



Optimization of Stock Portfolio in Indonesian Health Sector using Markowitz Modern Portfolio Theory

Kalfin^{1*}, Rizki Apriva Hidayana²

¹Statistics Study Program, Faculty of Science, Technology and Mathematics, Matana University

²Department of Mathematics, Faculty of Mathematics and Natural Sciences, National University of the Republic of Indonesia, Bandung, Indonesia

*Corresponding author email: kalfin@matanauniversity.ac.id

Abstract

This study analyzes the optimization of the health sector stock portfolio on the Indonesia Stock Exchange using the Markowitz Modern Portfolio Theory method. The data used are the daily closing prices of health sector stocks over the last three years obtained through web scraping techniques from Yahoo Finance. The analysis includes the calculation of daily returns, daily risks, and covariance matrices between stocks. The results of the portfolio optimization show that out of the ten stocks analyzed, the optimal portfolio consists of four stocks, namely MIKA.JK (62.82%), KLBF.JK (15.58%), CARE.JK (15.37%), and SAME.JK (6.23%). This portfolio generates a daily return of 0.216% with a risk level of 1.996%. MIKA.JK contributes the highest return of 0.02063% with a risk of 1.52601%. This study provides guidance for investors in optimizing fund allocation in the health sector stock portfolio in Indonesia.

Keywords: Portfolio optimization, modern portfolio theory, health sector, risk.

1. Introduction

Stock investment has become one of the main ways to generate financial profits, especially in the ever-growing stock market (Atmaningrum et al., 2021). In Indonesia, the health sector is one of the sectors that is increasingly attracting investor interest, considering the prospects of this industry that continue to grow along with increasing public health awareness and the development of medical technology (Sarwal et al., 2021). The Indonesia Stock Exchange (IDX) provides a platform for investors to invest in various stocks, including health sector stocks. Therefore, analyzing the performance of health sector stocks on the IDX is very important to provide guidance for investors in making the right investment decisions.

One of the techniques used to evaluate the performance of an investment portfolio is to calculate the return and risk of a group of stocks (Sofyan & Saepudin, 2024). Portfolio return refers to the results obtained from investments that have been made, while risk measures the fluctuations in stock prices that can affect the results of the investment. Accurate measurement of portfolio return and risk is essential to maximize profits and minimize losses that may occur in stock investments (Cunningham, 2024).

Although there are many ways to calculate portfolio return and risk, one method that is often used is the Markowitz model, which combines stock returns with the covariance between stocks in a portfolio (Yuwono & Ramdhani, 2017). By using the covariance matrix, investors can find out the relationship between stocks, whether the stocks have a positive or negative relationship, and how much impact they have on portfolio risk. This will help investors determine the optimal combination of stocks to minimize risk and maximize returns (Anuno et al., 2024).

One of the main factors that can influence investment decisions is the analysis of daily returns and stock risks. Daily returns describe changes in stock prices from day to day, which can provide an overview of the potential profits that can be obtained (Joseph et al., 2017). While daily risk measures stock price fluctuations over a certain period of time, which can provide an overview of how much uncertainty is involved in the investment (Almashaqbeh et al., 2021). Therefore, calculating daily returns and stock risks is an important initial step in portfolio analysis.

Sharpe Ratio analysis can also be used to evaluate portfolio performance. Sharpe Ratio measures the level of portfolio return relative to the risk taken. A portfolio with a high Sharpe Ratio indicates that the portfolio provides good returns with relatively lower risk. Conversely, a portfolio with a low Sharpe Ratio indicates that the portfolio

may be less efficient in generating returns that are commensurate with its level of risk (Corporate Finance Institute, 2017).

Although the healthcare sector shows promising prospects, many investors still face difficulties in selecting the right stocks and forming an optimal portfolio. The risks associated with investing in this sector can vary greatly between stocks, requiring more precise calculations in determining the right combination of stocks. Therefore, the main problem in this study is how to calculate and evaluate the performance of healthcare sector stocks to form an optimal portfolio that has minimal risk and maximum return. The purpose of this study is to calculate daily returns, daily risks, and covariance between stocks of healthcare sector stocks listed on the IDX, as well as to evaluate the optimal portfolio using the Markowitz model and Sharpe Ratio analysis. This study aims to provide recommendations for stocks with the best returns and lowest risks, as well as to assist investors in determining the right allocation of funds to form an efficient and profitable portfolio in the healthcare sector.

2. Methodology

2.1. Data Collection

The data used are the daily closing prices of health sector stocks listed on the Indonesia Stock Exchange (IDX) during the observation period of the last three years. The data retrieval technique was carried out through web scraping from the Yahoo Finance website using Python and the yfinance library (Pagar et al., 2023; Chandra et al., 2023). This process involves scraping a web page using the code in figure 1:

```
!pip install yfinance --quiet
import yfinance as yf

tickers = ['INAF.JK', 'KAEF.JK', 'KLBF.JK', 'SIDO.JK', 'CARE.JK',
           'OMED.JK', 'SAME.JK', 'SOHO.JK', 'MIKA.JK', 'SILO.JK']

start_date = '2021-01-01'
end_date = '2024-01-01'

data = yf.download(tickers, start=start_date, end=end_date)
```

Figure 1: Data collection techniques

After performing web scraping as in figure 1, the data that has been taken is then stored in a data frame with the aim of high time efficiency because it is able to collect large amounts of historical data automatically. In addition, storing data in the form of a DataFrame provides its own advantages in data management and analysis.

2.2. Data Processing

In modern Markowitz portfolio mode, data processing to obtain maximum results is carried out in the following stages:

1. Calculating Daily Returns

Daily returns are calculated for each stock using the formula:

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

Where R_t : return on period t , P_t : closing price in period t and P_{t-1} : closing price in the previous period.

2. Calculating Risk (Standard Deviation)

Daily risk is calculated as the standard deviation of daily returns using the formula:

$$\sigma = \sqrt{\frac{1}{n-1} \sum_{i=1}^n (R_{ti} - R)^2} \quad (2)$$

Where σ : volatility (standard deviation), R : average daily return, n : number of days in the observation period and R_{ti} : daily return on the i th day.

3. Constructing the Covariance Matrix

The covariance between stocks is calculated as:

$$Cov = \frac{\sum_{t=1}^n (R_{ti} - R)^2}{n - 1} \quad (3)$$

Where R_{ti} : return of stock i at time i , R : the average return of stock i and Σ : the summation notation shows that we add up the values for each period n (from 1 to n).

2.3. Portfolio Optimization

Optimization is done using algorithm-based numerical methods in Python, using the `scipy.optimize` library. The objective function is to minimize the risk of portfolio σ_p with the constraint that the stock weights must total 100% and non-negative. The stages include:

- 1) Portfolio return is calculated using the weighted average return formula of each stock in the portfolio.
- 2) Portfolio risk is calculated based on the covariance matrix between stocks in the portfolio.
- 3) Sharpe Ratio is used to evaluate portfolio performance by considering the risk and return generated.
- 4) The contribution of return and risk of each stock is calculated to determine how much impact each stock has on the return and risk of the overall portfolio.

3. Results and Discussion

3.1. Closing Stock Price

Daily closing price data for all stocks used in this analysis is presented in figure 2. This chart provides a visual representation of the stock price fluctuations that occurred during the analysis period.

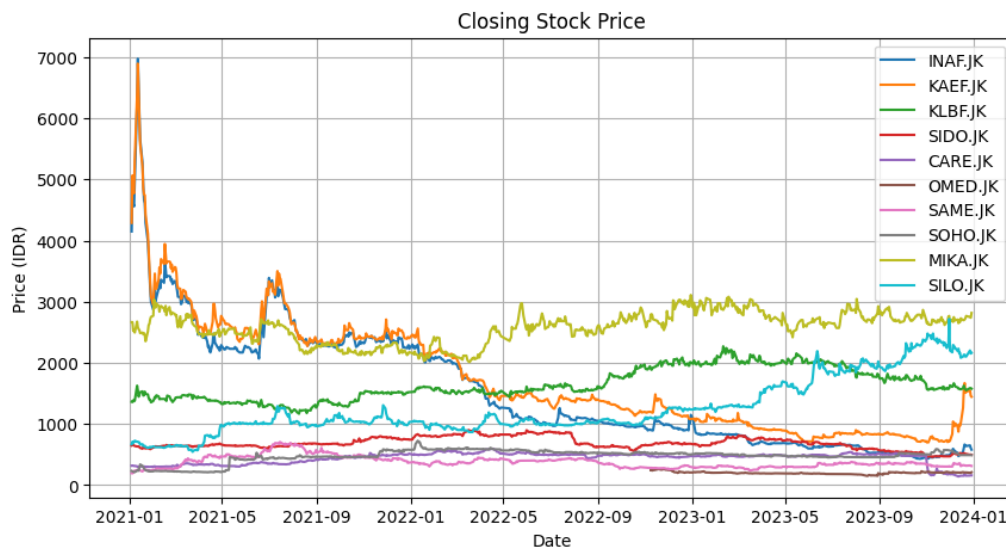


Figure 2: Closing price of all shares

Based on figure 2 which displays the closing price of health sector stocks, it can be seen that KLBF.JK (Kalbe Farma) stocks showed the highest price movement among other stocks. The price movement of KLBF.JK is relatively stable with a trend that tends to increase, reflecting strong market confidence in the company's performance. INAF.JK price fluctuations tend to be more volatile with several significant declines.

3.2. Average Daily Return

The average daily return for each stock is calculated to provide an overview of the performance of each stock during the analysis period. Here are the average daily returns for each stock used in the study:

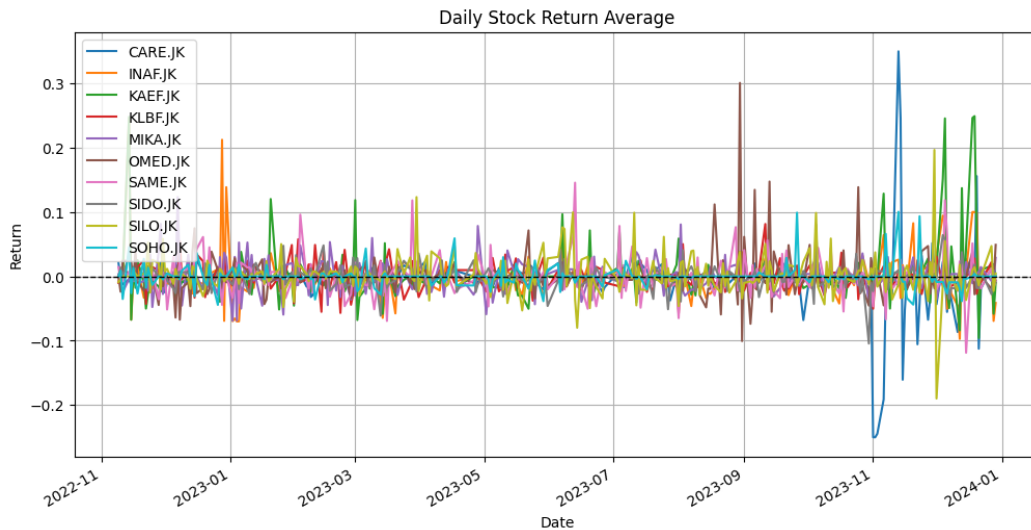


Figure 3: Average daily return of all stocks

In chart 3, SAME.JK (Sarana Meditama Metropolitan) shares recorded the highest daily return with a positive value of 0.07993%. This indicates that SAME.JK consistently provides a good rate of return for investors during the observation period. In contrast, CARE.JK (Metro Healthcare Indonesia) shares recorded the lowest daily return with a negative value of -0.28505%, indicating that this stock experienced a significant decline in value on a daily average.

3.3. Covariance Matrix

The following is the covariance matrix calculated based on the daily return data obtained:

Table 1: Covariance matrix results of all stocks

Ticker	CARE.JK	INAF.JK	KAEF.JK	KLBF.JK	MIKA.JK	OMED.JK	SAME.JK	SIDO.JK	SILO.JK	SOHO.JK
CARE.JK	0.00199	0.00009	0.00006	0.00005	0.00004	0.00002	0.00009	0.00003	0.00005	0.00013
INAF.JK	0.00009	0.00109	0.00084	0.00001	0.00000	0.00004	0.00006	0.00011	0.00001	0.00003
KAEF.JK	0.00006	0.00084	0.00168	0.00006	-0.00005	0.00008	0.00019	0.00019	0.00006	0.00002
KLBF.JK	0.00005	0.00001	0.00006	0.00039	0.00002	-0.00007	0.00005	0.00004	0.00005	0.00001
MIKA.JK	0.00004	0.00000	-0.00005	0.00002	0.00059	0.00009	0.00003	-0.00002	-0.00003	-0.00000
OMED.JK	0.00002	0.00004	0.00008	-0.00007	0.00009	0.00104	-0.00000	0.00003	0.00008	-0.00002
SAME.JK	0.00009	0.00006	0.00019	0.00005	0.00003	-0.00000	0.00079	0.00009	0.00013	-0.00004
SIDO.JK	0.00003	0.00011	0.00019	0.00004	-0.00002	0.00003	0.00009	0.00009	0.00006	-0.00001
SILO.JK	0.00005	0.00001	0.00006	0.00005	-0.00003	0.00008	0.00013	0.00006	0.00093	-0.00000
SOHO.JK	0.00013	0.00003	0.00002	0.00001	-0.00000	-0.00002	-0.00004	-0.00001	-0.00000	0.00026

From the results presented in table 1, CARE.JK shares have the highest covariance value with itself of 0.00199, indicating a relatively high level of volatility. KAEF.JK shares also show quite high volatility with a covariance value with itself of 0.00168. A fairly strong movement relationship is seen between INAF.JK and KAEF.JK with a positive covariance value of 0.00084, indicating that these two stocks tend to move in the same direction. On the other hand, several stock pairs show a very weak or even negative relationship, such as MIKA.JK with KAEF.JK which has a negative covariance of -0.00005, indicating a tendency to move in the opposite direction. Overall, the majority of relatively small covariance values between different stock pairs indicate that these health sector stocks have a relatively low level of correlation, which can provide diversification benefits in portfolio formation.

3.4. Optimal Weight Analysis and Stock Fund Allocation

The following is a table containing the results of the analysis of optimal weights, fund allocation, daily returns, daily risks, return contributions, and risk contributions of each stock in the optimal portfolio:

Table 2: Optimal weight analysis and stock fund allocation

Stocks	Optimal Weight	Fund Allocation (IDR)	Daily Return (%)	Daily Risk (%)	Return Contribution (%)	Risk Contribution (%)
KLBF.JK	0.15580	15,580,000.00	-0.04884	197.285	-0.00761	0.30737
CARE.JK	0.15370	15,370,000.00	-0.28505	446.092	-0.04381	0.68564

SAME.JK	0.06230	6,230,000.00	0.07993	280.213	0.00498	0.17457
MIKA.JK	0.62820	62,820,000.00	0.03284	242.918	0.02063	152.601

Based on the portfolio optimization calculation, the table above shows the optimal weight and recommended fund allocation for each stock in the health sector. MIKA.JK stock gets the largest optimal weight of 0.6282, which means that around 62.82% of the total invested funds should be allocated to this stock. KLBF.JK and CARE.JK each have optimal weights of 0.1558 and 0.1537, with fund allocations of IDR 15,580,000 and IDR 15,370,000. SAME.JK is also included in the optimal portfolio with a weight of 0.0623, which means that around 6.23% of the funds should be used for this stock.

The selection of stocks with optimal weights aims to maximize returns and reduce risk, as seen in the results of the optimal portfolio calculation. In terms of daily performance, KLBF.JK and CARE.JK stocks showed quite large daily negative returns, with KLBF.JK having a daily return of -0.04884% and CARE.JK of -0.28505%. In contrast, SAME.JK and MIKA.JK stocks provided positive daily returns, namely 0.07993% for SAME.JK and 0.03284% for MIKA.JK.

The contribution of return and risk is also calculated for each stock in the portfolio. MIKA.JK provided the highest return contribution of 0.02063% with a risk contribution of 1.52601%, which means that this stock contributed significantly to the final result of the portfolio. In contrast, CARE.JK stocks provided a fairly large negative return contribution, -0.04381%, and also had the largest risk contribution of 0.68564%. The optimal portfolio yields a return of 0.00216 or 0.216% per day, with a daily risk of 0.01996 or around 1.996%. Thus, this portfolio is expected to provide positive returns even with a relatively low level of risk.

4. Conclusion

Based on the analysis and discussion conducted, several conclusions can be drawn regarding the application of Markowitz's Modern Portfolio Theory to health sector stocks. First, the theory successfully identified the optimal portfolio, comprising four main stocks: MIKA.JK, which holds the largest weight of 62.82%, followed by KLBF.JK and CARE.JK at approximately 15% each, and SAME.JK at 6.23%. Second, despite some stocks experiencing negative daily returns, the overall portfolio managed to achieve a positive return of 0.216%, accompanied by a relatively controlled risk level of 1.996%. Lastly, the covariance matrix analysis revealed a low correlation among the health sector stocks, emphasizing the advantages of diversification in enhancing portfolio performance.

References

- Almashaqbeh, M., Islam, M. A., & Bakar, R. (2021, May). Factors affecting share prices: A literature revisit. In *AIP Conference Proceedings* (Vol. 2339, No. 1). AIP Publishing.
- Anuno, F., Madaleno, M., & Vieira, E. (2024). Testing of Portfolio Optimization by Timor-Leste Portfolio Investment Strategy on the Stock Market. *Journal of Risk and Financial Management*, 17(2), 78.
- Atmaningrum, S., Kanto, D. S., & Kisman, Z. (2021). Investment decisions: The results of knowledge, income, and self-control. *Journal of Economics and Business*, 4(1).
- Chandra, D. P., & Manuaba, I. B. K. (2023). Prediction of Stock Value Web-scraped Google Trends and Twitter data-driven model. *Procedia Computer Science*, 227, 253-261.
- Corporate Finance Institute. (2017). Risk-adjusted return ratios. Retrieved January 17, 2025, from <https://corporatefinanceinstitute.com/resources/wealth-management/risk-adjusted-return-ratios/>
- Cunningham, T. (2024). *Portfolio Optimization with Risk Management Through Dividend-Paying Stocks* (Master's thesis, St. John's University (New York)).
- Joseph, A., Larrain, M., & Turner, C. (2017). Daily stock returns characteristics and forecastability. *Procedia computer science*, 114, 481-490.
- Pagar, S., Jaiswal, A., Auti, A., Purohit, V., & Mishra, V. (2023, August). Technical Analysis of Stock Market using Data Science and its tools. In *2023 7th International Conference On Computing, Communication, Control And Automation (ICCUBEA)* (pp. 1-5). IEEE.
- Sarwal, R., Prasad, U., Gopal, K. M., Kalal, S., Kaur, D., Kumar, A., ... & Sharma, J. (2021). Investment opportunities in India's healthcare sector.
- Sofyan, D., & Saepudin, D. (2024). Clustering-based stock return prediction using K-Medoids and Long Short-Term Memory (LSTM). *Building of Informatics, Technology and Science (BITS)*, 6(3). <https://doi.org/10.47065/bits.v6i3.5744>
- Yuwono, T., & Ramdhani, D. (2017). Comparison analysis of portfolio using Markowitz model and single index model: Case in Jakarta Islamic Index. *Journal of Multidisciplinary Academic*, 1(1), 25-31.