Analysis of Optimal Portfolio Formation Using Single Index Model and Stochastic Dominance on Sri-Kehati Index

Samsul Huda and Pardomuan Sihombing

ABSTRACT

This study directly applies the Single Index Model and Stochastic Dominance to solve the portfolio selection problem. This study aims to determine the difference in performance between the Single Index Model and Stochastic Dominance. The use of secondary data was used in this study by selecting the sample using the purposive sampling technique. If viewed based on the portfolio return, the single-index model can produce a portfolio return of (1.548%) and a stochastic dominance return of (0.888%). The results show that the value of the Stochastic Dominance portfolio formation has a Treynor index which is 2.22% higher than the Single Index Model with a Treynor index of 2.09%.

Keywords: Optimal Portfolio, Single Index Model, Stochastic Dominance.

Submitted : January 11, 2022

Published : February 05, 2022

ISSN: 2507-1076

DOI: 10.24018/ejbmr.2022.7.1.1264

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I. INTRODUCTION

Investment has a role in improving the economy of a country because investment is one component of aggregate expenditure in the calculation of national income. Investments can be made in real assets in the form of buildings, land, and gold, while financial assets in the form of stocks and bonds.

Stocks are one of the most desirable investment alternatives because stocks can provide benefits in the form of dividends and capital gains. In stock investment, the profits received by investors are called returns which are divided into two, namely expected returns and realized returns. However, in addition to providing returns, stocks also contain risks that must be borne by investors.

The greater the risk borne, the greater the return that is compensated, the risk in investment makes investors have to do the right ways to minimize the risks that may occur. Investors do not know for sure the results that will be obtained so investors need to diversify to reduce risk.

In investing, investors do not stop at diversification to reduce risk, but also investors want optimal returns from their investments. In selecting the optimal portfolio, investors can use several models of financial analysis. The research in this study reviews two methods used in forming an optimal portfolio, namely: Single Index Model and Stochastic Dominance.

Stochastic dominance is a technique that does not pay attention to how the distribution of the level of return on investments is being considered. In other words, stochastic dominance does not require the distribution of profit levels to be normal. Stochastic dominance uses three assumptions, namely first order, second order and third order. First-order stochastic dominance states that investors prefer a lot to a

little. Second-order stochastic dominance states that investors are risk-averse. While the third-order stochastic dominance states that investors have decreasing absolute risk aversion (Ningrum *et al.*, 2018).

Optimal portfolio testing using the single index model method (single index) has proven that this model makes it possible to obtain optimal stock portfolio performance. Based on the results of a study conducted by Achmad Khotim (Khotim & Topowijono, 2014) stated that there is a significant difference in portfolio returns using the Single Index Model or using Stochastic Dominance. The results of the optimal portfolio formation from the Single Index Model show that the expected return is higher than the optimal portfolio expected return using Stochastic Dominance. While the results of a study conducted by Wulandari (Putu *et al.*, 2016) stated the opposite, namely the results of forming an optimal portfolio using Stochastic Dominance showed a higher expected return than the optimal expected return of a portfolio using the Single Index Model. The results of these calculations indicate that the risk of the portfolio is smaller than the risk of the stock before the portfolio. This shows that forming an optimal portfolio can reduce the amount of risk.

From various backgrounds and contradictory findings regarding the differences in the use of the Single Index Model and Stochastic Dominance in determining the optimal portfolio in the previous study, the author is interested in re-investigating the comparison of the two methods using the Sri-Kehati index.

The selection of the Sri-Kehati index as a study of the increasing number of investment product indexes as an investment guide that is widely used by investors in determining their investment decisions (kontan.co.id, 14-April-2019) since the beginning of the year the Sri-Kehati

index has increased by 4.68 % greater than the JCI which increased by 3.41%. This shows that the Sri-Kehati index has a fairly good performance and deserves to be used as an alternative investment for investors.

Fig. 1. Chart Index Sri-Kehati Period 2010-2019.

Looking at the picture above, it can be seen that the Sri-kehati index experienced a higher increase than the JCI and LQ45 indexes. So, the authors decided in this study to examine Sri-Kehati stocks listed on the IDX during the period January 2017 – December 2021.

II. LITERATURE REVIEW

A. Portfolio Theory

Portfolio theory was first introduced by Markowitz (1952). This model will produce a portfolio through a process based on the mean variance. The mean is the expected return which is mostly calculated by means of an average and the variance is a measure of risk used. Markowitz's model of portfolio theory teaches investing by breaking down the invested funds, which is called then putting them on different paths, instead of focusing on only one path or called diversification. The separate placement of funds is intended to reduce the risks that will arise in the future which will give birth to the Efficient Frontier.

Portfolio is a field of science that examines how an investor can reduce risk in investing to a minimum, including one of them by diversifying these risks (Fahmi, 2015). By forming a portfolio to maximize the expected return at the level of risk borne by investors, the index model or factor model assumes that the rate of return of a security is sensitive to changes in various factors or indices. As a process of calculating the rate of return, an index model seeks to include the main economic forces that can systematically move stock prices for all securities (Hadar & Russell, 1971).

B. Efficient and Optimal Portfolio

According to Pardomuan, an efficient portfolio is a portfolio that has a maximum return at each level of risk. The efficient portfolio dominates all other portfolios. The dominant portfolio offers a maximum return for a certain level of risk or vice versa, a minimum risk for a certain return (Sihombing, 2018).

An efficient portfolio only has one good factor, namely the expected return or portfolio risk, so it has not combined the two. The optimal portfolio is selected from the efficient portfolio members. Hartono (Hartono, 2015) explains that an efficient portfolio is a portfolio that provides the largest expected return with a certain risk or provides the smallest

risk with a certain expected return. An optimal portfolio is an efficient portfolio, but an efficient portfolio is not necessarily an optimal portfolio.

C. Single Index Model

The Single Index Model was developed by William Sharpe, an American economist in 1963. This model can be used to simplify calculations on the Markowitz model. The Single Index Model is based on the observation that the price of a security fluctuates in the direction of the market price index. Stocks in general will experience an increase in price if the stock price index rises and vice versa the price of most stocks will decrease if the stock price index falls.

Hartono (2016: 427) explains that the single index model is based on the observation that the price of a security fluctuates in the direction of the market price index. The model assumes that the movement of stock returns is only related to market movements. The Single Index Model divides the return from securities into two parts, namely the unique return component represented by i which is independent of market returns, and the return component associated with market returns represented by βi .

D. Stochastic Dominance

Stochastic dominance was developed by Hadar and Russell (1971). Decision-making theory faces uncertainty, a company usually aims to maximize the expected value of the utility function (expected utility), a certain objective function set by the company based on the choice of existing conditions. Suppose there are two choices of conditions, A and B, then condition A will be preferred over condition B if and only if the expected utility value of A is higher or equal to the expected value of B's utility (Hadar & Russell, 1971).

Stochastic dominance is a technique that does not pay attention to how the distribution of the level of return on investments is being considered. In other words, stochastic dominance does not require the distribution of profit levels to be normal. Stochastic dominance is applied to overcome problems regarding the selection and evaluation of stock and portfolio investments, due to the weakness of economic theory in providing predictions or future descriptions of investor preferences and profit distribution (Ningrum *et al.*, 2018).

E. Return and Risk Investigation

According to Fahmi, return is the profit obtained by companies, individuals, and institutions from the results of their investment policies. Return or return on investment is income (gain) or loss (loss) due to a decrease in investment value in a certain period. Return is the result obtained from the investment (Fahmi, 2015).

The expected rate of return is a weighted average of the expected rate of return on the assets in the investment. The weight reflects the fraction of the total invested in each asset (Sihombing, 2018).

Risk according to Fahmi risk can be interpreted as a form of uncertainty about a situation that will occur later (future) with decisions taken based on various considerations at this time, risk is the amount of deviation between the expected return and the level of risk. actual return. The greater the occurrence of deviations, the greater the level of risk (Fahmi, 2015).

III. RESEARCH METHOD

The type of research in this research is descriptive with a quantitative approach. The quantitative approach gives freedom to researchers to determine various criteria or variables to be studied.

The population is also a collection of objects or subjects that meet the characteristics that the researcher wants to study and then draw a conclusion. The population used in this study is the shares of companies registered in Sri-Kehati from January 2017 to December 2021.

Sri-Kehati Index data was obtained from the closing price of the Index from January 2017 to December 2021. Data obtained from www.finance.yahoo.com

Data Suku Bunga Indonesia (SBI) was obtained from www.bi.go.id in the period January 2017 – December 2021. Indonesia's interest rate data is a reference for risk-free returns or as a risk-free rate.

Data analysis uses two analytical models, namely the single index model and the stochastic dominance model. The analysis using a single index model is to calculate the realized return value (R_i) of each stock every month, calculate the expected return ($E(R_i)$) of each stock, calculate the market return (RM) for the period January 2017 – December 2021, calculate the expected return. market ($E(RM)$), calculate the covariance R_i and RM , calculate market variance (σM^2), calculate the beta of the i -th stock (β_i), determine the risk-free rate of return (RBR) using the average BI rate for the period January 2017 – December 2021, calculate i for each stock, calculate residual error (residual error), calculate residual error variance for i -stock, calculate the excess return to beta ($ERBi$), calculate A_i for each i -share, calculate B_i for each i -th stock, calculates the cut off rate (C_i), calculates Z_i and W_i and calculates the return of the portfolio formed by the single index model.

Analysis of optimal portfolio formation with stochastic dominance through several stages of data analysis, namely calculating the realized return value (R_i) of each stock every month, sorting stocks based on the smallest return value to the largest return value (in ascending sort), determining all pairs stocks that may occur, determine the probability for each stock, calculate first-order stochastic dominance, calculate second-order stochastic dominance (if there is no stochastic dominance of the pair between stocks in the first order), calculate third-order stochastic dominance (if there is no stochastic dominance of the pair) between stocks in the second-order), making decisions regarding stochastic dominance in stock pairs, recording the results of stochastically dominant and non-stochastically dominant pairs between stocks, determining the proportion of shares (W_i) for optimal portfolio stock candidates and calculating returns on stock. of the optimal portfolio formed.

The difference test is also known as a comparison test, where both compare the results of the research sample whether there is a significant difference from the results of the study. The different test used in this study is the Treynor index method.

IV. RESULT AND DISCUSSION

In calculating returns from individual stocks, the first thing to look for is the return value each month by dividing last month's closing price divided by the current month's closing price and then dividing by last month's closing price, after the monthly return value is obtained.

$$R_{it} = \frac{P_{it} - P_{it-1}}{P_{it-1}}$$

Sources: Hartono (2016)

Next, calculate the average return value for 60 months to determine the value of $E(R_i)$, where stocks that have a negative $E(R_i)$ value will be eliminated.

$$E(R_i) = \frac{\sum R_{it}}{n}$$

Sources: Hartono (2016)

So, after doing this calculation, the previous sample of 15 stocks decreased to 10 stocks because there were 5 stocks that had a negative $E(R_i)$ value.

TABLE I: EXPECTED RETURN OF 15 SAMPLE COMPANIES

No	Issuer	Company profile	$E(R_i)$
1	ASII	Astra International Tbk.	-0,0020647
2	BBCA	Astra International Tbk.	0,0159941
3	BBNI	Bank Negara Indonesia (Persero) Tbk.	0,0095438
4	BBRI	Bank Rakyat Indonesia (Persero) Tbk.	0,0125589
5	BMRI	Bank Mandiri (Persero) Tbk.	0,0074833
6	BSDE	Bumi Serpong Damai Tbk.	-0,0053916
7	INDF	Indofood Sukses Makmur Tbk.	-0,0017854
8	JSMR	Jasa Marga (Persero) Tbk.	0,0048208
9	KLBF	Kalbe Farma Tbk.	0,0037653
10	PGAS	Perusahaan Gas Negara (Persero) Tbk.	0,0028258
11	SMGR	Semen Indonesia (Persero) Tbk.	0,0028323
12	TLKM	Telekomunikasi Indonesia (Persero) Tbk.	0,0028505
13	UNTR	United Tractors Tbk.	0,0043538
14	UNVR	Unilever Indonesia Tbk.	-0,0095495
15	WIKA	Wijaya Karya (Persero) Tbk.	-0,001612

A. Single Index Model

Stocks that are included in the optimal portfolio with a single index model are stocks that have a high excess return to beta (ERB) value, stocks with a low ERB are not included in the portfolio. To be able to determine and calculate $ERBi$, it is necessary to first calculate market return (RM), market expected return or $E(RM)$, covariance R_i and RM , market variance, beta of the i -th stock (β_i), determine the risk-free rate of return. (RBR), i for each stock, residual error (residual error), calculating the variance of the residual error of the i -th stock

Market return (R_m) is calculated using the Sri-Kehati index stock data. Market return is calculated by the formula:

$$R_{m(i)} = \frac{XISR_{t(i)} - XISR_{t-1(i)}}{XISR_{t-1(i)}}$$

Sources: Hartono (2016).

Calculating the expected return or expected profit rate is by using the following formula:

$$E(R_m) = \frac{\sum R_{t_m}}{n}$$

Sources: Hartono (2016).

The results of the calculation of the Sri-Kehati Index show a market return of 0.24802 and an expected market return of 0.00413.

Market variance is the difference between the expected market return and the market return. Market Variance can be calculated by the formula:

$$= \sum_{i=1}^n \frac{[(R_{t(i)} - E(R_m))]^2}{n}$$

Sources: Hartono (2016).

Based on the data that has been processed by researchers, the market variance is obtained at 0.00254.

Excess return to beta means measuring the excess return relative to beta, where to measure this *ERB* it is necessary to return risk-free assets. certain. *ERB* can be calculated by the formula:

$$ERB = \frac{E(R_i) - R_f}{\beta_i}$$

Sources: Hartono (2016).

To determine which stocks, have a high *ERB* and which stocks have a low *ERB*, it is necessary to set a cutoff rate. The limiting point or cut-off rate (*Ci*) is used to determine which stocks are then included in the optimal portfolio and which stocks are not included in the optimal portfolio. *Ci* will provide an overview of the last point where stocks can still be included in the optimal portfolio.

As for calculating the Cut off rate with the formula:

$$C_i = \frac{\sigma_m^2 \sum_{j=1}^i \frac{(E(R_i) - R_f)\beta_j}{\sigma_{ei}^2}}{1 + \sigma_m^2 \sum_{j=1}^i \left[\frac{\beta_j^2}{\sigma_{ei}^2} \right]}$$

Sources: Hartono (2016).

The cut off point (*C**) is the *Ci* value where the last *ERB* value was still greater than the *Ci* value. The securities that make up the optimal portfolio are securities that have an *ERB* value greater than or equal to the *ERB* value at point *C**. securities that have a smaller *ERB* value with an *ERB* of point *C** are not included in the formation of the optimal portfolio.

The shares included in the candidate portfolio will then be determined by the proportion of funds for each share in the optimal portfolio. The proportion of funds can be calculated by the following formula:

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

$$W_i = \frac{Z_i}{\sum Z}$$

Sources: Hartono (2016).

After knowing the proportion of each stock, then calculate the expected return and the risks, expected return, and optimal portfolio risk.

The shares included in the candidate portfolio will then be determined by the proportion of funds for each share in the optimal portfolio. The proportion of funds can be calculated by the following formula:

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

From the table above, the single-index model method can produce a return of 1.548% and a risk of 0.888%.

TABLE II: CALCULATION RESULTS OF OPTIMAL PORTFOLIO CANDIDATES

NO	Emiten	Wi	E(Ri)	E(Rp)	Ap	Bp	
1	BBCA	85,08%	0,01599	1,3608%	0,010593	0,729400	0,003957
2	BBRI	14,92%	0,01256	0,1873%	0,001069	0,194591	0,001560
				1,5482%	0,011662	0,923990	0,005517
						E(Rm)	0,00413
						E(Rp)	0,01548
							1,55%
						Variance Market	0,00254
						Variance Portofolio	0,00769

TABLE III: CALCULATION OF RETURN AND PORTFOLIO RISK

No.	Emiten	A	B	ERB	C _i	C*	Remarks
1	BBCA	0,01245	0,857284	0,004651	0,014175	0,004061	OPTIMAL
2	BBNI	0,00183	1,865414	0,021107	0,003057	0,000902	0,004061
3	BBRI	0,00717	1,304459	0,01046	0,006682	0,001954	0,004061
4	BMRI	0,00224	1,269547	0,009967	0,002868	0,000835	0,004061
5	JSMR	-0,00033	1,246912	0,015052	0,000785	0,000163	0,004061
6	KLBF	0,00135	0,585314	0,004846	-0,00013	-0,000020	0,004061
7	PGAS	-0,00585	2,0976	0,036305	-0,00048	-0,000114	0,004061
8	SMGR	-0,00308	1,429341	0,018344	-0,00071	-0,000156	0,004061
9	TLKM	0,00016	0,650273	0,005395	-0,00152	-0,000253	0,004061
10	UNTR	0,00181	0,615887	0,009498	0,000831	0,000077	0,004061

B. Stochastic Dominance

After knowing the return value of each stock, the next step is to calculate the probability of each stock. In this study, the observation period was 60 months. The calculation of the probability is obtained by using the formula:

$$Prob = \frac{x}{\sum x}$$

Then the probability value obtained is 0.01667. Then the individual stock returns and stock probabilities are sorted from the smallest to the largest value.

The next step is to calculate the first assumption, namely the first-order. Stochastic dominance, which means investors prefer a lot to a little. What many here means is the risk of shares that investors will accept, so it can be said that investors like risk. First-order stochastic dominance is calculated by adding up each probability of each stock.

$$[F_B(W) - F_A(W)] \geq 0$$

(Ningrum *et al.*, 2018).

Because there is no first-order stochastic dominance, then the second-order stochastic dominance assumption is calculated, which means that investors are risk-averse. After calculating the second-order stochastic dominance and the result of the dominance is still unknown, then proceed to the calculation of the third-order stochastic dominance, which means that investors are desiring absolute risk aversion or reducing risk aversion. After calculating the third-order stochastic dominance by adding up the cumulative probabilities of the second-order stochastic dominance until there is no cumulative probability sum that is greater than or equal to the pair of shares being tested.

From the calculation of the assumption of stochastic dominance on 45 stock pairs that have been calculated, the first-order stock dominance is that there is no dominance.

For the second assumption, the second-order stochastic domination is BBKA's dominance over BBNI, BBRI, BMRI, JSMR, KLBF, PGAS, SMGR, UNTR, and TLKM. BBRI dominates BBNI, JSMR, and PGAS. BMRI dominates over BBNI, JSMR and PGAS. KLBF dominates JSMR, PGAS, SMGR, and UNTR. SMGR dominates over PGAS. TLKM dominates over BBNI, JSMR, PGAS, TLKM and UNTR. UNTR dominates over PGAS and SMGR. And the final assumption is that the third-order stochastic dominance is the dominance of KLBF over BBNI.

The results of stochastic dominance in Table IV are used to sort the shares of issuers based on the magnitude of dominance. The stock ranking based on the amount of dominance is presented in the following table:

TABLE V: ISSUER'S STOCK RATING

No.	Code	Domination
1	BBKA	9
2	KLBF	5
3	TLKM	5
4	BBRI	3
5	BMRI	3
6	UNTR	2
7	SMGR	1
8	BBNI	0
9	JSMR	0
10	PGAS	0
Total		28

Next, it is necessary to determine the proportion of funds for each stock in the optimal portfolio and calculate the return and risk of the portfolio.

So, the portfolio return (R_p) formed by the stochastic dominance analysis is 0.888%, and the risk is 0.876%.

TABLE IV: RESULTS OF DOMINANCE OF ISSUER SHARES

No	Code	1	2	3	4	5	6	7	8	9	10
		A	B	C	D	E	F	G	H	I	J
1	BBKA	A									
2	BBNI	A	C								
3	BBRI	A	D								
4	BMRI	A									
5	JSMR	A		C	D						
6	KLBF	A	F			F					
7	PGAS	A		C	D		F				
8	SMGR	A					F	H			
9	TLKM	A	I			I		I	I		
10	UNTR	A					F	J	J	I	
First Order											
second Order											
Third Order											
None											

TABLE VI: CALCULATION OF RETURN AND PORTFOLIO RISK

No.	Emiten	Domination	Calculation	Wi	Wi%	ap	Bp	
1	BBKA	9	9/28x100%	0,321429	0,321428571	0,004002	0,275555	0,001495
2	KLBF	5	5/28x100%	0,178571	0,178571429	0,00024	0,10452	0,000865
3	TLKM	5	5/28x100%	0,178571	0,178571429	2,9E-05	0,11612	0,000963
4	BBRI	3	3/28x100%	0,107143	0,107142857	0,000768	0,139763	0,001121
5	BMRI	3	3/28x100%	0,107143	0,107142857	0,00024	0,136023	0,001068
6	UNTR	2	2/28x100%	0,071429	0,071428571	0,000129	0,043992	0,000678
7	SMGR	1	1/28x100%	0,035714	0,035714286	-0,00011	0,051048	0,000655
TOTAL		28		1	1	0,005298	0,867022	0,006846
								E(Rm)
								E(Rp)
								0,008882
								0,888%
								Variance Market
								0,002541
								Variance Portofolio
								0,008756
								0,876%

C. Treynor

After the expected return and risk of the two methods between the single-index model and stochastic dominance are known, then they are tested with the index Treynor.

TABLE VII: TEST RESULTS WITH TREYNOR INDEX

Portfolio	Index Treynor	Index Treynor(%)
Single Index Model	0,020857	2,09%
Stochastic Dominance	0,022194	2,22%
Market	0,000292	0,03%

The results show that the value of portfolio formation using the Single Index Model has a higher Treynor index of 2.09% compared to Stochastic Dominance with a Treynor index of 2.22%. This study shows that the performance of a portfolio that is above the securities market line has a performance above the market performance, which indicates that the two methods above can produce an optimal portfolio.

V. CONCLUSION

A. Conclusion

1. In this study, based on the discussion in the previous chapter, the process and results of data using the Single Index Model were able to produce two candidate stock portfolios. The two optimal portfolios are BBKA and BBRI. The result of the calculation of portfolio return for the Single Index Model is 1548%, with a risk of 0.769%.
2. The use of Stochastic Dominance is able to produce seven stocks. The thirteen portfolio stocks are BBKA, KLBK, TLKM, BBRI, BMRI, UNTR, SMGR. The result of the calculation of portfolio return for Stochastic Dominance is 0.888%, with a risk of 0.876%.
3. The results showed that the value of the Stochastic Dominance portfolio formation had a higher Treynor index of 2.22% compared to the Single Index Model with a Treynor index of 2.09%. This study shows that the performance of a portfolio that is above the securities market line has a performance above the market performance, which indicates that both can be used as an optimal portfolio.

B. Suggestions

1) For Investors

Investors who want to invest in stocks in the capital market can use both methods, namely the Single Index Model and Stochastic Dominance, which can produce an optimal portfolio and the Treynor index above the market, but it is also necessary to consider many things, including the analytical tools used to determine which one to choose. Each analysis tool produces a different stock candidate. Investing in stocks in the capital market, investors should choose the right stocks to include in their portfolios and diversify stocks to reduce the risk of loss. If there is a decrease in the price of one share, the loss can be compensated for by other shares.

2) Further Research

Some important things from the findings can be suggested based on the limitations of the study, namely the sample that is still below 30, namely as many as 15 stock samples that are consistently included in the Sri-Kehati Index during the

period January 2017 to December 2021. The object of research can be carried out outside the Sri-Kehati index. Be careful; apart from using the Treynor Index, the Sharpe Index and the Jensen Index can also be added to the assessment of performance measurement. This is done to compare each performance (Sharpe, Treynor, and Jensen) with two optimal portfolio formation methods, namely Single Index Model and Stochastic Dominance. Based on the limitations of this study, it is recommended for further researchers to analyze the optimal portfolio of research samples plus and the object of research is carried out on stocks whose correlation between securities is perfectly negative. Performance testing can use three indices, namely Sharpe, Treynor, and Jensen, to find out how the differences between each index are.

CONFLICT OF INTEREST

The authors declare that they do not have any conflict of interest.

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