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Constructing an Optimal Portfolio with a Single Index Model on the Shares of Bumn Companies Listed in the IDXBUMN20 Index on the Indonesia Stock Exchange

Bagus Wicaksono Kurniawan[1], C. Ambar Pujiharjanto[2], Nilmawati[3]
[1,2,3]Management Department, Universitas Pembangunan Nasional "Veteran" Yogyakarta, Indonesia

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ABSTRACT

This study aims to determine the optimal portfolio using a single index model on the shares of state-owned companies listed in the IDXBUMN20 index on the Indonesia Stock Exchange. The population was 20 issuers and using purposive sampling, 13 issuers were obtained as samples. By using a single index model, the results show that 7 stocks make up the optimal portfolio with the proportion of funds as follows ANTM (27.52%), BBNI (24.02%), PTBA (17.86%), BMRI (15.08%), TINS (7.51%), BBRI (7.45%) and PGAS (0.56%). Measurement of portfolio performance using the Treynor method of 0.17233 is higher than market performance which has a value of 0.01441.

Corresponding Author:

Name: C. Ambar Pujiharjanto and Nilmawati
Institution: Universitas Pembangunan Nasional "Veteran" Yogyakarta, Indonesia
e-mail: ambar.pujiharjanto@upnyk.ac.id and nilmawati@upnyk.ac.id

1. INTRODUCTION

The level of public awareness to invest is increasing in the current era. Investment is an activity related to investing a number of funds in real assets or financial assets such as land, gold, stocks, deposits, bonds and other forms to obtain future profits [1].

One of the most popular investment options for people today is investing in financial assets in the capital market in the form of shares. The capital market is a meeting between parties who have excess funds and parties who need funds by trading shares. Shares are securities that show ownership of a company. While the place where the buying and selling of shares occurs is called the stock exchange [1].

The capital market offers a variety of sectors that can be used as investment options, especially in forming a portfolio. In Indonesia itself, the shares listed on the Indonesia Stock Exchange (IDX) at the end of 2022 amounted to 825 company shares [2] consisting of 11 main stock sectors from various companies that can be used as choices by investors.

Among the various choices of company shares listed on the Indonesia Stock Exchange, BUMN company shares are always one of the choices of investors in investing. SOEs are business entities whose capital is wholly or mostly owned by the state through direct capital participation. Currently, there are 27 BUMN and BUMD companies whose shares have been listed on the IDX and are actively traded in the capital market. To make

it easier for investors to choose stocks, the Indonesia Stock Exchange (IDX) publishes stock indices with certain criteria [3]. One of the stock indices located on the IDX is the IDX BUMN20. The index contains 20 stocks of State-Owned Enterprises (BUMN), Regional-Owned Enterprises (BUMD) and their affiliates as a measure that reflects stock price movements, especially shares of BUMN companies [4]. The IDX BUMN20 index consists of 20 stocks with large capitalization and good performance. This ensures that the stocks that are components of the IDX BUMN20 Index have the potential to provide good and relatively stable investment returns.

As an investor, you certainly want to invest in stocks that generate high returns with low risk. Investment in stocks offers a fast rate of return with comparable risk. Rational investors will choose a portfolio that provides maximum return at a certain level of risk [5]. The basis used in portfolio formation is to choose the optimal portfolio [6].

Before determining the optimal portfolio, the first thing to do is to form an efficient portfolio [7]. An efficient portfolio is a portfolio with the largest expected return among equal-risk portfolios or a low-risk portfolio among portfolios that offer the same return [8]. Determination of the optimal portfolio can be done in several ways, one of which is the Markowitz model. The Markowitz model is a portfolio formation model discovered by Harry Markowitz in 1952. This method emphasizes that the optimal portfolio is a portfolio that produces maximum returns with minimum risk. Markowitz approach can utilize all available information as the basis for the formation of the optimal portfolio [1]. 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 rather on the relationship of these risks to the securities [9].

In 1963 the Markowitz Model was developed by William Sharpe by creating the Single Index Model to simplify the calculation of the Markowitz model. The advantage of the Single Index Model compared to the Markowitz Model is its simpler calculation [1]. The Markowitz model calculates risk with covariance through the use of a variance-covariance relationship matrix, which requires complex calculations, in the Single Index Model the risk is simplified into two components, namely market risk and company-unique risk, so that based on this simplification the calculation of complex Markowitz portfolio risk becomes a simple calculation.

In the formation of an optimal portfolio of Islamic stocks with the Markowitz Method and produces 4 portfolio forming stocks, namely ELSA with a proportion of funds of 18.25%, PGAS with a proportion of funds of 11.53%, PTBA with a proportion of funds of 12.80%, and TLKM with a proportion of funds of 57.42% [10].

Other research on the formation of optimal portfolios on stocks in the IDX-MES BUMN 17 index uses the Single Index model and produces 3 portfolio-forming stocks, namely PGAS with a proportion of funds of 12.53%, PTBA with a proportion of funds of 29.47% and TLKM of 57.99% [11].

Optimal portfolio research using the Single Index model on stocks in the IDX-MES BUMN 17 index obtained different results where there are 3 different stocks in forming the optimal portfolio, namely BRIS shares with a portfolio proportion of 67.093%, PTBA shares with a portfolio proportion of 21.481% and IPCC shares with a portfolio proportion of 11.426% [12].

This study will use the optimal portfolio analysis with the Single Index Model. As mentioned earlier, the advantage of the Single Index Model is its simpler calculation, especially when compared to the Markowitz Model. The Single Index Model is one of the important and easy-to-use methods for calculating the optimal portfolio [13].

2. LITERATURE REVIEW

a. Portfolio Theory

In 1952, Harry M. Markowitz wrote a journal containing a method for solving risk problems in portfolio selection using

probability theory and quadratic programming. Markowitz's thinking symbolized the birth of modern portfolio management theory [14].

In the capital market, the portfolio is associated with a portfolio of financial assets, namely a combination of several stocks so that investors can achieve optimal returns and minimize risk [15]. portfolio is a collection of investments to identify the selected stocks and determine the proportion of funds for investment in each stock [16]. Asset diversification can be done to develop a portfolio and reduce risk. Diversification means that investors will form a portfolio by choosing a combination of various assets to minimize risk without reducing the expected return in accordance with the investor's investment objectives [1].

The concept of risk reduction as a result of "adding assets to a portfolio" is central to understanding portfolio risk [1]. On average, the risk of a portfolio will decrease as more stocks are added to the portfolio, but the decrease in risk will stop at some point and the risk will never reach zero [17]. An optimal portfolio should be an efficient portfolio, but not the other way around [6].

In 1952, Harry M. Markowitz developed a theory called Markowitz theory. Markowitz theory uses some basic statistical measurements to develop a portfolio plan, including expected return, standard deviation of both securities and portfolios, and correlation between returns [6]. In the next development in 1963, Wiliam F Sharpe developed the Single Index Model which is a simplification of the model previously developed by Markowitz [6].

This model provides an alternative method for calculating the variance of a portfolio, which is simpler and easier to calculate when compared to the Markowitz method of calculation. This alternative approach can be used as a basis for solving portfolio construction problems.

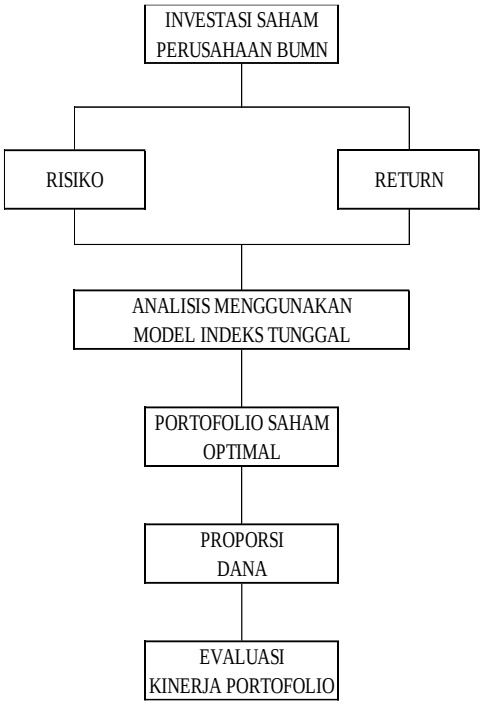
b. Single Index Model

The Single Index Model was first introduced by William Sharpe through his paper titled "A Simplified Model for Portfolio Analysis" in 1963. The model utilizes low-cost analysis coupled with the need for a relatively smaller amount of information making it an attractive candidate as a practical application of the Markowitz technique [18].

Sharpe simplified many of the calculations and complexities for optimal portfolio construction as required in the Markowitz model [19]. Sharpe found that there was considerable similarity between the efficient portfolios generated by the Single Index Model and the Markowitz Model, with the Single Index Model performing quite well [20], [21]. The Single Index Model simplifies many input requirements and performs well, as well as representing a greater practical advance in portfolio analysis [22].

This Single index model can explain in more detail in a simple way, but the optimal stock results differ from one study to another due to different market [11], [12], [23], [24], [25]. The results of these optimal stocks can be used by investors as a benchmark for good stocks to invest in the short and long term.

c. Framework of the Study



3. METHODS

This research is a quantitative descriptive study that describes the determination of the optimal portfolio model based on existing facts and data. The analysis technique in this study uses a Single Index Model and is carried out on daily shares of BUMN issuers included in the IDX BUMN20 index on the Indonesia Stock Exchange for the period June 2018 to December 2022.

Researchers used purposive sampling techniques to obtain the samples needed in the study. The considerations used to determine the sample in this study are:

1. Shares of state-owned companies that are consistently included in the IDX BUMN20 index of the Indonesia Stock Exchange since the index was first released until the end of 2022 (period June 2018 to December 2022).
2. The issuer's shares did not conduct a stock split during the period June 2018 to December 2022, because it would cause the share price to be unstable due to the split in the number of shares.

Based on these criteria, 13 shares of state-owned companies that are sampled in this study can be determined as follows:

No	Code	Name of corporation
1	ANTM	Aneka Tambang Tbk
2	BBNI	Bank Negara Indonesia Tbk.
3	BBRI	Bank Rakyat Indonesia Tbk
4	BBTN	Bank Tabungan Negara Tbk.
5	BJBR	BPD Jawa Barat dan Banten Tbk.
6	BMRI	Bank Mandiri Tbk.
7	ELSA	Elnusa Tbk.
8	JSMR	Jasa Marga Tbk.
9	PGAS	Perusahaan Gas Negara Tbk.
10	PTBA	Tambang Batubara Bukit Asam Tbk
11	SMGR	Semen Indonesia Tbk.
12	TINS	Timah Tbk
13	TLKM	Telekomunikasi Indonesia Tbk.

The data analysis model used in this study is an analysis technique based on the Single Index Model which explains the relationship between the return of each individual stock and the market return.

The analysis steps taken to form optimal portfolio of single index model [6]:

1. Calculating the stock return per day (realized return) of each company's shares is calculated using the formula [6]:

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

   Description:

   Rit = stock return

   Pt-1 = Stock price in the past period

   Pt = Share price in the current period

   Dt = Dividends distributed
2. Calculating the expected return of each stock (E(Ri)) in the research sample is calculated using the formula [6]:

   $E(R_i) = \frac{\Sigma_{t=1}^{n} Rit}{n}$

   Description:

   E(Ri) = expected return of stock i

   Rit = stock return i in period t

   n = number of observations

3. Calculate the Market Return (Rm) which can be calculated using the following formula [6]:

$$R_M = \frac{BUMN20_t - BUMN20_{t-1}}{BUMN20_{t-1}}$$

Description:
RM = Market risk period t
BUMN20t = Stock price index at the end of period t
BUMN20t-1 = Share price index at the beginning of period t

4. Calculating Market Return Expectation which can be calculated by the following formula [6]:

$$E(R_M) = \frac{\Sigma_{n=1}^{n} Rm}{n}$$

Description:
E(RM) = Expected market return
RM = Market return
n = Number of observations

5. Calculating Beta (β) and Alpha (α) of stocks which can be calculated with the following formula [6]:
   - βi = σim/σ(m²)
     Description:
     βi = Beta of stock i
     σim = Covariance between stock return i and market return
     σm2 = Market return variance
   - αi = E(Ri) – βi.E(Rm)
     αi = Alpha of stock i
     E(Ri) = Expected return of stock i
     E(Rm) = Expected market return
6. Calculating the Market Return Variance (σM2) which can be calculated by the formula [26]:

$$(\sigma_m^2) = \frac{\Sigma_{i=1}^{n}(R_M - E(R_M))^2}{n}$$

Description:
σM2 = Market return variance
RM = Market return
E(Rm) = Expected market return
N = Number of observation periods

7. Calculating Residual Error Variance (σei²)

$$(\sigma_{ei}^2) = \frac{\Sigma_{i=1}^{n}(R_i - \alpha_i - \beta_i \cdot R_m)^2}{n}$$

Description:
σei² = Residual error variance for stock i or unique risk
αi = Alpha of stock i
βi = Beta of stock i
Ri = Return of security i
Rm = Market index return
N = Number of observation periods

8. Calculating the total risk (σi2) can be calculated with the following formula [6]:

$$\sigma_i^2 = \beta_i^2 * \sigma_M^2 + \sigma_{ei}^2$$

Description:
σi2 = Total risk
βi = Beta of stock i
σM2 = Market variance
σei2 = Residual error variance for stock i or unique risk

9. Determining Risk-Free Return (RBR). RBR in this study uses BI-7 Day Reverse Repo Rate (BI7DRR) data as a reference.
10. Calculating Excess Return to Beta (ERB) which can be calculated with the following formula [6]:

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

Description:
ERBi = Excess Return to Beta of stock i
E(Ri) = Expected return of stock i
RBR = Risk-free asset return
Bi = Beta of stock i

11. Determine the Cut Off Point (C*). Stocks included in the optimal portfolio that have ERB greater than the Cut-Off Point [21].
12. Determine the optimal portfolio. the optimal portfolio is seen from the ERB value greater than or equal to the ERB value at point C* [6].
13. Determine the proportion of the i-th security (Wi). which can be calculated by the following formula [6]:

$$W_i = \frac{Z_i}{\Sigma_j^k Z_j}$$

With the value of Zi equal to:

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

Description:
Wi = Proportion of i-th stock
Zi = Z value of the i-th stock
K = Number of stocks in the optimal portfolio
Zj = Accumulated Z value
Bi = Beta of stock i
σei2 = Residual error variance for stock i or unique risk
ERBi = Excess Return to Beta of stock i
C* = Cut-off point value which is the largest Ci value

14. Calculating Beta (βp) and Alpha (αp) portfolios which can be calculated by the following formula [6]:
$\alpha_p = \sum_{i=1}^{n} W_i * \alpha_i$
$\beta_p = \sum_{i=1}^{n} W_i * \beta_i$
Description:
αp = Alpha of the portfolio
βp = Beta portfolio
Wi = Proportion of stock i
αi = Alpha of stock i
βi = Beta stock i
15. Determine the portfolio's expected return which can be calculated by the following formula [6]:
$E(R_p) = \alpha_p + \beta_p * E(R_m)$
Description:
E(Rp) = Portfolio expected return
E(Rm) = Market expected return
αp = Alpha portfolio
βp = Beta portfolio
16. Calculating portfolio risk can be calculated using the following formula [6]:
$\sigma_p^2 = \beta_p^2 * \sigma_m^2$
Description:
σp2 = Portfolio risk
σM2 = Market return variance
βp = Beta portfolio
17. Measuring Portfolio Performance. Portfolio performance measurement in this study will be measured by the Treynor Index measurement method. The advantage of the Treynor index is that it uses beta as a divisor, meaning that the Treynor index measures systematic srisk. The weakness of this model is that it is less appropriate when used during a negative market or at a negative level of return because it can provide incorrect results [1].

The Treynor Index equation is formulated as follows [6]:

$$RVOL=\frac{\overline{TR_p}-\overline{R_{BR}}}{\beta_p}$$

Keterangan:
RVOL = portfolio Treynor index
$\overline{TR_p}$ = average return of portfolio p over the observation period
$\bar{R}_{BR}$ = average risk-free rate of return during the observation period
$\widehat{\beta_p}$= Beta of portfolio p

4. RESULTS AND DISCUSSION

Formation of optimal stocks using the Single Index Model using the steps contained in the method as follows:

1. Calculate the stock expected return and market expected return with the following calculation results:

Table 4.1. E(Ri) and E(Rm)

Stocks	E(Ri)	E(Rm)
ANTM	0,00137	
BBNI	0,00055	
BBRI	0,00079	
BBTN	-0,00027	
BJBR	0,00017	
BMRI	0,00094	
ELSA	0,00035	
JSMR	-0,00004	
PGAS	0,00050	
PTBA	0,00100	
SMGR	0,00025	
TINS	0,00084	
TLKM	0,00042	
IDXBUMN20		0,00017

Based on table 4.1. of the 13 issuers analyzed, the results show that BBTN and JSMR issuers have negative E(Ri), which means that the shares of these issuers are not optimal and are excluded in this study.

2. Calculating Alpha (α) and Beta (β). After obtaining a positive E(Ri), the next step is to determine the value of α and β, and the following results are obtained:

Table 4.2. α and β

Stocks	α	β
ANTM	0,00137	0,00100
BBNI	0,00055	0,00093
BBRI	0,00060	1,14516
BJBR	-0,00000118	1,03255
BMRI	0,00076	1,12972
ELSA	0,00023	0,71538
PGAS	0,00036	0,83586
PTBA	0,00087	0,82947
SMGR	0,00006	1,09804
TINS	0,00071	0,79925
TLKM	0,00027	0,95223

Based on table 4.2. The results obtained from the 10 optimal stock issuers, BJBR issuer is an issuer with a negative value on α. So that the issuer BJBR is taken out of this study.

3. Calculate market return variance (σm^2), residual error variance *(σei^2)* and total risk (σi^2).

Table 4.3. σm^2, σei^2 and σi^2

Stocks	σ_m^2	σ_{ei}^2	σ_i^2
IDXBUMN20	0,31564	0,81932	
ANTM		1,33948	1,339798
BBNI		0,59834	0,598630
BBRI		0,55035	0,911806
BMRI		0,56007	0,916650
ELSA		0,96070	1,186504
PGAS		1,01644	1,280273
PTBA		0,81071	1,072527
SMGR		0,88405	1,230633
TINS		1,38983	1,642102
TLKM		0,44017	0,740735

Based on table 4.3. the value of σm^2 is 0.31 or 31%, which means that the IDXBUMN20 index has a market risk of 31%. The value of the largest σ_{ei}^2 is the issuer TINS of 1.389. value σ_i^2.

4. Calculate the Excess Return to Beta (ERB) and get the following results:

Table 4.4. Excess Return to Beta (ERB)

Stocks	ERB_i
ANTM	1,352324
BBNI	0,567229
PTBA	0,001183
TINS	0,001022
BMRI	0,000817
BBRI	0,000674
PGAS	0,000568
ELSA	0,000460
TLKM	0,000423
SMGR	0,000204

The lowest ERB value is SMGR by 0.0204% and the highest ERB value is ANTM by 135.23%.

5. Calculating Cut off point (C*). The C* value is the highest Ci value in the group of stocks included in the optimal portfolio. To determine the value of C*, it is necessary to determine the value of Ci first. Ci is calculated by multiplying the market variance and cumulative value of Ai divided by the sum of the constant and the product of the market variance with the cumulative value of Bi and the following results are obtained:

Table 4.5. Calculation of Ai, Bi and Ci

Stocks	A_i	B_i	C_i
ANTM	0,0000010	0,0000007	0,0000003
BBNI	0,0000008	0,0000014	0,0000006

PTBA	0,0010043	0,8486596	0,0002505
TINS	0,0004697	0,4596259	0,0003297
BMRI	0,0018623	2,2787783	0,0004942
BBRI	0,0016068	2,3828374	0,0005411
PGAS	0,0003906	0,6873594	0,0005430
ELSA	0,0002449	0,5327027	0,0005387
TLKM	0,0008712	2,0599636	0,0005195
SMGR	0,0002784	1,3638298	0,0004883

The C* value is obtained from the max Ci value or the highest value of Ci and the result shows that the C* value is 0.0005430.

5. Determining the optimal portfolio. The optimal portfolio is obtained by comparing the ERB value with the C* value. And the result is obtained:

Table 4.6. ERBi and C*

Saham	ERB	C_i	Hasil
ANTM	1,352324	0,0000003	Lolos
BBNI	0,567229	0,0000006	Lolos
PTBA	0,001183	0,0002505	Lolos
TINS	0,001022	0,0003297	Lolos
BMRI	0,000817	0,0004942	Lolos
BBRI	0,000674	0,0005411	Lolos
PGAS	0,000568	0,0005430	Lolos
ELSA	0,000460	0,0005387	Tidak Lolos
TLKM	0,000423	0,0005195	Tidak Lolos
SMGR	0,000204	0,0004883	Tidak Lolos

In table 4.6, the results show that there are 7 stocks that are included in the optimal portfolio, namely ANTM, BBNI, PTBA, TINS, BMRI, BBRI and PGAS.

7. Composition of the Proportion of Funds in the Optimal Portfolio by calculating the proportion of funds (Wi) and weighted scale (Zi). And the results obtained are as follows:

Table 4.7. Wi dan Zi

Stocks	Zi	Wi
ANTM	0,0010092	27,52%
BBNI	0,0008808	24,02%
PTBA	0,0006552	17,86%
TINS	0,0002753	7,51%
BMRI	0,0005531	15,08%
BBRI	0,0002732	7,45%
PGAS	0,0000207	0,56%

Based on table 4.7. It is known that the optimal portfolio shares are ANTM (27.52%), BBNI (24.02%), PTBA (17.86%), TINS (7.51%), BMRI (15.08%), BBRI (7.45%) and PGAS (0.56%).

8. Calculate the alpha and beta of the portfolio. This portfolio alpha and beta will be used to calculate the expected return and risk of the optimal portfolio formed. And the results obtained are as follows:

Table 4.8. Ap and Bp

Stocks	βp	Ap
ANTM	0,000235	0,000322
BBNI	0,000176	0,000104
PTBA	0,181267	0,000190
TINS	0,079114	0,000070
BMRI	0,292191	0,000197
BBRI	0,085312	0,000045
PGAS	0,004719	0,000002

9. Calculate the Portfolio Expected Return and get the following results:

Table 4.9. Portfolio Expected Return

Stocks	E(Rp)
ANTM	0,0003216174061
BBNI	0,0001040408919
PTBA	0,0002201732107
TINS	0,0000833941247
BMRI	0,0002450015971
BBRI	0,0000588410155
PGAS	0,0000028144796
Total	**0,0010358827256**

Based on Table 4.9, the optimal portfolio formed is able to provide an expected return of 0.001036 or 0.1036% per day.

10. Calculating Portfolio Risk. Portfolio risk is calculated from the sum of the risks generated by each stock that makes up the optimal portfolio. The results of the portfolio risk calculation are as follows:

Table 4.10. Portfolio Risk

Stocks	σ_p^2
ANTM	0,00000002
BBNI	0,00000001
PTBA	0,01037120
TINS	0,00197557
BMRI	0,02694787
BBRI	0,00229729
PGAS	0,00000703
Total	**0,04159899**

Based on Table 4.10, the optimal portfolio formed contains a risk of 0.0416 or 4.16% per day.

11. Optimal Portfolio Composition. From the description above, the details of the optimal portfolio and the proportion of each stock can be obtained, as follows ANTM with a proportion of 27.52%, BBNI with a proportion of 24.02%, PTBA with a proportion of 17.86%, BMRI with a proportion of 15.08%, TINS with a proportion of 7.51%, BBRI with a proportion of 7.45% and PGAS with a proportion of 0.56%. Expected return of the portfolio formed is 0.1036% per day with a risk of 4.16% per day.

12. Evaluation of Optimal Portfolio Performance. Portfolio performance is evaluated during the period June 2018 to December 2022. Evaluation is carried out by the Treynor method, namely by comparing the portfolio risk premium with the portfolio risk expressed by beta. Then the calculation of portfolio performance according to Treynor against the optimal portfolio that has been generated is:

RVOLp = (0,018% - 0,0022%) / 9,1859% = 0,17233.

While the market performance as a reference is:

RVOLp = (0,0166% - 0,0022%) / 1 = 0,014

The RVOLp value is greater than RVOLm, meaning that every one unit increase in risk (in beta) will provide a higher risk premium return than the market. In other words, the performance of the investment portfolio assessed by the Treynor method has good performance.

5. CONCLUSION

Based on the results of the calculation and analysis of optimal portfolio formation using the Single Index Model on the shares of state-owned companies included in the IDXBUMN20 index on the Indonesia Stock Exchange for the period June 2018 to December 2022, the following conclusions are obtained:

- Of the 13 shares of state-owned companies included in the sample in this study, 7 shares were obtained as optimal portfolio compilers, namely ANTM, BBNI, PTBA, BMRI, TINS, BBRI and PGAS.
- The proportion of funds allocated to each stock forming the optimal portfolio is ANTM with a proportion of 27.52%, BBNI with a proportion of 24.02%, PTBA with a proportion of 17.86%, BMRI with a proportion of 15.08%, TINS with a proportion of 7.51%, BBRI with a proportion of 7.45% and PGAS with a proportion of 0.56%.
- Analysis of the performance of stocks that make up the optimal portfolio with the Single Index Model in this study is able to

produce stocks with better performance in the sense of being able to produce stocks with a positive ERB and can provide an expected return from the portfolio formed of 0.1036% per day with a risk of 4.16% per day.

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