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Optimal Portfolio Using Roy's Safety-First Method on Primary Consumer Goods Sector Stocks

Estu Putri Dianti[1*], Riaman[2], Sukono[3]

[1]*Mathematics Undergraduate Study Program, Faculty of Mathematics and Natural Science, Universitas Padjadjaran, Sumedang, Indonesia*
[2,3]*Department of Mathematics, Faculty of Mathematics and Natural Science, Universitas Padjadjaran, Sumedang, Indonesia*

**Corresponding author email: estu20001@mail.unpad.ac.id*

Abstract

Before carrying out investment activities, investors need to form an optimal investment portfolio. This study aims to form an optimal portfolio in primary consumer goods sector stocks that sell the basic needs of the community so that stocks in the sector tend to be stable. The method used in forming the optimal portfolio is Roy's Safety-first method. The portfolio formed produces 6 combinations of stocks consisting of WIIM, DSNG, MRAT, CAMP, SIMP, and MBTO stocks respectively with a proportion of funds of 44.05%, 16.38%, 18.61%, 15.06%, 4.32%, and 1.59% with an expected return portfolio of 3.10% and a portfolio risk of 1.65%.

Keywords: Optimal portfolio; Safety-first; Roy; Primary consumer goods.

1. Introduction

Investment is the allocation of a certain amount of money or resources in the present with the expectation of obtaining returns in the future. Investments can be made in various types of assets, either in the form of physical assets such as land, gold, property, or financial assets through capital markets such as stocks, bonds, or mutual funds (Vraneš et al., 1996).

Nowadays, investment has begun to be favoured and practised by the public to protect the value of money from inflation. One of the popular investments is investment through the capital market, such as stocks. Stocks provide high returns with high risks as well. Stocks are proof of capital or fund ownership in a company (Castrén, 2019).

The goal of investors investing in stocks is to make a profit. However, in addition to providing profits, stock investment also has risks so investors need to understand the characteristics of assets to maximize profits and minimize risks. To reduce investment risk, investors can diversify, namely allocating capital to different assets through the formation of a stock portfolio (Martínez-Nieto et al., 2021).

A stock portfolio is a collection of stocks invested by an investor with the aim of maximizing return and minimizing risk. Investors need to determine the weight or proportion of funds to be allocated to each stock in the portfolio. To achieve maximum profit, the formation of an optimal portfolio is required. The optimal portfolio is a portfolio that provides the highest rate of return for the lowest level of risk (Zhang et al., 2020).

The optimal portfolio can be formed with Roy's Safety-first method. This method prioritises safety and focuses on downside risk Downside risk is the financial risk associated with losing or earning lower returns than expected.

Investors can invest in various types of sectors listed on the Indonesia Stock Exchange (IDX). One of the sectors listed on the IDX is the primary consumer goods sector which sells the basic needs of the community so that under any circumstances these products are always needed. Therefore, stocks in the primary consumer goods sector tend to be stable (Herwany et al., 2021).

2. Literature Review

2.1 Investment

Investment is the allocation of a certain amount of money or resources in the present with the expectation of obtaining returns in the future. Things that need to be considered in making an investment are return and risk. Return is the profit obtained through stock ownership and risk is the difference between the actual return and the expected return (Hidayatullah and Manda, 2021).

2.2 Stock

Stocks are proof of capital ownership in a company. Stocks are classified into several sectors, one of which is the primary consumer goods sector. Primary consumer goods sector stocks are sectors that provide primary needs, such as food, beverages, and household products. Population density in Indonesia continues to increase every year. This shows that the need for primary goods will continue to grow and be sustainable so that the shares of this sector tend to be stable (Ferdinanda, & Gantino, 2021).

2.3 Stock Return

Investors invest in stocks to get profits or investment returns. Stock return consists of realized return, which is the return that has occurred, and expected return, which is the return that investors expect to get in the future (Sholehah et al., 2020). Realized return and expected return of stocks are calculated using equations (1) and (2).

$$R_{i,t} = \frac{P_{i,t} - P_{i(t-1)}}{P_{i(t-1)}} \tag{1}$$

$$E(R_i) = \frac{\sum_{t=1}^{m}(R_{i,t})}{m} \tag{2}$$

where,

$R_{i,t}$: return of stock i at time t,
$P_{i,t}$: price of stock i at time t,
$P_{i(t-1)}$: price of stock i at time $(t-1)$,
$E(R_i)$: expected return.

2.4 Stock Risk

Stock risk is the difference between actual return and expected return. Stock risk can be calculated by standard deviation using equation (3).

$$\sigma_i = \sqrt{\frac{\sum_{t=1}^{m}\left(R_{i,t} - E(R_i)\right)^2}{m-1}} \tag{3}$$

where,

σ_i : stock risk.

2.5 Portfolio

An investment portfolio is a collection of two or more investment instruments to achieve maximum return with a minimum level of risk. The best portfolio is the optimal portfolio. In forming an optimal portfolio, diversification is carried out to reduce investment risk. Diversification is allocating different assets. If a stock experiences a decline in performance, then other stocks that are in stable conditions can help reduce the risk of loss (Anastasia and Chrestella, 2021).

2.6 Portfolio Expected Return and Portfolio Risk

Portfolio expected return and portfolio risk can be calculated by equations (4) and (5). In forming the optimal portfolio, it is necessary to calculate the portfolio expected return and portfolio risk. Portfolio expected return and portfolio risk can be calculated by equations (4) and (5).

$$E(R_p) = \sum_{i=1}^{n} w_i E(R_i) \tag{4}$$

$$\sigma_p^2 = \sum_{i=1}^{n}\sum_{j=1}^{n} w_i w_j \sigma_{i,j} \tag{5}$$

where,
$E(R_p)$: portfolio expected return,
σ_p^2 : portfolio risk.

2.7 Roy's Safety-first Method

The method used to form the optimal portfolio is the Safety-first method or the method that prioritizes safety. This method is used by investors who tend to avoid risk or risk averse because this method prioritizes capital safety over potential profits. Roy's safety-first method is one of the methods in the Safety-first method which aims to minimize risk so that the expected return is not smaller than the minimum return limit (Manurung et al., 2024). Roy's safety-first method is expressed in equation (6).

$$Minimize : Probality(E(R_i) < R_L) \tag{6}$$

where,
$E(R_i)$: expected return,
R_L : minimum return limit.

Equation (6) has not considered the risk factor. Therefore, it is necessary to add risk factors in portfolio formation by assuming normally distributed returns so that R_L is expressed as an average value and risk is expressed as a standard deviation. Then, normalisation is performed on the variables $E(R_i)$ and R_L using the Z_{score} normalization technique. Therefore, equation (6) can be expressed as equation (7).

$$Z_i = \frac{E(R_i) - R_L}{\sigma_i} \tag{7}$$

where,
Z_i : Z_{score} value of $E(R_i)$.

The objective of Roy's Safety-first method is to minimize the risk that the expected return of the stock $E(R_i)$ is smaller than the minimum return limit (R_L) so that the value of Z_i must be negative. For negative values of Z_i, we can use equation (8).

$$Minimize \ : \frac{R_L - E(R_i)}{\sigma_i} \tag{8}$$

Equation (8) is equivalent to equation (9).

$$Maximize : \frac{E(R_i) - R_L}{\sigma_i} \tag{9}$$

The result of the comparison or ratio between the difference between $E(R_i)$ and R_L against σ_i can be written with the symbol K as in equation (10).

$$K = \frac{E(R_i) - R_L}{\sigma_i} \tag{10}$$

where,
K : roy ratio.

Stocks selected into the portfolio are those that have a positive K value because investors do not want a negative return or loss. After the portfolio is formed, then determine the stock weight using equation (11).

$$w_i = \frac{K_i}{\sum_{i=1}^{n} K_i} \tag{11}$$

2.8 Jarque-Bera Normality Test

In determining stock weights with Roy's Safety-first method, stock returns must be normally distributed. Therefore, the normality test of stock returns is carried out using the Jarque-Bera test. The Jarque-Bera test is expressed by equation (12).

$$JB = \frac{n}{6}\left(S^2 + \frac{(K-3)^2}{4}\right) \tag{12}$$

where,
JB : Jarque-Bera test,
S : skewness,
K : kurtosis.

Skewness and kurtosis can be calculated using equations (13) and (14).

$$S = \frac{\frac{1}{n}\sum_{i=1}^{j}(x_i - \bar{x})^3}{\left(\frac{1}{n}\sum_{i=1}^{j}(x_i - \bar{x})^2\right)^{\frac{3}{2}}} \tag{13}$$

$$K = \frac{\frac{1}{n}\sum_{i=1}^{j}(x_i - \bar{x})^4}{\left(\frac{1}{j}\sum_{i=1}^{j}(x_i - \bar{x})^2\right)^{2}} \tag{14}$$

where,
x_i : x value to be tested,
$\bar{x}$: the mean to be tested,
Return is normally distributed if:

$$p - value < \alpha$$

where,
$p - value$: Jarque-Bera probability,
α : significance level which is 5%.

3. Materials and Methods

3.1. Materials

The object used in this study is the closing price of monthly shares in the primary consumer goods sector (IDXNONCYC) listed on the Indonesia Stock Exchange (IDX) for the period January 2020 to December 2023.

3.2. Methods

1. Calculate stock returns using equation (1).
2. Test the normality of stock return data with the Jarque-Bera test using equation (12).
3. Calculate the expected stock return using equation (2).
4. Calculating stock risk using equation (3).
5. Form the optimal portfolio using equation (10).
6. Determining stock weights using equation (11).
7. Determine the portfolio expected return using equation (4) and portfolio risk using equation (5).

4. Results and Discussion

The first step in forming an optimal portfolio is to calculate the return value and expected return of each stock using equations (1) and (2). The results of the calculation of the expected return can be seen in Table 1.

Table 1: Expected return of stocks value

Stocks	Expected return
ANJT	0.00149
CAMP	0.01180
DSNG	0.01066
ICBP	0.00081
JPFA	0.00170
MBTO	0.00448
MRAT	0.01935
MYOR	0.00874
ROTI	-0.00147
SGRO	-0.00161
SIMP	0.00569
TCID	-0.01123
UCID	-0.01034
UNVR	-0.01470
WIIM	0.05359

Stocks that have negative expected return values are not included in further calculations because these stocks do not provide benefits to investors.

In forming a stock portfolio using Roy's Safety-first method, stock return data must be normally distributed. Therefore, a normality test is carried out on stock return data using the Jarque-Bera test From the Jarque-bera test conducted, the Jarque-Bera probability value is obtained in Table 2.

Table 2: Jarque-bera normality test

Stocks	Jarque-Bera value	$p-value$
ANJT	0.86957	0.64740
CAMP	4.35356	0.11341
DSNG	1.91735	0.38340
ICBP	0.13289	0.93571
JPFA	2.17486	0.33708
MBTO	0.75969	0.68397
MRAT	1.37200	0.50359
MYOR	26.00341	0.00000
SIMP	1.90652	0.38548
WIIM	1.93732	0.37959

Based on Table 2, there are 9 stocks that are normally distributed, namely ANJT, CAMP, DSNG, ICBP, JPFA, MBTO, MRAT, SIMP, and WIIM. Stocks that are not normally distributed are not included in further calculations. Next, calculate the stock risk using equation (3). The results of the calculation of the risk of each stock can be seen in Table 3.

Table 3: Stock risk

Stocks	σ_i
ANJT	0.09785
CAMP	0.11897
DSNG	0.09410
ICBP	0.06942
JPFA	0.11830
MBTO	0.11381
MRAT	0.18557
SIMP	0.10324
WIIM	0.24954

In Table 3, it can be seen that the biggest stock risk is WIIM stock, which is 0.24954. The greater the risk, the greater the potential profit or loss received by investors.

The optimal portfolio formation uses Roy's Safety-first method. This method is one of the criteria in the Safety-first method. To determine the stocks selected into the portfolio can use equation (10). The selected stocks are stocks that have a positive K value. The R_L value or the minimum return limit value used in the calculation is the risk-free rate of return obtained from the BI 7 Days Repo Rate for the period January 2020 to December 2023. The R_L value used is 0.00366. Optimal portfolio formation using Roy's Safety-first method can be seen in Table 4.

Table 4: Optimal portfolio formation using Roy's Safety-first method

Stocks	$E(R_i)$	R_L	$E(R_i)-R_L$	σ_i	K
ANJT	0.00149	0.00366	-0.00217	0.09785	-0.02214
CAMP	0.01180	0.00366	0.00814	0.11897	0.06844
DSNG	0.01066	0.00366	0.00700	0.09410	0.07442
ICBP	0.00081	0.00366	-0.00285	0.06942	-0.04111
JPFA	0.00170	0.00366	-0.00196	0.11830	-0.01660
MBTO	0.00448	0.00366	0.00082	0.11381	0.00724
MRAT	0.01935	0.00366	0.01569	0.18557	0.08456
SIMP	0.00569	0.00366	0.00203	0.10324	0.01963
WIIM	0.05359	0.00366	0.04993	0.24954	0.20008

Stocks selected into the portfolio are stocks that have a positive K value because investors do not expect negative returns or losses. In Table 4, it can be seen that stocks that have a positive K value and are selected into the optimal portfolio are CAMP, DSNG, MBTO, MRAT, SIMP, and WIIM stocks.

After the portfolio is formed, the weight of each stock is calculated using equation (11). The weight of each stock can be seen in Table 5.

Table 5: Weight of each stock

Stocks	w_i	w_i (in %)
WIIM	0.44046	44.05%
DSNG	0.16376	16.38%
MRAT	0.18613	18.61%
CAMP	0.15061	15.06%
SIMP	0.04315	4.32%
MBTO	0.01586	1.59%

In Table 5, the weight of each stock is obtained, for WIIM stocks of 44.05%, DSNG of 16.38%, MRAT of 18.61%, CAMP of 15.06%, SIMP of 4.32%, and MBTO of 1.59%.

The optimal portfolio has been formed using Roy's Safety-first method. Next, the calculation of portfolio expected return and portfolio risk is carried out. Portfolio expected return and return portfolio can be seen in Table 6.

Table 6: Portfolio expected return and return portfolio

$E(R_p)$	σ_p
0.03105	0.01646

In Table 6, the portfolio expected return is 3.10% and the portfolio risk is 1.65%.

5. Conclusion

Based on the results of the research that has been done, it is concluded that the optimal stock portfolio in primary consumer goods sector stocks formed using Roy's Safety-first method produces 6 stock combinations consisting of WIIM shares with a share weight of 44.05%, DSNG 16.38%, MRAT 18.61%, CAMP 15.06%, SIMP 4.32%, and MBTO 1.59% with an portfolio expected return value of 3.10% and a portfolio risk of 1.65%.

References

Anastasia, N., & Chrestella, T. (2021). The Effect of Geographical Diversification Towards Property Investment Decisions in Indonesia. *International Journal of Finance, Insurance and Risk Management*, *11*(1), 78-95.

Castrén, A. M. (2019). Becoming “us”: Marital name, gender, and agentic work in transition to marriage. *Journal of marriage and family*, *81*(1), 248-263.

Ferdinanda, F., & Gantino, R. (2021). The Comparison of The Effect of Profitability, Solvency and Firm Size on Firm Value:(Empirical Study Sub-Sector Companies on Food and Beverage and Sub-Sector Companies on Cosmetic and Household Listed on Indonesia Stock Exchange Period 2015-2019). *International Journal Of Trends In Accounting Research*, *2*(2), 205-213.

Herwany, A., Febrian, E., Anwar, M., & Gunardi, A. (2021). The influence of the COVID-19 pandemic on stock market returns in Indonesia stock exchange. *The Journal of Asian Finance, Economics and Business*, *8*(3), 39-47.

Hidayatullah, W., & Manda, G. S. (2021). The Influence of Systematic Risk and Liquidity On Stock Return At Mining Sector Companies. *The Accounting Journal of Binaniaga*, *6*(2), 105-114.

Manurung, A. H., Manurung, A., Machdar, N. M., & Sijabat, J. (2024). Stock Selection using Semi-variance and Beta to construct Portfolio and Effect Macro-variable on Portfolio Return. *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, *15*(1), 14-25.

Martínez-Nieto, L., Fernández-Navarro, F., Carbonero-Ruz, M., & Montero-Romero, T. (2021). An experimental study on diversification in portfolio optimization. *Expert Systems with Applications*, *181*, 115203.

Sholehah, N. A., Permadhy, Y. T., & Yetty, F. (2020). The Comparison of Optimal Portfolio Formation Analysis with Single Index Model and Capital Asset Pricing Model in Making Investment Decision. *European Journal of Business and Management Research*, *5*(4).

Vraneš, S., Stanojević, M., Stevanović, V., & Lučin, M. (1996). INVEX: investment advisory expert system. *Expert Systems*, *13*(2), 105-119.

Zhang, Z., Zohren, S., & Roberts, S. (2020). Deep learning for portfolio optimization. *arXiv preprint arXiv:2005.13665*.