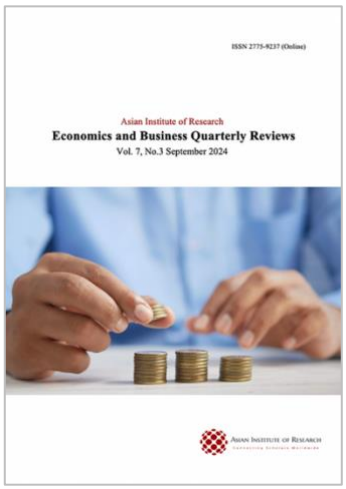

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Analysis of Optimal Portofolio Formation Using Markowitz Model and Portofolio Performance Evaluation

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Abstract
The year 2020 was a challenging year for investment worldwide, especially for the stock market. This was due to the World Health Organization (WHO) declaring Covid-19 a pandemic. This resulted in the composite stock price index (IHSG) dropping from 6300 to 3900. High volatility occurred from March 2020 until the end of 2022, and traders took advantage of this by engaging in high-risk short selling. The purpose of this research is to analyze the formation of a Markowitz portfolio and evaluate the performance of portfolios formed from the IDX30 index and the BSE Sensex index, focusing on the period from one month before the rebound, which is from August 2020 to January 2023. This analysis aims to provide guidance in selecting companies for investment. The research methodology is descriptive research. The methodology used is Markowitz modeling to obtain an optimal portfolio, followed by evaluation using the Treynor, Sharpe, and Jensen indexes. The results, for the IDX30 index, an optimal portfolio comprising six stocks achieved an expected annual return of 19.97% with a risk level of 8.77%. In contrast, the optimal portfolio for the BSE Sensex index consisted of eight stocks, yielding an expected annual return of 28.4% with a risk level of 4%. Regarding performance, the portfolio formed from the BSE Sensex index outperformed the IDX30 portfolio when assessed using the Sharpe indices. However, considering the Jensen and Treynor index, the optimal portfolio formed from the IDX30 index exhibited superior performance.

Keywords: Markowitz Portfolio, Optimum Portfolio, Portfolio Performance, Sharpe Indice, Treynor Indice, Jensen Indice

1. Introduction

In 2020, the world faced significant challenges due to the Covid-19 pandemic, which was officially declared by the World Health Organization (WHO) on March 9, 2020. Various countries implemented policies to prevent the spread of the virus, including lockdowns, physical distancing measures, and travel restrictions.

Muhammad Adisurya (2020) highlighted that the Covid-19 pandemic triggered a crisis worldwide, affecting various sectors, including finance. Indonesia's Financial Services Authority (OJK) reported a severe blow to the composite stock price index, with a significant decline in stock prices. At the beginning of 2020, stock prices hovered around 6300 but dropped to 3900 by March 2020. Additionally, trading volume also decreased from 36.5 billion in 2019 to 27.4 billion in 2020. Factors influencing the capital market during the Covid-19 pandemic included speculation related to government stimulus measures and responses from central banks.

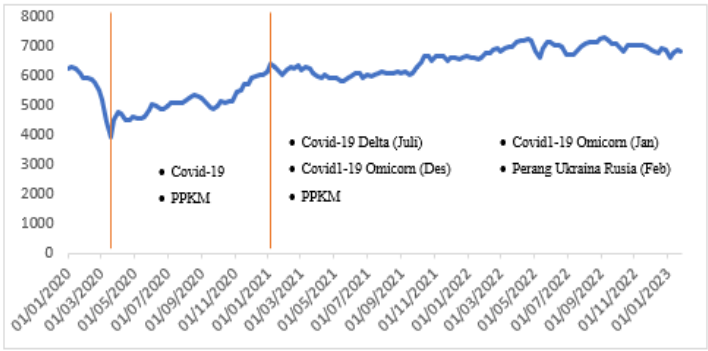

Figure 1: IDX30 Indices

Figure 1 illustrates the pattern of the Indonesian Composite Stock Price Index (IHSG) from March 2020 to January 2023. Based on the graph, IHSG experienced a decline in March 2020. According to Putranto (2021), there is a significant difference between IHSG in December 2019 and March 2020, where stock prices before Covid-19 were higher compared to after the pandemic hit. Even in June 2020, three months later, the price movement had not significantly recovered. The trend of IHSG prices during the Community Activities Restriction Enforcement (CARE) period (June 2020 to July 2021) was better compared to the early Covid-19 period.

According to Haryati (2021), Indonesia was hit by cases of the Covid-19 Delta variant, with the peak occurring in July 2021 and declining in October 2021. However, this condition did not significantly affect the overall capital market. This can be observed from a study conducted by Soputan (2022), which found no significant difference in abnormal returns and trading volume activity before and after the announcement of the Delta variant. By the end of 2021, the Indonesian Composite Stock Price Index (IHSG) demonstrated positive performance, reaching 6581 or a 10.1% year-on-year increase (Binekasri, 2022). Abnormal return refers to the difference between expected profit levels and actual measurement levels (Jogiyanto, 2016).

In December 2021, the first cases of the Covid-19 Omicron variant were detected in Indonesia, suspected to have entered the country through Indonesian citizens originating from Nigeria (source: www.kemkes.go.id). Subsequently, the BA.4 and BA.5 variants entered Indonesia in mid-2022, with cases detected in Bali (source: www.kompas.com).

However, the majority of Omicron cases in 2022 did not significantly impact abnormal returns in the stock market. This was revealed by Arlitha (2022) and Putra (2023), whose research indicated no significant changes in abnormal returns and average volume activity for the LQ45 Index and IDX30 Index.

In 2022, several events also influenced the performance of the Indonesian Composite Stock Price Index (IHSG), including the Ukraine-Russia conflict and the Federal Reserve's interest rate hikes, leading to fluctuating movements in the IHSG. Nevertheless, based on data as of December 30, 2022, the IHSG stood at 6868, representing a 4.35% year-to-date increase. Additionally, in 2022, the IHSG ranked first in Asia, surpassing Singapore's STI index (source: www.idxchannel.com).

The Nikkei 225 (Japan), HSI (Hong Kong), and STI (Singapore) indices in Figure 1.5 exhibit a pattern similar to the JKSE/IHSG (Indonesia). There was a decline in March 2020, followed by an upward trend until early 2023. However, it is noticeable that the Hang Seng index experienced a decline in the fourth quarter of 2022 and then rebounded at the beginning of 2023.

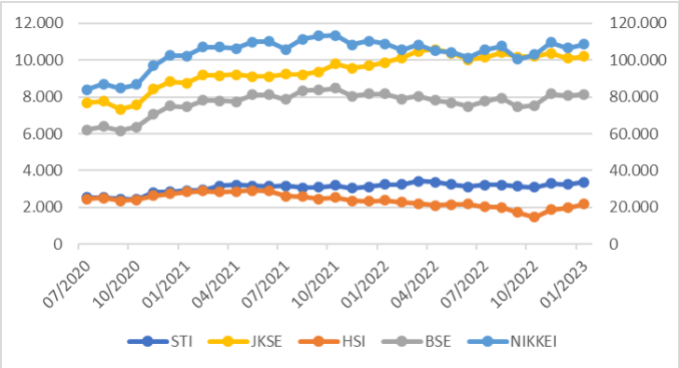

Figure 2: Asia Pasific Indices

Several Asia Pacific indices, represented by the BSE Sensex 30 (India), Nikkei 225 (Japan), HSI (Hong Kong), and STI (Singapore) as shown in Figure 1.5, exhibit a pattern similar to the JKSE / IHSG (Indonesia) with a decline in March 2020 followed by an increase until early 2023. However, the Hang Seng index shows a decline in the fourth quarter of 2022 and then rises again at the beginning of 2023.

The average monthly returns for the Asia Pacific indices are presented in Table 1. Based on the table, the majority of indices have positive average returns, and the BSE has a larger average return compared to the JKSE.

Table 1: Average Return of Asia Pacific Indices

Index	***Average Return***
JKSE	*1,14%*
BSE Sensex	*1,83%*
NIKKEI	*0,07%*
HSI	*-0,09%*
STI	*0,93%*

Table 1 illustrates the average returns of several Asia Pacific indices. According to the table, only the BSE Sensex index has a higher average return compared to the JKSE (IHSG). The performance of stocks post-pandemic has influenced investment conditions and opportunities (Febrianto, 2023). According to Eduardus Tandelilin (2017), an investor buys a number of shares with the expectation of gaining profits from the increase in stock prices or dividends in the future, as a reward for the time and risk associated with the investment. The basis of investment decisions consists of the expected return rate, the level of risk, and the relationship between return and risk.

According to Oktaviani (2022), investors need to assess portfolio performance to analyze and determine whether the formed portfolio can increase the likelihood of achieving investment goals and to identify which portfolios perform better. Performance evaluation begins with calculating the return of the portfolio. One method to calculate portfolio return is by summing all received cash flows (dividends plus changes in base value). However, this simple method has a drawback as it only calculates a "static" return rate (Tandelilin, 2017). There are three indices that can be used in measuring portfolio performance: the Sharpe index, Treynor index, and Jensen index. When measuring portfolio performance, it can be assumed that there is a linear relationship with the market index. These three methods perform analysis based on historical returns and predict future returns and risks (Samsul, 2015).

Previous studies have captured the phenomenon of stock declines and rises due to several events from 2020 to the end of 2023. Research conducted by Puspitasari (2023) titled “Comparative Analysis of Optimal Portfolio

Performance Using the Sharpe, Treynor, and Jensen Methods Before and During the Covid-19 Pandemic" was carried out on the IDX30 index from 2018 to 2021. This study shows differences in portfolios formed before and during the pandemic, as some companies were unable to maintain their performance.

Research conducted by Sandhi et al. (2017), titled "Comparative Study of SME Stock Portfolio Performance in the Capital Markets of Indonesia, China, and India," aims to compare the performance of SME stock portfolios in the capital markets of Indonesia, China, and India based on the Sharpe index and the significance of the average performance differences among these capital markets. The results of this study indicate that the SME stock portfolios in the capital markets of Indonesia, China, and India outperform A-list stocks. However, for composite stocks, only Indian SME stocks have performance below the composite stocks.

Based on the aforementioned background, this study aims to provide insights to investors in determining investment strategies when systematic risks occur in the stock market. The IDX30 index is used due to its high liquidity and large market capitalization, while the BSE Sensex index is selected for its higher average return compared to the IHSG index. Historical data from August 2020 to January 2023 is utilized, encompassing events such as the Covid-19 pandemic, the Ukraine-Russia war, and post-Covid-19 economic recovery in Indonesia.

2. Research Method

This study employs a descriptive method. According to Sugiyono (2013), the descriptive method is the formulation of a problem related to the statement of independent variables, whether only one or several variables, without comparing one variable with another. A depiction of the occurring phenomenon is required so that the collected and analyzed data are relevant, thus obtaining a profile of events, people, and situations (Saunders et al., 2016).

The research paradigm used is positivism. Positivism relates to the philosophical stance of the researcher and operates based on observed reality without being influenced by interpretation. Positivist researchers tend to use structured methodologies (Saunders et al., 2016).

The approach to theory development in this study is deductive. Deductive reasoning is a research technique that starts from a theory, which is then developed and a strategy is designed that can be generally applied. Some characteristics of deductive reasoning include first, seeking causal relationships between concepts and variables; then, quantitative data collection; and finally, generalization, which involves careful sampling techniques so that the measurements can be generally applied to the objects (Saunders et al., 2016).

The research methodology used is quantitative. Quantitative research is the process of discovering knowledge using numerical data. This method explains the problem-solving process of a research object based on data that is then interpreted (Darmawan, 2013).

The variables used in this study are the stock returns in the IDX30 and BSE Sensex indices, which are calculated from the stock closing data. The return data are then processed to obtain an optimal portfolio using the Markowitz method.

According to Sugiyono (2013), a population is a generalization area consisting of objects/subjects that have certain qualities and characteristics to be studied and drawn conclusions from. In this study, the population includes the Asia Pacific indices such as JKSE (Indonesia), BSE Sensex (India), Nikkei 225 (Japan), HSI (Hong Kong), and STI (Singapore), as well as the listed companies on the Indonesia Stock Exchange (IDX) and the listed companies on the BSE Sensex.

2.1 Sample

The definition of a sample is a part of the quantity and characteristics possessed by a population (Sugiyono, 2013). The sample taken in this study consists of the companies included in the IDX30 index of the Indonesia Stock

Exchange (IDX) according to IDX Announcement No. Peng-00018/BEI.POP/01-2023 and the companies in the BSE Sensex for the year 2023 according to www.spglobal.com.

Sampling technique refers to the method used to select a sample in research (Sugiyono, 2013). One sampling technique is purposive sampling. Purposive sampling is a technique classified under non-probability sampling, where the sample is determined based on certain considerations (Sugiyanto, 2023).

Table 2: Sample Selection Criteria

Index	Criteria	Amount
IDX30	Numbers of issuers	30
BSE Sensex	Numbers of issuers	30
	Total sample	60

Based on Table 2, the number of samples that meet the criteria in this study includes 30 companies for the IDX30 index and 30 companies for the BSE Sensex index.

Table 3: Sample from IDX30 Indices

No	Code	Company	No	Code	Company
1	ADRO	Adaro Energi	16	HRUM	Harum Energi
2	AMRT	Sumber Alfaria Trijaya	17	INCO	Vale Indonesia
3	ANTM	Aneka Tambang	18	INDF	Indofood Sukses Makmur
4	ARTO	Bank Jago	19	ITMG	Indo Tambangraya Megah
5	ASII	Astra Internasional	20	KLBF	Kalbe Farma
6	BBCA	Bank Central Asia	21	MDKA	Merdeka Copper Gold
7	BBNI	Bank Negara Indonesia	22	MEDC	Medco Energi Internasional
8	BBRI	Bank Rakyat Indonesia	23	PGAS	Perusahaan Gas Negara
9	BMRI	Bank Mandiri	24	PTBA	Bukit Asam
10	BRPT	Barito Pacific	25	SMGR	Semen Indonesia
11	BUKA	Bukalapak.com	26	TBIG	Tower Bersama Infrastruktur
12	CPIN	Charoen Pokphand Indonesia	27	TLKM	Telkom Indonesia
13	EMTK	Elang Mahkota Teknologi	28	TOWR	Sarana Menara Nusantara
14	ESSA	Surya Esa Perkasa	29	UNTR	United Tractor
15	GOTO	GoTo Gojek Tokopedia	30	UNVR	Unilever Indonesia

Table 4: Sampel from BSE Sensex Indices

No	Code	Company	No	Code	Company
1	ASPN	Asian Paints Ltd	16	LART	Larsen & Toubro Ltd
2	AXBX	Axis Bank Ltd	17	MAHM	Mahindra & Mahindra Ltd
3	BJFN	Bajaj Finance Ltd	18	MRTI	Maruti Suzuki India Ltd
4	BJFS	Bajaj Finserv Ltd	19	NEST	Nestle India Ltd
5	BRTI	Bharti Airtel Ltd	20	NTPC	NTPC Ltd
6	REDY	Dr. Reddy/s Laboratories Ltd	21	PGRD	Power Grid Corp of India
7	HCLT	HCL Technologies Ltd	22	RELI	Reliance Industries Ltd
8	HDBK	HDFC Bank Ltd	23	SBI	State Bank of India Ltd
9	HLL	Hindustan Unilever Ltd	24	SUN	Sun Pharmaceutical Ltd
10	HDFC	Housing Dev Finance Ltd	25	TCS	Tata Consultancy Servi Ltd
11	ICBK	ICICI Bank Ltd	26	TISC	Tata Steel Ltd
12	INBK	Indusind Bank Ltd	27	TEML	Tech Mahindra Ltd
13	INFY	Infosys Ltd	28	TITN	Titan Company Ltd
14	ITC	ITC Ltd	29	ULTC	Ultratech Cement Ltd
15	KTKM	Kotak Mahindra Bank Ltd	30	WIPR	Winpro Ltd

2.2 Data Analysis

The steps in conducting data analysis in this study are as follows:

1. Collecting monthly closing price data for each stock for the period from August 1, 2020 to January 31, 2023.
2. Calculating the return (Rit) for each stock within the specified period.

$$R_{it} = \frac{P_t - P_{t-1}}{P_{t-1}} \quad (1)$$

R_{it} = Stock Return
P_{t-1} = Stock Price at start
P_t = Stock Price at end

3. After obtaining the returns for all stocks, calculate the average value of the returns. This average value is referred to as the average return or expected return (E(Ri).

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

$E(R_i)$= Expected Return
R_{it} = Return in Month t
n = Number of Calculated Month

"To obtain an optimal portfolio, stocks that do not have average returns below the market will not be included in the portfolio selection process."

4. After obtaining the expected returns, the next step is to calculate the variance of the returns for each stock.

$$\sigma i^2 = \frac{1}{n}\sum\left(R_{it} - E(R_i)\right)^2 \quad (3)$$

σi = Stock Varians
$E(R_i)$ = Expected Return
R_{it} = Return in Month t
n = Number of Calculated Month

5. Calculate the standard deviation of each stock. This step is performed by taking the square root of the variance of each stock (σi).

$$\sigma i = \sqrt{\sigma i^2} \quad (4)$$

6. The next step is to calculate the covariance between each pair of stocks.

$$\sigma_{12} = \sum_{i=1}^{n} \frac{[(R_{1i} - E(R_1)).(R_{2i} - E(R_2)]}{n} \quad (5)$$

7. After obtaining the covariance, portfolio formation is carried out using the Solver program from Microsoft Excel.
8. After forming the portfolio, the calculation of realized return is performed.

$$R_p = \sum_{i=1}^{n}(w_i \times R_i) \quad (6)$$

Rp = Portfolio Return
wi = Weight Assigned to Each Asset
Ri = Return of Individual Asset
n = Total Number of Assets in the Portofolio

9. Calculate expected return using equation

$$E\left(R_p\right) = \sum_{i=1}^{n}\left(wi \times E(R_i)\right) \quad (7)$$

E(Rp) = Expected Return of the Portofolio
wi = Weight Assigned to Each Asset
E(Ri) = Expected Return to Each Individual Asset
n = Total Number of Assets in the Portofolio

10. Calculate the standard deviation of the portfolio.

$$\sigma_p = \sum_{i=1}^{n} W_i \times \sigma_i^2 + 2 \times \sum_{i=1}^{n}\sum_{i=1}^{n} W_i W_j \sigma_{ij} \quad (8)$$

σp = Portofolio Standar Deviation

Wi = Weight of Aset Return
n = Total Number of Assets in the Portofolio

11. Calculate the portfolio beta. Before calculating the portfolio beta, calculate the individual stock beta.

$$\beta_i = \frac{\sigma_{i,M}}{\sigma_M^2} \quad (9)$$

β_i = Beta Coefficient for Asset
$\sigma_{i,M}$ = Covariance Between the Return of Asset
$\sigma^2_{,M}$ = Market Variance

12. Calculate Risk Free Rate (Rf).Risk-free Rate is calculated using the BI-7 Day Reverse Repo Rate (BI7DRR) and the 364-Day Treasury Bill Yield as benchmarks for the risk-free rate in the financial markets of Indonesia and India.

$$R_f = \frac{R_t - R_{t-1}}{R_{t-1}} \quad (10)$$

R_f = Risk free rate
R_{t-1} = Risk free at start
R_t = Risk free at end

13. The next step is to calculate the portfolio performance using the Sharpe, Treynor, and Jensen indices. The equations used to calculate portfolio performance are as follows.

$$\widehat{S_p} = \frac{\bar{R}_p - \overline{RF}}{\sigma_{TR}} \quad (11)$$

S_p = Sharpe Ratio
Rp = Expected Return of Portofolio
RF = Risk Free Rate
σ_{TR} = Standard Deviation of Portofolio

$$\widehat{T_p} = \frac{\bar{R}_p - \overline{RF}}{\beta_p} \quad (12)$$

T_p = Treynor Ratio
Rp = Expected Return of Portofolio
RF = Risk Free Rate
β_p = Beta Portofolio p

$$\overline{J_p} = \overline{R_p} - (\overline{RF} + (R_M - \overline{RF})\hat{\beta}_p \quad (13)$$

J_p = Jensen Ratio
Rp = Expected Return of Portofolio
RF = Risk Free Rate
β_p = Beta Portofolio p

3. Results & Discussion

The data for each constituent stock of both the IDX30 and BSE Sensex indices were obtained from www.investing.com and www.finance.yahoo.com for the period from August 1, 2020, to January 31, 2023. The analysis includes 30 constituents from the IDX30 index and 30 constituents from the BSE Sensex index.

Table 5: Example of IDX30 Average Monthly Price

Date	AMRT	ANTM	ARTO	ASII	BBCA
01/07/2020	740	730	2.322	5.150	6.240
01/08/2020	715	820	2.181	5.100	6.275
01/09/2020	665	705	2.355	4.460	5.420
01/10/2020	680	1055	2.364	5.425	5.790
……	……	……	……	……	……
……	……	……	……	……	……

01/10/2022	2.820	1845	5.100	6.650	8.800
01/11/2022	3.090	1985	4.590	6.050	9.300
01/12/2022	2.650	1985	3.720	5.700	8.550
01/01/2023	2.830	2310	3.210	6.000	8.475

Table 5 illustrates the average monthly prices of each stock from August 2020 to January 2023. This data collection was conducted for the IDX30 and BSE Sensex stock indices.

The risk-free rate data will be used in performance calculations. For portfolios formed on the IDX30 index, the BI-7 Day Reverse Repo Rate (BI7DRR) sourced from www.bi.go.id will be used, while for portfolios formed on the BSE Sensex index, the 364-Day Treasury Bill (primary) Yield sourced from www.rbi.org.in will be utilized.

Table 5: BI-7 Day Reverse Repo Rate

Month	BI-7 Day Reverse Repo Rate	Month	BI-7 Day Reverse Repo Rate	Month	BI-7 Day Reverse Repo Rate
Aug-20	4.00%	Jun-21	3.50%	Apr-22	3.50%
Sep-20	4.00%	Jul-21	3.50%	May-22	3.50%
Oct-20	4.00%	Aug-21	3.50%	Jun-22	3.50%
Nov-20	3.75%	Sep-21	3.50%	Jul-22	3.50%
Dec-20	3.75%	Oct-21	3.50%	Aug-22	3.75%
Jan-21	3.75%	Nov-21	3.50%	Sep-22	4.25%
Feb-21	3.50%	Dec-21	3.50%	Oct-22	4.75%
Mar-21	3.50%	Jan-22	3.50%	Nov-22	5.25%
Apr-21	3.50%	Feb-22	3.50%	Dec-22	5.50%
May-21	3.50%	Mar-22	3.50%	Jan-23	5.75%
Average risk free rate					**3.85%**

Table 6: 364-Day Treasury Bill Yield

Month	364-Day Treasury Bill (Primary) Yield	Month	364-Day Treasury Bill (Primary) Yield	Month	364-Day Treasury Bill (Primary) Yield
Aug-20	3.54%	Jun-21	3.85%	Apr-22	3.75%
Sep-20	3.63%	Jul-21	3.77%	May-22	5.92%
Oct-20	3.48%	Aug-21	3.66%	Jun-22	6.28%
Nov-20	3.45%	Sep-21	3.58%	Jul-22	6.24%
Dec-20	3.45%	Oct-21	3.95%	Aug-22	6.20%
Jan-21	3.63%	Nov-21	4.10%	Sep-22	6.66%
Feb-21	3.71%	Dec-21	4.26%	Oct-22	6.94%
Mar-21	3.84%	Jan-22	4.47%	Nov-22	6.86%
Apr-21	3.75%	Feb-22	4.49%	Dec-22	6.90%
May-21	3.73%	Mar-22	4.65%	Jan-23	6.91%
Risk Free Rate Average					**4.62%**

Source: www.rbi.org.in (2024)

From Table 5 and Table 6. it can be observed that the BI-7 Day Reverse Repo Rate taken from August 2020 to January 2023 has an average of 3.85%. whereas the 364-Day Treasury Bill (Primary) Yield has an average risk-free rate of 4.62%.

The next step involves calculating the return. expected return. variance. standard deviation. covariance. and portfolio formation. Once the portfolio is formed. the calculation of beta and risk-free rate follows as components of the Sharpe. Treynor. and Jensen index performance calculations.

Returns and expected returns are calculated for the IDX30 and BSE Sensex indices. For example calculation. using PT Aneka Tambang Tbk with the stock code ANTM. In August 2020. the average monthly price of ANTM was Rp. 730. while in September 2020. it was Rp. 830. The calculation of return for ANTM in September is derived as follows:

$$R_{it} = \frac{830-730}{730} = 0.1232$$

Therefore. the realized return. or also known as the actual return. of ANTM in September 2020 is 0.1232 or 12.32%. For calculating the Expected Return. we use the average monthly price data of ANTM from August 2020 to January 2023.

$$E(R_i) = \frac{(0.1232)+(-0.1402)+\cdots+(0.1637)}{31} = 0.549$$

Therefore. the expected return obtained for ANTM stock during the observation period from August 2020 to January 2023 is 0.549 or 5.49%. Microsoft Excel was used in this research to facilitate the calculation of expected return using the AVERAGE function.

The calculations for return and expected return are conducted for all constituents of the IDX30 and BSE Sensex indices. In addition to individual stocks. average return calculations are performed for IHSG and BSE Sensex. The results of the average return calculations for both indices show an average return of 1.83% for IHSG and 1.01%.

Portfolio formation begins by selecting stocks based on their average return compared to their respective index. If a stock has an average return below that of its index. it will be eliminated. Out of the 30 constituents in the IDX30 index. 20 stocks have an average return higher than IHSG. Similarly. in the case of BSE Sensex. out of the 30 constituents. 20 stocks have an average return higher than the index.

Table 7: Issuer With Average Return Higher than IHSG

No.	Code	*Return*	No	Code	*Return*
1.	ADRO	4.18%	11.	INCO	3.38%
2.	AMRT	5.13%	12.	KLBF	1.03%
3.	ANTM	5.49%	13.	HRUM	9.38%
4.	ARTO	3.00%	14.	ITMG	6.15%
5.	BBCA	1.19%	15.	MDKA	4.16%
6.	BBNI	2.80%	16.	MEDC	5.60%
7.	BBRI	1.62%	17.	PGAS	1.50%
8.	BMRI	2.07%	18.	PTBA	2.26%
9.	EMTK	5.02%	19.	TLKM	1.03%
10.	ESSA	8.61%	20.	TBIG	2.21%

Table 8: Issuer With Average Return Higher than BSE Sensex

No.	Code	*Return*	No	Code	*Return*
1.	ASPN	1.95%	11.	ICBK	3.13%
2.	AXBK	2.89%	12.	INBK	3.55%
3.	BJFN	3.05%	13.	INFY	2.75%
4.	BJFS	3.61%	14.	ITC	2.13%
5.	HCLT	2.73%	15.	SUN	2.76%
6.	LART	2.92%	16.	TISC	5.14%
7.	MAHM	3.52%	17.	TEML	2.68%
8.	NTPC	2.22%	18.	TITN	3.35%
9.	PGRD	1.84%	19.	ULTC	2.19%
10.	SBI	4.26%	20.	WIPR	2.38%

Based on the table above. for the IDX30 index. it can be observed that out of the total 20 selected constituents. the average return ranges from 1.03% to 9.38%. Similarly. for the BSE Sensex index. which also consists of 20 constituents. the average return ranges from 1.84% to 5.14%.

The next steps involve calculating returns and average returns. followed by computing variance and covariance. As an example. stocks ANTM and ARTO used for variance and covariance calculation.

$$\sigma i^2 = \frac{((0.1232-0.0549)+(-0.1402-0.0549)+\cdots+(0.1637-0.0549))}{31} = 0.0378$$

$$\sigma_{12} = \sum_{i=1}^{n} \frac{[(0.1232-0.0549).(-0.0097-0.03)+\cdots(0.1637-0.0549).(-0.137-0.03)]}{31} = 0.016$$

If we look at the result. the covariance value between ANTM and ARTO is 0.016. which is positive. This indicates a positive covariance. meaning these two stocks move in the same direction; when one stock increases. the other tends to increase as well.

The calculation of variance and covariance is performed for 20 selected stocks from both the IDX30 and BSE Sensex indices. To facilitate these calculations. this research utilizes Microsoft Excel with the functions VAR.P for variance and COVAR.P for covariance. The table below shows the variance and covariance for IDX30 and BSE Sensex.

Table 9: Variance and Covariance of IDX30

Code	ADRO	AMRT	ANTM	ARTO	BBCA	BBNI	BBRI	BMRI	EMTK	ESSA
ADRO	0.017	0.002	-0.001	-0.004	0.002	0.003	0.002	0.001	0.001	0.009
AMRT	0.002	0.018	-0.005	0.002	-0.001	0.001	0.000	0.001	-0.001	0.001
ANTM	-0.001	-0.005	0.037	0.016	0.005	0.005	0.006	0.003	0.023	0.007
ARTO	-0.004	0.002	0.016	0.044	-0.001	-0.004	0.000	-0.004	0.026	0.008
BBCA	0.002	-0.001	0.005	-0.001	0.003	0.004	0.003	0.003	0.000	0.000
BBNI	0.003	0.001	0.005	-0.004	0.004	0.010	0.006	0.005	-0.001	0.003
BBRI	0.002	0.000	0.006	0.000	0.003	0.006	0.006	0.003	0.001	0.001
BMRI	0.001	0.001	0.003	-0.004	0.003	0.005	0.003	0.005	0.000	0.002
EMTK	0.001	-0.001	0.023	0.026	0.000	-0.001	0.001	0.000	0.044	0.018
ESSA	0.009	0.001	0.007	0.008	0.000	0.003	0.001	0.002	0.018	0.055
INCO	0.002	-0.001	0.014	0.002	0.002	0.005	0.005	0.002	0.006	0.006
KLBF	0.000	0.001	-0.003	-0.004	0.001	0.002	0.001	0.001	-0.003	-0.001
HRUM	0.012	-0.004	0.017	0.017	0.003	0.000	0.005	0.001	0.007	-0.007
ITMG	0.010	0.000	0.003	0.000	0.002	0.006	0.005	0.002	-0.002	0.005
MDKA	0.000	-0.005	0.016	0.003	0.003	0.005	0.003	0.003	0.011	0.006
MEDC	-0.002	-0.009	0.008	-0.007	0.005	0.006	0.004	0.005	-0.002	-0.005
PGAS	0.005	0.000	0.009	-0.004	0.005	0.010	0.006	0.005	-0.003	0.002
PTBA	0.010	0.003	0.006	0.002	0.002	0.004	0.003	0.001	0.002	0.006
TLKM	0.003	-0.001	0.003	0.002	0.002	0.004	0.003	0.002	0.001	0.005
TBIG	-0.002	-0.002	0.007	0.011	0.000	-0.004	-0.002	0.000	0.009	-0.003
Code	INCO	KLBF	HRUM	ITMG	MDKA	MEDC	PGAS	PTBA	TLKM	TBIG
ADRO	0.002	0.000	0.012	0.010	0.000	-0.002	0.005	0.010	0.003	-0.002
AMRT	-0.001	0.001	-0.004	0.000	-0.005	-0.009	0.000	0.003	-0.001	-0.002
ANTM	0.014	-0.003	0.017	0.003	0.016	0.008	0.009	0.006	0.003	0.007
ARTO	0.002	-0.004	0.017	0.000	0.003	-0.007	-0.004	0.002	0.002	0.011
BBCA	0.002	0.001	0.003	0.002	0.003	0.005	0.005	0.002	0.002	0.000
BBNI	0.005	0.002	0.000	0.006	0.005	0.006	0.010	0.004	0.004	-0.004
BBRI	0.005	0.001	0.005	0.005	0.003	0.004	0.006	0.003	0.003	-0.002

BMRI	0.002	0.001	0.001	0.002	0.003	0.005	0.005	0.001	0.002	0.000
EMTK	0.006	-0.003	0.007	-0.002	0.011	-0.002	-0.003	0.002	0.001	0.009
ESSA	0.006	-0.001	-0.007	0.005	0.006	-0.005	0.002	0.006	0.005	-0.003
INCO	0.014	-0.002	0.009	0.007	0.010	0.002	0.005	0.005	0.002	0.002
KLBF	-0.002	0.002	-0.002	-0.001	-0.002	0.001	0.002	0.000	0.000	-0.003
HRUM	0.009	-0.002	0.061	0.012	0.004	0.007	0.004	0.013	0.005	0.008
ITMG	0.007	-0.001	0.012	0.023	0.001	0.005	0.011	0.011	0.006	-0.003
MDKA	0.010	-0.002	0.004	0.001	0.016	0.003	0.005	0.002	0.002	0.005
MEDC	0.002	0.001	0.007	0.005	0.003	0.027	0.009	0.001	0.004	-0.001
PGAS	0.005	0.002	0.004	0.011	0.005	0.009	0.017	0.008	0.005	-0.004
PTBA	0.005	0.000	0.013	0.011	0.002	0.001	0.008	0.011	0.004	-0.002
TLKM	0.002	0.000	0.005	0.006	0.002	0.004	0.005	0.004	0.005	-0.003
TBIG	0.002	-0.003	0.008	-0.003	0.005	-0.001	-0.004	-0.002	-0.003	0.013

Table 10: Variance and Covariance of BSE Sensex

Code	ASPN	AXBK	BJFN	BJFS	HCLT	LART	MAHM	NTPC	PGRD	SBI
ASPN	0.008	0.001	0.005	0.004	0.003	0.002	-0.001	0.001	0.000	0.001
AXBK	0.001	0.008	0.007	0.007	0.000	0.004	0.002	0.003	0.002	0.006
BJFN	0.005	0.007	0.015	0.017	0.001	0.005	0.003	0.003	0.003	0.008
BJFS	0.004	0.007	0.017	0.021	0.000	0.007	0.003	0.002	0.003	0.008
HCLT	0.003	0.000	0.001	0.000	0.008	0.001	0.000	-0.001	0.000	-0.002
LART	0.002	0.004	0.005	0.007	0.001	0.004	0.002	0.002	0.002	0.005
MAHM	-0.001	0.002	0.003	0.003	0.000	0.002	0.006	0.001	0.001	0.003
NTPC	0.001	0.003	0.003	0.002	-0.001	0.002	0.001	0.007	0.003	0.005
PGRD	0.000	0.002	0.003	0.003	0.000	0.002	0.001	0.003	0.003	0.003
SBI	0.001	0.006	0.008	0.008	-0.002	0.005	0.003	0.005	0.003	0.012
ICBK	0.003	0.005	0.006	0.007	-0.001	0.004	0.002	0.003	0.002	0.007
INBK	0.004	0.008	0.014	0.014	-0.001	0.006	0.004	0.006	0.003	0.011
INFY	0.002	0.001	0.003	0.003	0.006	0.001	0.000	-0.002	0.000	0.000
ITC	0.001	0.002	0.004	0.004	0.000	0.002	0.002	0.002	0.001	0.002
SUN	0.002	0.001	0.004	0.005	0.002	0.002	0.000	0.000	0.000	0.002
TISC	0.004	0.007	0.012	0.014	0.000	0.005	0.001	0.002	0.002	0.007
TEML	-0.001	0.000	-0.003	-0.005	0.002	0.000	0.001	-0.001	-0.001	-0.003
TITN	0.005	0.002	0.007	0.008	0.003	0.003	0.001	0.001	0.001	0.002
ULTC	0.003	0.002	0.003	0.004	0.002	0.003	0.001	0.001	0.001	0.003
WIPR	0.002	0.000	0.003	0.004	0.006	0.001	0.000	-0.003	-0.001	-0.001

Code	ICBK	INBK	INFY	ITC	SUN	TISC	TEML	TITN	ULTC	WIPR
ASPN	0.003	0.004	0.002	0.001	0.002	0.004	-0.001	0.005	0.003	0.002
AXBK	0.005	0.008	0.001	0.002	0.001	0.007	0.000	0.002	0.002	0.000
BJFN	0.006	0.014	0.003	0.004	0.004	0.012	-0.003	0.007	0.003	0.003
BJFS	0.007	0.014	0.003	0.004	0.005	0.014	-0.005	0.008	0.004	0.004
HCLT	-0.001	-0.001	0.006	0.000	0.002	0.000	0.002	0.003	0.002	0.006
LART	0.004	0.006	0.001	0.002	0.002	0.005	0.000	0.003	0.003	0.001
MAHM	0.002	0.004	0.000	0.002	0.000	0.001	0.001	0.001	0.001	0.000

NTPC	0.003	0.006	-0.002	0.002	0.000	0.002	-0.001	0.001	0.001	-0.003
PGRD	0.002	0.003	0.000	0.001	0.000	0.002	-0.001	0.001	0.001	-0.001
SBI	0.007	0.011	0.000	0.002	0.002	0.007	-0.003	0.002	0.003	-0.001
ICBK	0.006	0.008	0.000	0.002	0.002	0.007	-0.001	0.003	0.003	0.000
INBK	0.008	0.019	0.000	0.004	0.003	0.012	-0.003	0.006	0.003	0.000
INFY	0.000	0.000	0.007	0.000	0.003	0.003	0.000	0.003	0.003	0.006
ITC	0.002	0.004	0.000	0.004	0.002	0.002	0.001	0.002	0.001	-0.001
SUN	0.002	0.003	0.003	0.002	0.004	0.005	-0.001	0.002	0.002	0.003
TISC	0.007	0.012	0.003	0.002	0.005	0.018	-0.005	0.004	0.005	0.005
TEML	-0.001	-0.003	0.000	0.001	-0.001	-0.005	0.009	0.000	-0.001	-0.001
TITN	0.003	0.006	0.003	0.002	0.002	0.004	0.000	0.007	0.002	0.003
ULTC	0.003	0.003	0.003	0.001	0.002	0.005	-0.001	0.002	0.005	0.002
WIPR	0.000	0.000	0.006	-0.001	0.003	0.005	-0.001	0.003	0.002	0.009

Based on the table above. it is evident that the covariance between stocks shows both positive and negative values for both the IDX30 and BSE Sensex indices. This indicates that some stocks move in opposite directions while others move in the same direction. This has implications for portfolio formation. A positive covariance means that if one stock gains. its counterpart is likely to gain as well. and if one stock loses. its counterpart is likely to lose. On the other hand. if two stocks have a negative covariance. gains in one stock may offset losses in the other.

In portfolio formation. there are two approaches. First. portfolio construction can be done by allocating equal weights to each stock. This is achieved by evenly dividing 100% of the total weight among the stocks. For example. if there are 20 stocks in the IDX30 and BSE Sensex indices. each stock would have a proportional weight of 5%. Table 11 shows that the expected return for a portfolio formed from the IDX30 with equal weights is 35.44%. and the corresponding standard deviation is 66.00%. Meanwhile. Table 12 indicates an expected return of 45.49% and a standard deviation of 21.95% for a portfolio formed from the BSE Sensex using the same equal-weight approach.

Table 11: IDX30 Portofolio with Equal Weight

Code	Proportion	Code	Proportion	Code	Proportion	Code	Proportion
ADRO	5%	BBNI	5%	INCO	5%	MEDC	5%
AMRT	5%	BBRI	5%	KLBF	5%	PGAS	5%
ANTM	5%	BMRI	5%	HRUM	5%	PTBA	5%
ARTO	5%	EMTK	5%	ITMG	5%	TLKM	5%
BBCA	5%	ESSA	5%	MDKA	5%	TBIG	5%
Expected Return							35.44%
Standard Deviation							66.00%

Table 12: BSE Sensex Portofolio with Equal Weight

Code	Proportion	Code	Proportion	Code	Proportion	Code	Proportion
ASPN	5%	LART	5%	ICBK	5%	TISC	5%
AXBX	5%	MAHM	5%	INBK	5%	TEML	5%
BJFN	5%	NTPC	5%	INFY	5%	TITN	5%
BJFS	5%	PGRD	5%	ITC	5%	ULTC	5%
HCLT	5%	SBI	5%	SUN	5%	WIPR	5%
Expected Return							45.49%
Standard Deviation							21.95%

To crete an optimal portfolio. Solver software in Microsoft Excel is utilized. This software helps determine the most efficient weight allocation based on minimizing risk. According to Table 13. a portfolio formed from the IDX30 index consists of 6 stock issuers with an expected return of 19.97% and a standard deviation of 8.77%. Meanwhile. Table 14 reveals that the optimal portfolio formed from the BSE Sensex index comprises 8 stocks with an expected return of 28.4% and a standard deviation of 4.00%.

Table 13: Optimal Portfolio of IDX30

Code	Proportion
AMRT	4.90%
ESSA	1.00%
INCO	5.30%
KLBF	49.9%
TLKM	19.5%
TBIG	19.4%
Expected Return	19.97%
Standard Deviation	8.77%

Table 14: Optimal Portfolio of BSE Sensex

Code	Proportion
ASPN	9.3%
MAHM	7.38%
NTPC	1.72%
PGRD	33.38%
SUN	18.79%
TEML	19.11%
ULTC	3.16%
WIPR	7.16%
Expected Return	28.4%
Standard Deviation	4.00%

After forming the portfolio. the next step is to evaluate its performance using the Sharpe. Treynor. and Jensen indices. Below is an example calculation of the portfolio performance constructed from the IDX30 index.

Indeks Sharpe

$$\widehat{S_p} = \frac{19.97\% - 3.85\%}{8.77\%} = 1.84$$

Indeks Treynor

$$\widehat{T_p} = \frac{19.97\% - 3.85\%}{34\%} = 0.48$$

Indeks Jensen

$$\bar{J_p} = 19.97\% - (3.85\% + (12\% - 3.85\%) \times 34\% = 0.13$$

The same calculations were performed for the portfolio formed from the BSE Sensex index. The summary of performance calculations is summarized in the Table 14.

Table 15: Optimal Portofolio Performance

	IDX30	BSE Sensex
Indeks Sharpe	1.84	2.16
Indeks Treynor	0.48	0.42
Indeks Jensen	0.13	0.14

Tables 11 through Table 14 provide insights into portfolio performance based on equal-weighted and optimal weight allocations. When considering equal-weighted portfolios. the expected return for the IDX30 index stands at 35.44%. while the BSE Sensex index yields 45.49%. However. in the case of the optimal portfolio. the expected return decreases to 19.97% for IDX30 and 28.4% for BSE Sensex. Notably. the standard deviation—indicating risk—differs significantly. The equal-weighted portfolios exhibit a risk of 66.66% (IDX30) and 21.95% (BSE Sensex). whereas the optimal portfolios have substantially lower risk: 8.77% (IDX30) and 4% (BSE Sensex). Consequently. the optimal portfolio achieves a lower risk level while sacrificing some expected return compared to the equal-weighted approach.

Examining Tables 13 and 14. we observe that the optimal portfolio formed using the BSE Sensex index outperforms its counterpart based on the IDX30 index. Specifically. the BSE Sensex-based optimal portfolio

delivers a higher expected return and lower standard deviation. This finding underscores the importance of index selection in constructing efficient portfolios.

Performance metrics analysis presented in Table 15. the IDX30 portfolio shows a Sharpe ratio of 1.84. a Treynor index of 0.48. and a Jensen index of 0.13. Meanwhile. the BSE Sensex portfolio demonstrates a Sharpe ratio of 2.16. a Treynor index of 0.42. and a Jensen index of 0.14. These metrics suggest that the BSE Sensex portfolio outperforms the IDX30 portfolio in terms of Sharpe and Jensen indices. while the IDX30 portfolio shows better performance according to the Treynor index.

In addition to performing optimal portfolio construction and performance measurement. we also examine the differences between the optimal portfolio outcomes and the risk-free rate. as well as the individual stock standard deviations due to during the period from August 2020 to January 2023. stock markets experienced fluctuations. prompting risk-averse investors to consider stock investments alongside risk-free investments. Based on Table 16 and Table 17. it can be seen that the expected returns of the optimal portfolios from both the IDX30 and BSE Sensex indices exceed the risk-free rates. The IDX30 portfolio exhibits lower risk compared to individual stock risks. However. the optimal portfolio from the BSE Sensex index shows higher risk than individual stock risks.

Table 16: Risk Free Rate and Return Portofolio of IDX30 and BSE Sensex

Optimum Portfolio	Risk Free Rate	Return Portofolio
IDX30	3.85%	19.97%
BSE Sensex	4.62%	22.00%

Table 17: Standar Deviation Comparison Between of Individual Stock dan Portofolio

Optimum Portfolio	Code	Yearly Standard Deviation of Individual Stock	Yearly Standard Deviation of Portfolio
IDX30	AMRT	0.4648	0.087
	ESSA	0.8124	
	INCO	0.4099	
	KLBF	0.1549	
	TLKM	0.2449	
	TBIG	0.3950	
BSE Sensex	ASPN	0.0240	0.046
	MAHM	0.0180	
	NTPC	0.0210	
	PGRD	0.0090	
	SUN	0.0120	
	TEML	0.0270	
	ULTC	0.0150	
	WIPR	0.0270	

Source: Processed data (2024)

4. Conclusion

The formation of an optimal portfolio using the Markowitz method has been carried out on two indices. namely IDX30 and BSE Sensex. For the optimal portfolio formed from IDX30. the portfolio consists of 6 stocks with the following proportions: AMRT (4.9%). ESSA (1%). INCO (5.3%). KLBF (49.9%). TLKM (19.5%). and TBIG (19.4%). The annual expected return of the formed portfolio is 19.97% with a risk of 8.77%. Meanwhile. performance measurement using the Sharpe index shows a value of 1.84. using the Treynor index shows 0.48. and using the Jensen index shows 0.13.

The formation of a portfolio using the Markowitz method on the BSE Sensex index resulted in a portfolio consisting of 8 stocks with the following proportions: ASPN (9.3%). MAHM (7.38%). NTPC (1.72%). PGRD (33.38%). SUN (18.79%). TEML (19.11%). ULTC (3.16%). and WIPR (7.16%). The annual expected return

obtained is 28.4% with a risk of 4%. The performance measurement of the optimal portfolio using the Sharpe index shows a value of 2.16. using the Treynor index shows 0.42. and using the Jensen index shows 0.14.

When looking at the results from the returns and standard deviations. the optimal portfolio formed from the BSE Sensex index has a higher return with a lower risk compared to the portfolio formed from the IDX30 index. For portfolio performance measurement using the Sharpe and Jensen indices. the optimal portfolio formed from the BSE Sensex shows better performance compared to the optimal portfolio formed from IDX30. However. using the Treynor performance measurement. the optimal portfolio formed from IDX30 shows a better value.

The optimal portfolios formed on the IDX30 and BSE Sensex indices have lower risks but with lower expected returns compared to equally weighted portfolios. This indicates that the formation of an optimal portfolio using the Markowitz method can reduce risk but does not necessarily provide better expected returns compared to equally weighted portfolios.

However. if investments are made in risk-free instruments. the optimal portfolio formed using the Markowitz method provides better expected returns. These optimal portfolios also offer lower risks compared to the individual stock risks.

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