

## Analysis of the Single Index Model and Markowitz in Optimal Portfolio Selection in the Telecommunications Sub-Sector Listed on the Indonesia Stock Exchange for the Period 2020-2022

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### Abstract

*This study, which uses qualitative methodology, compares and finds the best results from two approaches, namely the Markowitz model and the single index model to build an optimal portfolio. The population of this study consists of all stocks included in the telecommunications subsector listed on the Indonesia Stock Exchange for the period 2020-2022. Purposive sampling is used in this study to select samples. There are 5 candidate company stocks that meet the requirements in the sample criteria. From the results of the research conducted, it proves that with the single index model method, 3 stocks are included in the optimal portfolio, namely PT Tower Bersama Infrastruktur Tbk (TBIG) with a proportion of 50%, PT Visi Telekomunikasi Infrastruktur Tbk (GOLD) with a proportion of 15%, and PT Indosat Ooredoo Hutchison Tbk (ISAT) with a proportion of 35%. From the research results of these 3 stocks to form an optimal portfolio, the expected return is 2% and the risk borne is 18%. While for the Markowitz model, 3 stocks were obtained as optimal portfolio candidates, namely PT Telekomunikasi Indonesia Tbk (TLKM) with a proportion of 68%, PT Visi Telekomunikasi Infrastruktur Tbk (GOLD) with a proportion of 15%, and PT Tower Bersama Infrastruktur Tbk (TBIG) with a proportion of 17%. From the research results of these 3 stocks to form the optimal portfolio, the expected return is 1% and the risk borne is 6%.*

**Keywords:** optimal portofolio, markowitz model, single index model

### INTRODUCTION

Investment is the activity of investing capital into assets and hoping to earn a greater return than fixed assets. The capital market is where investors want to invest in stocks and also provides them with an opportunity for diversification. Telecommunication stocks traded on the Indonesia Stock Exchange are used in this research. Investors are required to consider *return* and risk when making investment decisions. Both aspects are very important when making investment decisions. *Yield* and capital gain are the main components of investment returns (Tandelilin, 2010). Risk is defined as the probability of something unexpected happening as the definition of risk is "damage, disruption, danger of loss or accident" stated in Webster's dictionary.

Investors can use portfolios to minimize their risk. The terms "efficient portfolio" and "optimal portfolio" are used in portfolio theory. Researchers apply the Markowitz model and the single-index model to construct optimal portfolios. William Sharp created the single-index model, which is a portfolio model in which the *return of a* market index is used to determine the *return of each* asset. In addition, investors choose their portfolios based on their preferences for the expected return and risk of each portfolio option, in accordance with the Markowitz method. The main challenges faced by investors, according to (Bodie, Kane, & Marcus, 2006) is to determine which type of stocks to choose in order to create an optimal stock portfolio.

Markowitz model and single index model have been used in a number of previous studies. Research on investment analysis and the search for the best stock portfolio in the Indonesian stock market (a comparative study using a single index model and a random model on LQ-45 stocks) was conducted by (Risnawati, 2009). Based on the research findings, there is a difference in performance

between choosing a portfolio randomly and using a single index model. Creating a portfolio using the single index model produces better returns than allocating portfolios randomly. According to research submitted by (Septyanto & Kertopati, 2014), there are differences between the Markowitz model and the single index model in analyzing the formation of the optimal portfolio. The investigation found that the results of Markowitz and single index calculations were different.

According to research published by (Paudel & Koirala, 2006) in "Application of Markowitz and Sharpe Model to Nepal Stock Market", the investment portfolio created by using Markowitz model becomes the best optimization. As a result, investors who want to take part in the capital market by buying and selling stocks should pay careful attention to the stock trading market. Markowitz model and single index model are the models used in this research.

The research entitled "Comparative Analysis of Optimal Portfolios with a Single Index Model Approach and the Markowitz Model in the Telecommunications Sub-Sector Listed on the Indonesia Stock Exchange for the 2020-2022 Period" was designed to be carried out based on the background above.

## RESEARCH QUESTION

Based on the background information provided, the following research questions can be the main focus of the investigation of the comparative analysis of the optimal portfolio of the telecommunications subsector on the Indonesia Stock Exchange using the Markowitz model and the single index model approach:

1. How is the optimal portfolio formation using the single index model for telecommunication sector companies listed on the Indonesia Stock Exchange for the 2020-2022 period?
2. How is the Markowitz model used to create an optimal portfolio for telecommunications sector companies listed on the Indonesia Stock Exchange for the period 2020-2022?
3. How does the telecommunications sector companies listed on the Indonesia Stock Exchange compare in terms of optimal portfolio formation for the 2020-2022 period?

## RESEARCH OBJECTIVES

Based on the problem formulation that has been presented, the following research objectives can be identified:

1. Knowing the optimal portfolio formation using a single index model for telecommunication sector companies listed on the Indonesia Stock Exchange for the 2020- 2022 period.
2. Knowing the Markowitz model is used to create an optimal portfolio for telecommunications sector companies listed on the Indonesia Stock Exchange for the 2020- 2022 period.
3. Knowing the comparison of telecommunication sector companies listed on the Indonesia Stock Exchange in terms of optimal portfolio formation for the 2020-2022 period.

## LITERATURE REVIEW

### Investment Management

Investment management, according to (Alhidayatullah, et al., 2021), is the process of organizing, implementing, and monitoring decision-making related to any investment activity. On the other hand, investors are individuals or organizations that have money to invest with the aim of making more money in the future. On the other hand, according to (Wef, 2020) Investment management is the management of various securities, such as investments in stocks, bonds, and other assets, including real estate, in an effort to meet financial goals that will make money for investors. Based on both definitions, investment management is the process of organizing, implementing, and regulating decision-making on every aspect of investment with the aim of achieving financial goals that provide profits for investors.

## Investment

Investment is the process of allocating money into companies, stocks, or other assets with the aim of making a profit in the future. Jogiyanto said in (Ayuningsih, 2016). The investment process shows the process in which an investor makes decisions. Investment according to (Tandelilin, 2010) is a financial or resource commitment made now in the hope of receiving beneficial returns at a later date. Investment as defined by (Hartono, 2015) is a delay in the use of current consumption to be used in productive activities over a certain period of time. This definition leads to the conclusion that investment is a method of using present funds to generate future profits.

According to (Tandelilin E. , 2012) there are several aspects that become the basis for people in making investment decisions. First is the return on investment which is the main motivation behind investment activity. Risk comes second. The greater the risk involved in an investment, the greater the expected return. Thirdly there is a one-way or linear relationship between the return and the predicted rate of return. Whether parallel or inversely proportional. (Oktaviana, 2019) states that the investment decision-making process continues until the optimal choice.

## Shares

Ownership of shares in a limited liability company is evidence of participation in its operations, according to (Riyanto, 2008). On the other hand, shares as stated by (Mingka & Lubis, 2023), are proof of ownership of the company and shareholders are entitled to a portion of the income with the amount varying based on the number of shares owned in the company. Whatever percentage or number of shares a company issues, a share is a piece of paper that represents its owner. Thus, it can be said that shares in a corporation or limited liability business serve as proof of ownership of the company's assets. Buying shares entitles the buyer to a portion of the business's profits, which are then paid out as dividends. There are three categories of shares, according to (Kieso & Weygandt, 2008) treasury stock, preferred stock and common stock.

## Stock Return

Investments are made by investors to obtain various benefits in the future, according to (Hartono, 2015). The amount of profit from an investment is known as a return. One of the things that attracts investors to invest is return. According to Brigham in (Dewi, 2019), stock returns or also known as stock returns are calculated by dividing the total amount invested by the total amount received. According to (Tandelilin E. , 2012) one of the things that encourages investors to invest and rewards them for their courage to bear risk is stock returns.

The two main components of investment returns are yield and capital gains. The yield portion known as yield represents the consistent cash flow or income generated by an investment. The increase or decrease in the price of assets, including stocks and long-term debt instruments is referred to as capital gains (losses). This is the part of the yield that results in profit or loss for the investor. Capital gain is the difference between the current price of an investment and its previous price. A gain is realized when the selling price of a stock exceeds its purchase price. Conversely, a capital loss occurs when the selling price of a stock is less than its purchase price.

## Portfolio Optimal

(Tandelilin E. , 2010) states that the portfolio that investors choose from the various options in the efficient portfolio group is the optimal portfolio. There is no doubt that each investor's choice with regard to return expectations and risk tolerance is reflected in the portfolio they choose. An optimal portfolio according to (Hartono, 2014) is a portfolio designed to offer the maximum rate of return with the lowest risk. The actions required to create an optimal portfolio are as follows:

1. Asset Allocation
2. Optimizing Ownership
3. Selecting an Asset
4. Executing the Portfolio

### Single Index Model

One way to determine the optimal portfolio is to use William Sharpe's single index model, which was developed in 1963. The Markowitz model's very complicated covariance calculation is one of its weaknesses. The Markowitz model has been simplified into a single index model (Oktaviana, 2019). Based on the finding that security prices fluctuate in line with the stock market price index, the single index model predicts that most stocks will increase in value when the stock price index increases (Hartono, 2015). On the other hand, most stocks will decline in price if the stock index declines. This suggests the correlation of security returns may result from a collective response to shifts in market value.

The premise that stock prices will move in the same direction as the market price index is the basis of the single index concept. One method to determine the optimal portfolio is the single index approach. The single index model describes the correlation between the return of each investment and the market return. According to (Bawasir & Sitanggang, 1994). Using the single index approach, the optimal portfolio is sought by comparing the cut-off-rate ( $C_i$ ) and excess- return-to-beta (ERB). ERB is the return on a stock above the risk-free rate of return or risk return premium determined by beta. The cut-off rate ( $C_i$ ) is the final sum of the market variance, the return premium, the stock variance error with the market variance and the susceptibility of each stock to the stock variance error. The concept of this calculation is based on a system to rank stocks based on their ERB, from high to low (Elton & Gruber, 1995). Finding the excess return of a stock over the risk-free return per unit of risk is the purpose of ranking. Therefore, stocks with an ERB comparable to or greater than  $C^*$  are the best way to construct a portfolio.

### Markowitz Model

During the 1950s, Markowitz created a new theory of optimal portfolio theory with the Markowitz model. Markowitz's theory uses several fundamental statistical markers, such as expected returns or correlations, portfolio and security standard deviations, and correlations of returns, to create a portfolio plan. Harry Markowitz inspired the saying "Don't put your eggs in one basket, but put them in several baskets" (Fahmi, 2015). This statement states that the foundation of the Markowitz portfolio model is to advise investors on how to minimize risk and maximize returns from each investment decision. "The foundation of the Markowitz portfolio concept aims to provide investors with targeted knowledge and guidance to minimize risk and offer maximum returns when they make investment choices." According to this idea, an investment has a return and risk component. The risk component can be minimized by diversifying investment holdings and building a portfolio of investment instruments in the portfolio.

Markowitz's portfolio theory suggests investing in different directions by dividing the investor's funds to be allocated as an investment. The purpose of segregating funds is to lower the investor's risk exposure in the future. During the evaluation or valuation stage, investors evaluate the performance of their portfolio in terms of the risk taken and the amount of profit generated. (Husnan, 2009) provides the assumption that a portfolio with greater returns is always superior to other portfolios. The following are the assumptions made by the Markowitz model, according to (Hartono, 2015):

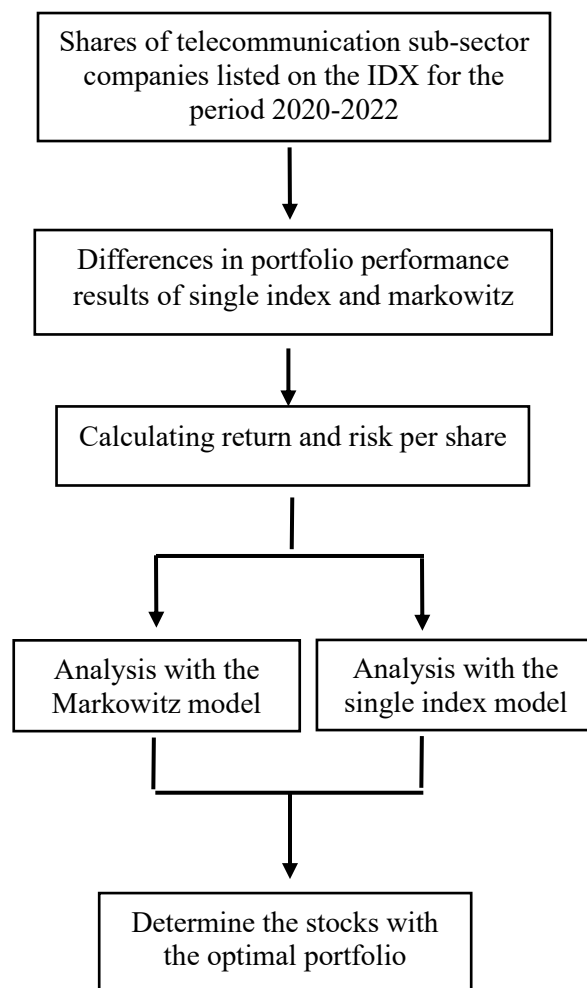
1. Only one time period is applied.
2. There is no transaction fee.
3. The projected return and risk of the portfolio are the only factors that influence investor preferences.
4. No risk-free savings and loans.

The Markowitz technique determines the optimal risk based on investor preferences determined by both risk-taking and risk-averse investors. The maximum predicted expected return with a certain desired risk based on each investor's risk preference is the notion of optimal measurement used.

## CONCEPTUAL FRAMEWORK

Two aspects that will be encountered when doing investment activities are *return* and risk. Therefore, determining stocks before making an investment needs to be done by an investor. Of course, an investor wants stocks that offer the highest return with the highest risk, or stocks that provide the lowest risk but the highest return. Investment risk can be reduced by creating an optimal portfolio with a diversity of stocks.

Both the single index model and the Markowitz model can be used to create an optimal portfolio. The Markowitz model outlines the steps an investor should take when constructing a portfolio and determines how much weight should be given to a particular stock when allocating funds. There is a weakness in the Markowitz model that requires calculating the complete covariance. Subsequently, the single index portfolio model was developed, a model developed from the Markowitz portfolio model and first proposed by William Sharpe in 1963. The calculation of the Markowitz model becomes easier with this model. The calculation of Markowitz portfolio risk, which was previously quite complicated, can then be calculated simply by applying the single index model. Investors can use whichever portfolio model will generate the highest returns.



## RESEARCH METHODS

Qualitative data or non-numerical data is used in this study to support a qualitative descriptive approach. In this study, stock market data, the composite stock index, and interest rates were used during the 2020-2022 research period. This study analyzes the telecommunications subsector listed on the Indonesia Stock Exchange from 2020 to 2022. In the telecommunications subsector there are 18 companies listed on the Indonesia Stock Exchange during the research period. This study uses a purposive sample method based on criteria that are in accordance with the research objectives. These criteria are as follows: 1.) Listed on the Indonesia Stock Exchange during the period 2020-2022. 2.) Telecommunication subsector companies engaged in telecommunication services that have been listed on the Indonesia stock exchange. 3.) Has had an IPO for more than five years.

Five telecommunications companies listed on the Indonesia Stock Exchange were selected as research samples based on predetermined criteria. The samples of this study are:

No.	Stock Code	Company Name
1	TLKM	PT Telekomunikasi Indonesia Tbk
2	FREN	PT Smartfren Telecom Tbk
3	ISAT	PT Indosat Ooredoo Hutchison Tbk
4	GOLD	PT Visi Telekomunikasi Infrastruktur Tbk
5	TBIG	PT Tower Bersama Infrastructure Tbk

In this research, the data analysis technique uses a single index model and Markowitz model with several estimation stages, such as:

### Single Index Model:

The following steps should be followed to form an optimal portfolio using the single index model, namely:

- 1) Determining stock returns

$$Return = \frac{P_t - P_{t-1} + D_1}{P_{t-1}} \quad (\text{Hartono, 2010})$$

- 2) Determine the expected return with the formula:

$$E(R_i) = \sum_{j=1}^N R_{it} \quad (\text{Hakim \& Waluyo, 2023})$$

- 3) Return of each stock

$$R_{mt} = \frac{IHSG_t - IHSG_{t-1}}{IHSG_{t-1}} \quad (\text{Hakim \& Waluyo, 2023})$$

- 4) Calculating Beta  $\beta$

$$B_i = \frac{\sigma_{iM}}{\sigma_M^2} \quad (\text{Hakim \& Waluyo, 2023})$$



5) Calculating Alpha ( $\alpha$ ) intercept

$$\alpha_i = E(R_i) - \beta_i \cdot E(R_m)$$

(Hakim & Waluyo, 2023)

6) Calculating Variance in residual error

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

(Hakim & Waluyo, 2023)

7) Calculate the ERB of each stock

$$ERB_i = \frac{[E(R_i) - R_{br}]}{\beta_i}$$

(Jogiyanto, 2010)

8) Cut off rate ( $C_i$ )

$$C_i = \frac{\sigma M^2 \sum_j^i = 1^A}{1 + \sigma M^2 \sum_j^i = 1^{Bj}}$$

(Jogiyanto, 2010)

9)  $A_i$  and  $B_i$

Results in  $A_i$  to get the value of  $B_i$ . The result will be used to determine the value of  $C_i$

$$i = \frac{E(R_i) - R_{br} \beta_i}{\sigma_{ei}^2}$$

(Hakim & Waluyo, 2023)

10) Calculate fund proportion ( $X_i$ ), percentage of fund proportion ( $W_i$ )

$$W_i = \frac{Z_i}{\sum_{j=1}^k Z_j}$$

(Hartono, 2010)

$$X_i = \beta_i (ERB_i - C) \cdot \sigma_{ei}^2$$

(Hakim & Waluyo, 2023)

11) Calculating  $E(R_p)$  portfolio projected return or known as expected return portfolio

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

(Hakim & Waluyo, 2023)

12) Standard deviation of the portfolio

$$\sigma_p^2 = \beta_p^2 \times \sigma_M^2 + \sum_{i=1}^n W_i^2 \times \sigma_{ei}^2$$

(Hakim & Waluyo, 2023)

### Markowitz Model:

To find the optimal portfolio in this model, follow these steps:

- 1) Using the formulas below, determine the stock return for each stock of the sample company

$$Return = \frac{P_t - P_{t-1} + D_1}{P_{t-1}}$$

(Hartono, 2010)

- 2) Use the formula below to calculate the expected return for each sample

$$E(R_i) = \frac{\sum_{i=1}^N R_{ij}}{N}$$

(Husnan, 2009)

- 3) Use the formula below to calculate the variance of each stock

$$\sigma_j^2 = \frac{\sum_{t=1}^n (R_{jt} - \bar{R}_j)^2}{(n-1)}$$

(Tandelilin E. , 2010)

- 4) Use the formula below to calculate the covariance value of the stocks in the portfolio

$$COV(R_A - R_B) = \sigma_{R_A, R_B} = \sum_{i=1}^n \frac{(R_{Ai} - E(R_A)) \cdot (R_{Bi} - E(R_B))}{n}$$

(Hartono, 2010)

- 5) Use the formula to calculate the expected return of the portfolio that has been created

$$E(R_p) = \sum_{i=1}^n W_i E(R_i)$$

(Tandelilin E. , 2010)

- 6) Use the formula below to determine the portfolio variance

$$Var(R_p) = \sigma_p^2 = E [R_p - E(R_p)]^2$$

(Hartono, 2010)

- 7) Minimize the objective function to determine the investment proportion ( $W_i$ ).

$$\sigma_p^2 = \sum_{i=1}^n W_i^2 \sigma_i^2 + \sum_{i=1}^n \sum_{j=1}^n W_i W_j \sigma_{ij}$$

(Hartono, 2010)

The main parameter to be used is  $W_i$  with constraints  $\sum_{i=1}^n w_i = 1$ ,  $W_i \geq 0$   
for  $i = 1, 2, \dots, n$ , dan  $\sum_{i=1}^n W_i \cdot R_i = R_p$

- 8) To find the optimal portfolio, construct an efficient frontier curve and a global minimum variance (GMV) curve.
- 9) Repeat the fifth step and get the optimal expected return of the portfolio.



10) Apply the same procedure to calculate the portfolio variance, but add the final proportion determined earlier using the following formula to get the optimal portfolio variance.

$$\sigma_p^2 = \sum_{t=1}^n W_1^2 \sigma_1^2 + \sum_{t=1}^n \sum_{t=1}^n w_i w_j \sigma_{ij}$$

(Hartono, 2010)

## ANALYSIS AND DISCUSSION

### Analysis

List of samples that will be used in this study on Telecommunication Sub-Sector companies listed on the Indonesia Stock Exchange for 2020-2022.

Number	Stock Code	Name
1	TLKM	PT Telekomunikasi Indonesia Tbk
2	FREN	PT Smartfren Telecom Tbk
3	ISAT	PT Indosat Ooredoo Hutchison Tbk
4	GOLD	PT Visi Telekomunikasi Infrastruktur Tbk
5	TBIG	PT Tower Bersama Infrastructure Tbk

### Single Index Model Optimal Portfolio

- Results of the calculation of Expected Return, Standard Deviation, Beta, Alpha, Unique Risk, and Excess Return To Beta.

	TLKM	FREN	ISAT	GOLD	TBIG
E(Ri)	0.001075425	0.001095343	0.043862552	0.018341463	0.024538056
$\Sigma i$	0.074022025	0.219335351	0.255719057	0.146904438	0.125367377
Bi	1.037665282	2.076877116	2.228745113	0.358560295	0.707573036
Ai	-0.002550862	-0.006162635	-0.007635421	0.017088417	0.022065329
$\sigma_{ei2}$	0.003078701	0.038491441	0.054317874	0.021294283	0.014600783
ERBi	-0.011567582	-0.005769894	0.013812189	0.014677475	0.016195293

- Market Expected Return Calculation Results

E(Rm)	$\Sigma m$	$\sigma m2$
0.00349466	0.047217061	0.002229451

- Sorting Result from Largest to Smallest Value

	TBIG	GOLD	ISAT	FREN	TLKM
ERBi	0.016195	0.014677	0.013812	-0.00577	-0.01157
E(Ri)	0.024538	0.018341	0.043863	0.001095	0.001075
$\sigma i$	0.125367	0.146904	0.255719	0.219335	0.074022
$\beta i$	0.707573	0.35856	2.228745	2.076877	1.037665
$\alpha i$	0.022065	0.017088	-0.00764	-0.00616	-0.00255
$\sigma_{ei2}$	0.014601	0.021294	0.054318	0.038491	0.003079

4. Calculation Result of Cut of Point Value (Ci)

	<b>TBIG</b>	<b>GOLD</b>	<b>ISAT</b>	<b>FREN</b>	<b>TLKM</b>
Aj	0.555335	0.088616	1.263108	-0.64658	-4.04566
$\sum A_j$	0.555335	0.643951	1.907059	1.260475	-2.78519
Bj	34.28991	6.037559	91.44881	112.0618	349.7415
$\sum B_j$	34.28991	40.32747	131.7763	243.838	593.5795
Ci	0.00115	0.001317	0.003286	0.00182	-0.00267

5. Comparison Results of Ci and ERBi Values

<b>Stock Code</b>	<b>Ci</b>	<b>ERBi</b>	<b>Conclusion</b>
TBIG	0.001326	0.016195	Optimal
GOLD	0.001491	0.014677	Optimal
ISAT	0.003426	0.013812	Optimal
FREN	0.001942	-0.00577	Not Optimal
TLKM	-0.00258	-0.01157	Not Optimal

6. The result of the calculation of the proportion of each share

<b>Stock Code</b>	<b>Zi</b>	<b>Wi</b>
TBIG	0.6255898	50%
GOLD	0.1918095	15%
ISAT	0.4318959	35%

7. Calculation results of alpha and beta portfolios

<b>Stock Code</b>	<b><math>\alpha_p</math></b>	<b><math>\beta_p</math></b>
TBIG	0.011049306	0.354320158
GOLD	0.002623656	0.055051262
ISAT	-0.002639654	0.770503116
<b>Total</b>	<b>0.011033308</b>	<b>1.179874535</b>

8. Expected return and portfolio risk

<b>Stock Code</b>	<b><math>\alpha_p</math></b>	<b><math>\beta_p</math></b>	<b><math>\sigma_{ep2}</math></b>
TBIG	0.011049	0.35432	0.007311
GOLD	0.002624	0.055051	0.003269
ISAT	-0.00264	0.770503	0.018778
<b>E(Rp)</b>	0.015157	2%	
<b><math>\sigma_p</math></b>	0.180174	18%	

### Markowitz Model Optimal Portfolio

#### 1. Calculation of expected return

Stock Code	E(R <sub>i</sub> )
TLKM	0.001075425
FREN	0.001095343
ISAT	0.043862552
GOLD	0.018341463
TBIG	0.024538056

#### 2. Calculation of standard deviation and stock variance

	Standard Deviation	Stock Variant
TLKM	0.075072035	0.00563581
FREN	0.222446646	0.04948251
ISAT	0.259346459	0.067260586
GOLD	0.148988293	0.022197511
TBIG	0.127145726	0.016166036

#### 3. Calculating the stock covariance value

	<i>TLKM</i>	<i>FREN</i>	<i>ISAT</i>	<i>GOLD</i>	<i>TBIG</i>
<b>TLKM</b>	0.00547926	0.00545272	0.00467823	-0.0015393	-0.000443828
<b>FREN</b>	0.005452721	0.048108	0.013538282	0.00682668	0.012443502
<b>ISAT</b>	0.00467823	0.01353828	0.065392236	0.00874003	0.011106319
<b>GOLD</b>	-0.0015393	0.00682668	0.008740035	0.02158091	0.00737831
<b>TBIG</b>	-0.00044383	0.0124435	0.011106319	0.00737831	0.015716979

#### 4. Calculating coefficients and correlations

	<b>TLKM</b>	<b>FREN</b>	<b>ISAT</b>	<b>GOLD</b>	<b>TBIG</b>
<b>TLKM</b>	1	0.33584871	0.247148225	-0.14155552	-0.04782652
<b>FREN</b>	0.335848712	1	0.241374752	0.211868342	0.45253215
<b>ISAT</b>	0.247148225	0.24137475	1	0.202535153	0.24152748
<b>GOLD</b>	-0.14155552	0.21186834	0.202535153	1	0.40062443
<b>TBIG</b>	-0.047826517	0.45253215	0.241527485	0.400624428	1

5. Calculation of expected return and risk of portfolios with equal proportions

Stock Code	Proportion (Wi)
TLKM	20%
FREN	20%
ISAT	20%
GOLD	20%
TBIG	20%
<b>TOTAL</b>	<b>100%</b>
<b>E(Rp)</b>	<b>2%</b>
<b><math>\Sigma p</math></b>	<b>11%</b>

6. Calculation of expected return and portfolio risk with optimal proportion

Stock Code	Proportion (Wi)
TLKM	68%
FREN	0%
ISAT	0%
GOLD	15%
TBIG	17%
<b>TOTAL</b>	<b>100%</b>
<b>E(Rp)</b>	<b>1%</b>
<b><math>\sigma p</math></b>	<b>6%</b>

Discussion

Number	Single Index	Markowitz
1	TBIG	TLKM
2	GOLD	GOLD
3	ISAT	TBIG
E(Rp)	2%	1%
$\sigma p$	18%	6%

In the calculation of the optimal portfolio that applies the single index model, 3 stocks are included in the optimal portfolio candidate. These stocks include shares of PT Tower Bersama Infrastructure Tbk (TBIG), shares of PT Visi Telekomunikasi Infrastruktur Tbk (GOLD), and shares of PT Indosat Ooredoo Hutchison Tbk (ISAT). The proportion of funds that can be distributed for stock investment as a result of the formation of the optimal portfolio by applying a single index model is TBIG of 0.500754 (50%), GOLD shares of 0.152534 (15%), and ISAT of 0.345711 (35%) with an expected return of 2% and a risk of 18%.

Based on the Markowitz model, three stocks are included in the optimal portfolio candidate. The proportion of funds distributed by each stock included in the optimal portfolio of the markowitz model is TLKM stock of 0.682377 (68%), GOLD stock of 0.150660 (15%), and TBIG stock of 0.166926 (17%) with an expected return of 1% and a risk of 6%.

## CONCLUSION

The following are the research results obtained from the comparison of optimal portfolio formation between the Markowitz model and the single index model:

1. Based on a sample of 5 stocks used in telecommunications companies listed on the Indonesia Stock Exchange for the 2020-2022 period, companies that can meet the criteria for forming an optimal portfolio based on the single index model are 3 stocks with the optimal proportion of funds from each stock, namely: PT Tower Bersama Infrastructure Tbk (TBIG) shares with a proportion of 50%, PT Visi Telekomunikasi Infrastruktur Tbk (GOLD) shares with a proportion of 15%, and PT Indosat Ooredoo Hutchison Tbk (ISAT) shares with a proportion of 35%. The level of profit and the amount of risk generated from 3 stocks that make up the optimal portfolio is to produce an expected return of 2% and the risk borne is 18%.
2. Based on a sample of 5 stocks used in telecommunications companies listed on the Indonesia Stock Exchange for the 2020-2022 period, companies that can meet the criteria for forming an optimal portfolio based on the Markowitz model are 3 stocks with the optimal proportion of funds from each stock, namely: PT Telekomunikasi Indonesia Tbk (TLKM) with a proportion of 68%, PT Visi Telekomunikasi Infrastruktur Tbk (GOLD) shares with a proportion of 15%. and PT Tower Bersama Infrastructure Tbk (TBIG) shares with a proportion of 17%. The level of profit and risk generated from 3 stocks that make up the optimal portfolio is to produce an expected return of 1% and the risk borne is 6%.
3. The comparison obtained in the formation of optimal portfolios using the single index method produces 3 stock candidates that enter the optimal portfolio, namely, PT Tower Bersama Infrastructure Tbk (TBIG) shares, PT Visi Telekomunikasi Infrastruktur Tbk (GOLD) shares, and PT Indosat Ooredoo Hutchison Tbk (ISAT) shares. While the Markowitz method produces 3 stock candidates, namely, PT Telekomunikasi Indonesia Tbk (TLKM), PT Visi Telekomunikasi Infrastruktur Tbk (GOLD) shares, and PT Tower Bersama Infrastructure Tbk (TBIG) shares. The results obtained from the 5 companies used as samples in this study show that the optimal portfolio of the single index model produces an expected return of 2% and a risk of 18%. While the Markowitz method produces an expected return of 1% and a risk of 6%.

## ADVICE

Based on the conclusions, there are several recommendations that can be considered based on the findings that have been made previously:

1. For Investors

By creating an optimal investment portfolio with the help of Markowitz model and single index model, investors can re-evaluate the diversification of their stock holdings. In addition, investors can evaluate the portfolio if a particular value stock has a high risk without a corresponding return, it may be worth reducing the exposure to that stock.

2. For the Company

Reviewing the performance and conducting a more in-depth assessment of the company's shares does not include the optimal portfolio. This is done so that investors can use it as an investment in the future. In order to be used as a purchase by investors in the future, this review can strive to get the best return.

3. For Future Researchers

1) This research only focuses on companies in the telecommunications subsector. Therefore, it is hoped that future researchers can explore other sectors.

2) Since there are only 5 samples in this study, it is hoped that there will be more samples. The research conducted now can serve as a source of information for additional studies using the same object or method.

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