alternative ways is to diversify the portfolio. To determine the optimal portfolio, an analysis model is needed to help investors make a decision. There are several models that are generally used, but the models discussed and compared in this study are the Markowitz Model and the Single Index Model..These models are chosen because there are already several studies using these two models to form an optimal portfolio (Septyanto and Kertopati (2014); Maryani, Haryetti, and Wijaya (2015); Nurdianingsih and Suryadi (2021); Susanti, Ervina, Grace, and Siregar (2021).

Researchers choose stocks from the index IDX BUMN20 as the sample because the performance of BUMN stocks are perceived to be good and therefore can give good return to investors (Maryani, et al, 2015). For the calculation purpose in the Single Index model, researchers chose to use IHSG as the market proxy because it shows the moving average for all

of the stocks in the market, which also includes the stocks in the IDX BUMN20 index. And for the risk-free asset, researchers chose the rate of deposit return from the BI 7-Day Repo Rate since deposits return is always positive thus can be regarded as risk-free, especially deposits from good performing banks such as state-owned BUKU 4 banks which are better than private-owned BUKU 4 banks (Kurniawan et al., 2021).

Thus, based on the background above, the goal of this study is to be the pilot study that compares the optimal portfolio formed with the Markowitz model and with those formed with the Single Index model within-study period from January 2020 to January 2022, which can still be regarded as pandemic Covid-19 period.

LITERATURE REVIEW

Investment

According to Reilly and Brown (2012), investment is a commitment of money today for some period with the hope of giving a return for investors in exchange for (1) time spent investing, (2) expected inflation rate in this period, and (3) uncertainties of payment in the future. According to Jogiyanto (2010) and Riandini & Risman (2022), investment is the postponement of today's consumption to be put into productive assets for some period. Therefore, it can be surmised that investment is a form of commitment of money in the present with the hope of giving a profitable return in the future.

Stocks

According to Reilly and Brown (2012), stocks are one of the most common types of security to accumulate equity issued by companies. There are two ways a company can issue common stocks in the primary market, by releasing part of equity owned by the company or by initial public offerings (IPO). There also exists a secondary market to trade publicly traded stocks.

Portfolio

According to Elton, Gruber, Brown, and Goetzmann (2014), a portfolio is a group of assets and could be real assets such as houses, cars, or refrigerators; or financial assets such as stocks and bonds. According to Reilly and Brown (2012), an investment portfolio must be arranged to reflect the economic environment and investor's needs. An investor's policy statement must be made (with the expected rate of return and risk), investment's goals, and investment's boundaries. After that, an investment strategy will be made according to the said policy. Then, the investment portfolio will be decided based on the strategy accepted, and finally, will need to periodically be reviewed to see whether it needs to be changed or not. According to Tandelilin (2010), an efficient portfolio is a portfolio with the highest rate of return with a certain level of risk or the lowest rate of risk with a certain level of return. And from all those efficient portfolios, the one chosen by the investor because it reflects his/her preferences is the optimal portfolio.

Markowitz Model

According to Reilly and Brown (2012), one of the basic portfolio theories is developed by Harry Markowitz, which took the rate of expected return from a portfolio of assets and measured the expected risk. Markowitz showed that the variance of the rate of return is a meaningful measurement for portfolio risk under a set of assumptions. Based on those assumptions, an asset or portfolio will be efficient if there is no other asset or portfolio that can

give a higher expected rate of return with the same or lower risk or a lower rate of risk with a higher or same rate of expected return. Tandelilin (2010) also states that one of the most important teachings from the Markowitz model is the rate of return from an asset is correlated to one another and not independent.

Single Index Model

According to Elton, et al (2014), the Single Index model is based on the observation that changes in a security's price will correlate with one thing only and that is the response of that security to the market's price changes, and this correlation can be searched by connecting the rate of return of a stock with the stock market index. In other words, to calculate the rate of return from a stock, we will only need two components: an independent one, and one that is dependent on the market.

IDX BUMN20

According to Djajadi (2021) in the Indonesia Stock Exchange handbook, a stock index is a statistical measurement that shows the overall price movement for a group of selected stocks that is chosen by a set of criteria and certain methodology and will be evaluated periodically. One of the indexes is the IDX BUMN20, an index that measures the performance of 20 BUMN, BUMD, or affiliated companies' stocks that have a big enough market capitalization and high liquidity. The election of IDX BUMN20 stocks is decided on the volume and frequency of traded stocks in the past 3, 6, and 12 months, and the market capitalization. Stock members of IDX BUMN20 will be reviewed periodically, with a major review every January and July, and a minor review in April and October.

METHOD

This study is quantitative research, where the variables being compared and analyzed will be the portfolio using Markowitz and Single Index model, with a cross-sectional approach. The data is secondary data, taken from BEI to determine the BI 7-day Repo Rate as the return of risk-free assets and the Yahoo! Finance website to get the IHSG closing price and the closing price from stocks member of IDX BUMN20 from January 2020-2022, which will be chosen with purposive sampling style. Of 20 stocks members of IDX BUMN20 at the beginning of January 2020, those will be included in the sample are stocks that: (1) never left the index until January 2022, (2) never had any changes to the stock amount in a major and minor review of IDX BUMN20, and (3) never did stock split in this study period.

With those approaches, 11 stocks were chosen to be the samples: ANTM, BBTN, ELSA, JSMR, PGAS, PTBA, PTPP, SMGR, TINS, WIKA, and WSKT.

Table 1. Formulas for Calculating Variables in Markowitz Model

No	Description	Formula
1	Calculating Stock Return (R_i)	$R_i = \frac{P_t - P_{t-1}}{P_{t-1}}$
2	Calculating Stock Expected Return ($E(R_i)$)	$E(R_i) = \frac{\sum R_i}{n}$
3	Calculating Stock Risk (SD) (σ_i)	$\sigma_i = \frac{\sqrt{\sum_{t=1}^{n}(R_{it} - E(R_i))^2}}{(n-1)}$

4	Calculating Two Stocks Covariance (σ_{ij})	$\sigma_{ij} = \sum_{t=1}^{n} \frac{[(R_{it} - E(R_i))(R_{jt} - E(R_j))]}{n}$
5	Calculating Portfolio Expected Return ($E(R_p)$)	$E(R_p) = \sum_{i=1}^{n} W_i . E(R_i)$ where W_i is the proportion of each stock in the portfolio
6	Calculating Proportion of Each Stock for Optimal Portfolio by Minimizing Function	$\sigma^2{}_p = \sum_{i=1}^{n} W_i^2 . \sigma_i^2 + \sum_{i=1}^{n} \sum_{j=1}^{n} W_i . W_j . \sigma_{ij}$ with the constraints of: $\sum_{i=1}^{n} W_i = 1$ $W_i \geq 0$ for i=1, 2,..., n

Source: Bodie, Kane, Marcus (2018); Elton, et al (2014)

Table 2. Formulas for Calculating Variables in Single Index Model

No	Description	Formula
1	Calculating Stock Return (R_i)	$R_i = \frac{P_t - P_{t-1}}{P_{t-1}}$
2	Calculating Stock Expected Return ($E(R_i)$)	$E(R_i) = \frac{\sum R_i}{n}$
3	Calculating Stock Risk (SD) (σ_i)	$\sigma_i = \frac{\sqrt{\sum_{t=1}^{n} (R_{it} - E(R_i))^2}}{(n-1)}$
3	Calculating Market Return (R_m)	$R_m = \frac{IHSG_t - IHSG_{t-1}}{IHSG_{t-1}}$
4	Calculating Market Expected Return ($E(R_m)$)	$E(R_m) = \frac{\sum R_m}{n}$
5	Calculating Market Risk (σ_m)	$\sigma_m = \frac{\sqrt{\sum_{t=1}^{n} (R_{mt} - E(R_m))^2}}{(n-1)}$
6	Calculating Stock and Market Covariance (σ_{im})	$\sigma_{im} = \sum_{t=1}^{n} \frac{[(R_{it} - E(R_i))(R_{mt} - E(R_m))]}{n}$
7.	Calculating Stock Beta (β_i) and Alpha (α_i)	$\beta_i = \frac{\sigma_{im}}{\sigma^2{}_m}$ $\alpha_i = E(R_i) - (\beta_i . E(R_m))$
8.	Calculating Stock Unsystematic Risk (σ^2_{ei})	$\sigma^2_{ei} = \sigma^2_i - \beta^2_i . \sigma^2_m$
9.	Calculating Risk-Free Return (R_f)	$R_f = \frac{\sum R_f}{n}$

10.	Calculating Excess Return to Beta (ERB)	$ERB = \frac{E(R_i) - R_f}{\beta_i}$
11.	Calculating C_i and Cutoff Point (C*)	$C_i = \frac{\sigma^2_m . \sum_{i=1}^{n} \frac{[E(R_i) - R_f].\beta_i}{\sigma^2_{ei}}}{1 + \sigma^2_m . \sum_{i=1}^{n} (\frac{\beta^2_i}{\sigma^2_{ei}})}$
12.	Calculating Stock Proportion (W_i)	$W_i = \frac{Z_i}{\sum_{i=1}^{n} Z_i}$ $Z_i = \frac{\beta_i}{\sigma^2_{ei}} . (ERB - C^*)$
13.	Calculating Portfolio Beta (β_p) and Alpha (α_p)	$\beta_p = \sum_{i=1}^{n} W_i . \beta_i$ $\alpha_p = \sum_{i=1}^{n} W_i . \alpha_i$
14.	Calculating Portfolio Unsystematic Risk (σ^2_{ep})	$\sigma^2_{ep} = \sum_{i=1}^{n} W_i^2 . \sigma^2_{ei}$
15.	Calculating Portfolio Expected Return ($E(R_p)$)	$E(R_p) = \alpha_p + \beta_p . E(R_m)$

Source: Bodie, et al (2018); Elton, et al (2014)

Some of the studies comparing these two models show conflicting results, such as the study from Maryani, et al (2015) which uses 12 BUMN stocks as samples, shows that the return from the Single Index model is higher than the Markowitz model (4.52% vs 3.97%), but the difference is not significant (α>0.05). Research from Nurdianingsih and Suryadi (2021) with samples from consumption goods manufacturing industry firms' stocks reveals that the Markowitz model gives a higher expected return than the Single Index model (0.90% vs 0.14%). Similar results are shown by Susanti, et al (2021) that uses LQ45 index stocks in the Covid-19 pandemic where the expected return by the Markowitz model is higher than those from the Single Index model (5.62% vs 0.77%). But the study by Septyanto and Kertopati (2014) that uses stocks from LQ45 index stocks before the Covid-19 pandemic shows contrary results, that is higher expected return was achieved by the Single Index model compared to the Markowitz model (0.596% vs 0.43%).

RESULTS AND DISCUSSION

Markowitz Model

To determine and calculate the optimal portfolio with the Markowitz model, we should first calculate the return and the expected return from individual stocks. From 11 stocks chosen to be sampled, the following result is shown:

Table 3. Return and Expected Return of Individual Stocks

No.	Code	Return	Expected Return
1.	**ANTM**	1,37587649	0,05732819
2.	**BBTN**	0,45798512	0,01908271

3.	**ELSA**	0,30349346	0,01264556
4.	**JSMR**	-0,0592325	-0,002468
5.	**PGAS**	0,17821788	0,00742574
6.	**PTBA**	0,36977165	0,01540715
7.	**PTPP**	0,15913273	0,00663053
8.	**SMGR**	-0,3704978	-0,0154374
9.	**WSKT**	-0,1482093	-0,0061754
10.	**WIKA**	-0,1478967	-0,0061624
11.	**TINS**	1,06093573	0,04420566

Source: Data processed (2022)

Because there are some stocks with a negative return, these stocks are not included as candidates for the optimal portfolio, the stocks are JSMR, SMGR, WSKT, and WIKA. The next step is to determine the risk from each remaining stock to be candidates for the optimal portfolio as shown below:

Table 4. Individual Stock's Risk

Code	Risk
ANTM	0,2159033
BBTN	0,21922906
ELSA	0,15987104
PGAS	0,17897576
PTBA	0,10366375
PTPP	0,20919553
TINS	0,18752443

Sumber: Data processed (2022)

After we found out the risk for each of them, we need to find the covariance between each of the stocks, the result is shown in the matrix below:

Table 5. Covariance Matrix Between Stocks

	ANTM	BBTN	ELSA	PGAS	PTBA	PTPP	TINS
ANTM	0,04661423	0,02063462	0,01993565	0,02013857	0,00489445	0,0250085	0,03270782
BBTN	0,02063462	0,04806138	0,02013052	0,03021864	0,0046381	0,02828292	0,02727365
ELSA	0,01993565	0,02013052	0,02555875	0,02179521	0,00707208	0,02764636	0,0217243
PGAS	0,02013857	0,03021864	0,02179521	0,03203232	0,00748422	0,03170967	0,02350683
PTBA	0,00489445	0,0046381	0,00707208	0,00748422	0,01074617	0,01056124	0,00630992
PTPP	0,0250085	0,02828292	0,02764636	0,03170967	0,01056124	0,04376277	0,02655398
TINS	0,03270782	0,02727365	0,0217243	0,02350683	0,00630992	0,02655398	0,03516541

Source: Data processed (2022)

After that, we will find the proportion of each stock that will be made for the optimal portfolio. Because there is no specific formula to calculate the proportion of each stock in the portfolio formed with the Markowitz model, we will use the Excel Solver program to determine

the optimal proportion from each of the 7 chosen stocks to form our portfolio, with the assumption that the investors are risk-averse. Therefore, the function of Excel Solver will be to minimize the risk. After the weight of each stock is found, we can also calculate the expected return and the risk of our optimal portfolio as shown in the table below:

Table 6. Stock's Proportion, Portfolio Expected Return, and Portfolio Risk

Code	Proportion
ANTM	7,29%
BBTN	7,64%
ELSA	3,81%
PGAS	0,00%
PTBA	81,25%
PTPP	0,00%
TINS	0,00%
Portfolio Expected Return	1.68%
Portfolio Risk	9.86%

Source: Data processed (2022)

Based on the calculations above, the expected return of the optimal portfolio formed with the Markowitz model is 1.68% with a portfolio risk of 9.86%.

Single Index Model

As with the Markowitz model, we need to calculate the return and the expected return of each stock as Table 3 above. But in the Single Index model, we also need to find the return, expected return, the risk of the market, and the risk-free asset return.

Table 7. Risk-Free Asset Return

No.	Period	BI-7 Day-RR
1	23-Jan-20	0,05
2	20-Feb-20	0,0475
3	19-Mar-20	0,045
4	14-Apr-20	0,045
5	19-May-20	0,045
6	18-Jun-20	0,0425
7	16-Jul-20	0,04
8	19-Aug-20	0,04
9	17-Sep-20	0,04
10	13-Oct-20	0,04
11	19-Nov-20	0,0375
12	17-Dec-20	0,0375
13	21-Jan-21	0,0375
14	18-Feb-21	0,035
15	18-Mar-21	0,035

16	20-Apr-21	0,035
17	25-May-21	0,035
18	17-Jun-21	0,035
19	22-Jul-21	0,035
20	19-Aug-21	0,035
21	21-Sep-21	0,035
22	19-Oct-21	0,035
23	18-Nov-21	0,035
24	16-Dec-21	0,035
25	20-Jan-21	0,035
Risk-Free Asset Return		0.0387

Source: Data processed (2022)

Table 8. Return, Expected Return, and Risk of Market

No.	Period	IHSG Closing Price	Market Return
1	January	5940,04785	-0,0820437
2	February	5452,7041	-0,1675818
3	March	4538,93018	0,03910011
4	April	4716,40283	0,00788927
5	May	4753,61182	0,03192946
6	June	4905,39209	0,04978906
7	July	5149,62695	0,01725559
8	August	5238,48682	-0,0703348
9	September	4870,03906	0,05301519
10	October	5128,2251	0,09441667
11	November	5612,41504	0,06532984
12	December	5979,07324	-0,0195216
13	January	5862,35205	0,06472553
14	February	6241,7959	-0,0410577
15	March	5985,52197	0,00168644
16	April	5995,61621	-0,0080314
17	May	5947,46289	0,00639363
18	June	5985,48877	0,01412588
19	July	6070,03906	0,01322228
20	August	6150,29883	0,02221746
21	September	6286,94287	0,04841834
22	October	6591,34619	-0,0087105
23	November	6533,93213	0,00727736
24	December	6581,48193	0,00754677
25	January	6631,15088	

Market Retutn	**0,1470573**
Market Expected Return	**0,0117646**
Market Risk	**0,0033217**

Source: Data processed (2022)

After that, we need to find the individual stock risk as in Table 4 in the Markowitz model. Once we did that, we need to find the covariance between each stock and the market. With the result, we can find the beta and alpha of the individual stocks to calculate the unsystematic risk from each stock as shown below:

Table 9. Stock's Risk, Beta, Alpha, Unsystematic Risk, and Covariance with Market

No	Code	Stock Risk	Covariance with Market	Stock's Beta	Stock's Alpha	Unsystematic Risk
1	ANTM	0,2159033	0,00745224	2,2434794	0,03093458	0,0298953
2	BBTN	0,21922906	0,00842833	2,53733017	-0,0107679	0,04806138
3	ELSA	0,15987104	0,00702177	2,11388988	-0,0122235	0,01071549
4	PGAS	0,17897576	0,00835549	2,51540123	-0,0221669	0,01101492
5	PTBA	0,10366375	0,00186143	0,56037812	0,00881454	0,00970307
6	PTPP	0,20919553	0,0093493	2,81458629	-0,0264819	0,01744836
7	TINS	0,18752443	0,00779134	2,34556529	0,01661105	0,01689032

Source: Data processed (2022)

After we got the result from the calculations above, the next step is to calculate the excess return to beta (ERB) from each stock. This ERB will be compared to the cutoff point of stocks to determine which stocks are suitable to be included in the portfolio. The cutoff point itself is calculated from the assumption that some number of stocks is forming the portfolio, starting from one stock, two stocks, three stocks, and so on. This calculation result is called the Ci, and the highest Ci will be made the C* (the cutoff point) (Elton, et al, 2014).

Table 10. ERB, Ci, and C* of Stock to Determine Portfolio Candidate

No	Code	ERB	Ci	Portfolio Candidate? (ERB > C*)
1	ANTM	0,00830326	9,8807E-06	YES
2	BBTN	-0,0077315	1,1100E-05	NO
3	ELSA	0,00041676	1,1518E-05	YES
4	PGAS	-0,0124331	-2,1338E-06	NO
5	PTBA	-0,0415663	4,2713E-06	NO
6	PTPP	-0,011394	1,0912E-05	NO
7	TINS	0,00234726	4,8715E-06	YES

Source: Data processed (2022)

The next step is to determine the weight of each stock forming our portfolio chosen from the C* criteria above. From the result, we can also find the beta, alpha, and unsystematic risks in our portfolio.

Table 11. Weight of Stocks, Beta, Alpha, and Portfolio's Unsystematic Risk

No	Code	Zi	Wi	Beta Portfolio	Alpha Portfolio	Portfolio Unsystematic Risk
1	ANTM	3,9915E-01	67,78%	1,52059005	0,0209669	0,02141404
2	ELSA	3,3516E-02	5,69%	0,12030678	-0,0006957	8,2786E-05
3	TINS	1,5624E-01	26,53%	0,62229125	0,004407	0,00247519

Source: Data processed (2022)

Finally, with all the data obtained above, we can calculate the expected return and the risk from the optimal portfolio formed with the Single Index model.

Table 12. Optimal Portfolio Expected Return and Risk

Portfolio Expected Return	5,13%
Portfolio Risk	2,72%

Source: Data processed (2022)

Therefore, from the calculations made, the expected return from the optimal portfolio is 5.13% with a portfolio risk of 2.72%.

CONCLUSION

From the results above, it can be concluded that the IDX BUMN20 stocks included in the optimal portfolio formed with the Markowitz model are ANTM, BBTN, ELSA, and PTBA with the biggest proportion in PTBA (81.25%), while those formed with Single Index model are ANTM, ELSA, and TINS with the biggest proportion in ANTM (67.68%).

When compared to each other, a higher expected return is achieved by the Single Index model (5.13% vs 1.68%), and the lower risk is, surprisingly, also achieved by the Single Index model (2.72% vs 9.86%). Thus, the result of this study is similar to Septyanto and Kertopati (2014) which shows that the Single Index model portfolio gives a better return.

Nonetheless, further study is needed to determine whether the return and risk difference between these models is significant at all and whether the expected return from both models differs significantly from the return from the risk-free asset. Also, further study is warranted to assess the effect of the Covid-19 pandemic on the return generated by these two models, for example by comparing the same portfolio of stocks outside the Covid-19 pandemic era.

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