International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 06 Issue 08 August 2023
DOI: 10.47191/ijcsrr/V6-i8-45, Impact Factor: 6.789
IJCSRR @ 2023

Portfolio Optimization Using Markowitz Model on Sri-Kehati Index

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ABSTRACT: This thesis investigates the portfolio optimization process using the Markowitz model on the SRI-KEHATI index, an esteemed sustainable investment index. The study aims to explore the potential advantages of incorporating environmental, social, and governance (ESG) factors into portfolio construction. By leveraging historical financial data and reliable ESG metrics, this research develops optimized portfolios that strike a balance between risk and return while adhering to the sustainability criteria of the SRIKEHATI index.

The methodology encompasses the collection of credible ESG data and financial information for the constituents of the SRIKEHATI index. The Markowitz model is subsequently employed to analyze the risk and return characteristics of each asset within the portfolio. Through the application of optimization algorithms, the study seeks to identify the optimal asset allocation that maximizes risk-adjusted returns, taking into account the ESG criteria outlined by the SRI-KEHATI index.

The outcomes of this research provide valuable insights into the effectiveness of portfolio optimization techniques within the realm of sustainable investing. By considering both financial metrics and ESG factors, investors can construct portfolios that align with their sustainability objectives while optimizing risk and return. The findings shed light on the performance of the optimized portfolios and compare them with conventional approaches, thereby demonstrating the potential benefits of integrating ESG considerations into portfolio decision-making.

Additionally, this study examines the practical implications associated with implementing sustainable portfolio strategies based on the SRI-KEHATI index.

Overall, this thesis contributes to the expanding body of knowledge on sustainable investing and portfolio optimization, specifically focusing on the SRI-KEHATI index. It provides valuable insights for investors, asset managers, and policymakers interested in sustainable investment strategies. Furthermore, it offers a framework for incorporating ESG considerations into the portfolio construction process using the Markowitz model, thereby aiding in the development of more robust and sustainable investment portfolios.

KEYWORDS: ESG, Markowitz, PESTLE, SRI-KEHATI, Sharpe ratio, Sustainable finance.

INTRODUCTION

The capital market is critical for allocating financial resources and driving economic growth. It enables businesses to raise capital for business expansion, new project investment, research and development, and other financing requirements. Governments use the capital market to fund public infrastructure projects and manage fiscal deficits. Investors, issuers (companies and governments), intermediaries (such as investment banks and brokerages), exchanges, and regulatory bodies are all participants in the capital market. Overall, the capital market is an important component of the financial system, facilitating the efficient allocation of capital, enabling economic growth, and allowing individuals and institutions to invest and earn returns on their investments.

Investing involves risks, such as the possibility of capital loss, market volatility, economic fluctuations, and other factors that may affect the investment's value. Investors must evaluate and manage these risks in accordance with their financial objectives, risk tolerance, time horizon, and investment knowledge. Individual preferences, financial circumstances, and desired level of involvement in investment management all influence the choice of investment strategies. Investors must conduct extensive research, diversify their portfolios, and seek professional advice when necessary. We all know that industrial activities have a negative impact on the environment. Beginning with rising carbon emissions, extreme weather, and natural disasters. That is why long-term investment is becoming increasingly important. Individuals and institutions can contribute to a more sustainable and equitable future while potentially earning financial returns by engaging in sustainable investment. It provides a means of aligning financial goals with broader societal and environmental goals, thereby promoting positive change and a more sustainable and inclusive economy. In this paper, author will identify optimum portfolio on SRI-KEHATI index using Markowitz model.

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LITERATURE REVIEW

I. Portfolio Theory

A portfolio is a collection of financial investments that can be used to diversify the level of risk associated with investing activities. An efficient portfolio is one that provides a higher overall expected return than any other portfolio with comparable risk. There are three portfolio selection methods to develop an efficient set of portfolios which are; Markowitz model, Sharpe single index model and Cohen and Pogue's multi-index model. Every model has its own advantages and disadvantages. Using Markowitz model, by minimizing the risk, as measured by variance, for a given expected return or maximizing the expected return for a given risk, portfolios, which are weighted combinations of their component stocks, are evaluated and put together. The optimal portfolios represent the effective set of portfolios in this sense. However, this model does not directly address the issue of deciding how many stocks to invest in or how to choose those stocks (Brito Irene, 2023). The Sharpe single index model is simplification from Markowitz model, the sensitivity of the security to changes in the portfolio market return determines the portfolio risk in this model. The expected return and portfolio risk are the two parameters that the portfolio analysis converges on. In addition, the portfolio analysis calculates the variance or correction of each pair of potential securities that make up the portfolio. The covariance that is calculated will rise along with the number of stocks included in the portfolio. This model examines stock market movement as a result of market index movement. Unfortunately, this model specifically focuses on single market index and neglects important relationships among securities

II. Environmental, Social and Governance (ESG)

ESG investing is an umbrella term for Social Responsibility Investing (SRI), Responsible Investing (RI), Sustainable Investing (SI), and Impact Investing (a subset of SRI) (Gorka & Kuziak, 2021). ESG, or "Environmental, Social, and Governance", is a set of standards that refers to the three key factors in determining sustainability. ESG is frequently used in business as a crucial metric for choosing investments and as a point of reference for businesses reporting the impacts of their operations. ESG factors have quickly taken center stage as more investors, regulators, and other stakeholders now aim to conduct business in a way that positively contributes to solving these problems. There are three types of ESG investments, each with a different investment objective: the first is ESG integration, which aims to improve a portfolio's risk-return characteristics; the second involves the investor attempting to match the portfolio with norms and beliefs; and the third is impact investing, in which investors use their wealth to effect social or environmental change, such as hastening the economy's decarbonization (Giese et al., 2019). These issues include climate change, ethical supply chains, environmental damage, and global welfare. As a result, ESG is now a widely accepted factor to take into account when making investment decisions, and it is increasingly taking center stage on business strategic and operational agendas. ESG investments may have distinct criteria, and their importance has grown since the early 2000s. According to Kilic et al., (2022), companies, financial market investors, and regulators are examining new issues, assessing new risks, and looking for new opportunities in future markets.

III. Markowitz Portfolio Theory

Markowitz portfolio theory is also known as the mean and variance of a portfolio which are developed by Harry Markowitz. Mean and variance can be calculated by adjusting the weights of different securities in a portfolio. Furthermore, portfolios with varying weights can be represented graphically, forming an oval scatter chart. Furthermore, Markowitz identifies one of the lines as the efficient frontier.

The efficient frontier is the set of various portfolio scenarios that achieve maximum returns with the least risk under a return-risk constraint. Standard deviation will be used to represent the portfolio's risk. Specifically, the risk here refers primarily to non-systematic risk, and because the model is based on the assumption that the market is highly efficient, systematic risk is ignored.

It is important to note that the Markowitz theory is based on the idea that with optimal model results, the investor does not need to make subsequent profits, but only needs to buy the portfolio based on the calculated portfolio weights, and ideally, the expected return will be close to the calculated results.

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DATA COLLECTION AND METHODOLOGY

In conducting the research author used secondary data which collected from IDX website. Secondary data for conducting this research consists of:

1. Constituents of SRI-KEHATI from June 2023 until November 2023. This data is used to get information about the 25 stocks listed on SRI-KEHATI index.
2. Consistent constituents listed on the SRI-KEHATI index from 2020 to 2023
3. Stock price of SRI-KEHATI index constituents which is obtained from yahoo finance. The purpose is to calculate weekly return and risk of each stock with total 104 weeks data.
4. Risk free rate return, author is used average historical data weekly of 10-year Government Bond in 2021-2022.

The portfolio selection method is chosen based on portfolio theory, author is decided to use the Markowitz model. ESG will be the foundation for selecting indices and become variable of this research. Therefore, author choose SRI-KEHATI index to be an object of this research, because of previous studies which giving author curiosity about this index. All stocks on SRI-KEHATI index will be put in and author will calculate expected return, standard deviation covariance and correlation in order to build an optimum portfolio.

PESTLE analysis is used to giving investor overview and macro condition about potential industries and might be give investor opportunities in the future and it will be supporting tool for our decision later. Finally, the use of the Markowitz model is applied to achieve the objective goal of maximizing return on investment. Solver is used to compute the proportional weight on portfolio, thereby author is using add-in solver on Microsoft Excel to complete the process of developing optimum portfolio. Lastly, the optimum portfolio is developed with the goal of highest expected return for a defined level of risk or the lowest risk for an expected return.

RESULTS AND DISCUSSION

A. Risk and Return

Calculations of risk and return based on Yahoo Finance weekly stock prices from 2021 to 2022. In total, the author used 104 weeks of stock price data. The table below depicts the risk and return of consistent constituents and most recent constituents:

Table 1. Risk and Return Analysis of SRI-KEHATI Index Company

Stocks Code	Geomean		Georisk	
	Weekly	Annually	Weekly	Annually
SILO	0,53%	27,73%	0,37%	19,22%
KLBF	0,37%	19,15%	0,10%	5,31%
UNTR	0,06%	3,12%	0,23%	12,17%
ASII	-0,00031%	-0,01613%	0,17%	8,69%
AUTO	0,35%	18,25%	0,14%	7,50%
INTP	-0,27%	-14,08%	0,18%	9,50%
SMGR	-0,56%	-29,01%	0,21%	10,84%
ANTM	-0,24%	-12,34%	0,51%	26,32%
INCO	0,08%	4,31%	0,50%	25,96%
TINS	-0,39%	-20,35%	0,45%	23,60%
JSMR	-0,37%	-19,45%	0,14%	7,50%
PTPP	-1,02%	-52,88%	0,28%	14,73%
WIKA	-0,95%	-49,20%	0,27%	13,83%
TLKM	0,18%	9,31%	0,09%	4,59%
ICBP	0,10%	5,07%	0,07%	3,87%
INDF	0,07%	3,88%	0,08%	3,90%
UNVR	-0,35%	-18,09%	0,31%	15,93%
DSNG	-0,05%	-2,39%	0,32%	16,87%
SSMS	0,25%	12,78%	0,38%	19,54%
JPFA	-0,07%	-3,65%	0,21%	10,99%
BBCA	0,23%	12,08%	0,07%	3,58%
BBNI	0,37%	19,42%	0,19%	9,78%
BBRI	0,20%	10,21%	0,13%	6,69%
BMRI	0,49%	25,42%	0,12%	6,31%
BBTN	-0,27%	-14,06%	0,21%	11,14%

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According to the table above, SILO has the highest return among all stocks (0,53%), however, compare it to KLBF, which has a lower return (0,37%) but has lower variance (0,1%) than SILO (0,37%). In the industrial sector, UNTR has a higher return (0,06%) than ASII, but ASII has a lower variance (0,17%). INCO, the index's newest constituent, has the highest return (0,08%) in the basic materials sector.

When compared to other constituents in the basic materials sector, INTP has the lowest variance (0,18%). In the infrastructure sector, TLKM has the highest return (0,18%) and the lowest variance (0,09%). Because the consumer noncyclicals sector is the most widely represented constituent on the SRI-KEHATI index, investors have a much wider range of options when selecting stocks in this sector. SMSS, the newest constituent, has the highest return (0,25%) in this sector, but it has a higher variance (0,38%) than ICBP (0,07%), which means it is riskier.

Based on the author's calculations, BMRI (0,49%) is in the top two with the highest return on the SRI-KEHATI index, and when compared to BBCA, even though the return cannot surpass BMRI, it has the smallest variance (0,07%) in the financial sector. Finally, the selection of stocks is determined by the investor's risk tolerance. Risk-averse investors prefer stocks with lower variance and lower returns because they are more conservative. Otherwise, less risk-averse investors prefer higher-returning stocks despite higher volatility.

B. Sharpe Ratio

The Sharpe ratio is calculated by dividing the expected return minus the risk-free rate by the standard deviation. This ratio is used to assess the performance of an investment while also considering risk and the overall investment portfolio. The author used the average of 10-year government bond rate data from the end of 2021 to the end of 2022 for this calculation and converted the result into weekly. The average risk-free rate is 6,741%, and when converted to weekly terms, it is 0.144%

Table 2. Sharpe Ratio of SRI-KEHATI Index Company

Stocks Code	Sharpe Ratio	
	Weekly	Annually
SILO	6,46%	47,87%
KLBF	7,13%	53,85%
UNTR	-1,66%	-10,38%
ASII	-3,44%	-22,92%
AUTO	5,54%	42,02%
INTP	-9,62%	-67,55%
SMGR	-15,29%	-108,57%
ANTM	-5,31%	-37,19%
INCO	-0,81%	-4,77%
TINS	-7,89%	-55,76%
JSMR	-13,54%	-95,61%
PTPP	-21,75%	-155,35%
WIKA	-21,07%	-150,41%
TLKM	1,30%	12,00%
ICBP	-1,58%	-8,51%
INDF	-2,40%	-14,47%
UNVR	-8,82%	-62,20%
DSNG	-3,27%	-22,23%
SSMS	1,72%	13,66%
JPFA	-4,58%	-31,36%
BBCA	3,50%	28,23%
BBNI	5,37%	40,54%
BBRI	1,56%	13,40%
BMRI	10,01%	74,39%
BBTN	-8,87%	-62,31%

Only nine stocks have a positive Sharpe ratio, according to the author's calculations: SILO, KLBF, AUTO, TLKM, SSMS, BBCA, BBNI, BBRI, and BMRI. Even though the financial sector dominates in terms of positive Sharpe ratios, this does

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not necessarily imply that the financial sector dominates in terms of having a positive Sharpe ratio compared to other sectors. A positive Sharpe ratio would be determined by the time period, the investments or portfolios under consideration, and the performance of the sectors during that time period.

A positive Sharpe ratio indicates that the investment or portfolio produced a higher return for the level of risk assumed. A negative Sharpe ratio, on the other hand, indicates that the investment or portfolio delivered a lower return than the riskfree rate when adjusted for volatility or risk. In other words, the investment has not produced enough returns to compensate for the level of risk taken.

C. Equally Weight Portfolio

Creating an equal-weight portfolio involves allocating an equal amount of investment capital to each individual asset within the portfolio. This approach ensures that each asset has an equal impact on the overall performance of the portfolio, regardless of their individual prices or market capitalizations. The author divides an equal stock weight allocation into a portfolio, ensuring that the total allocation across all stocks adds up to 100%. The table below depicts an equally weighted portfolio of consistent constituents and most recent constituents:

Table 3. Equally Weight of Consistent Constituents

Stocks	Weights
ASII	7,69%
UNTR	7,69%
BBCA	7,69%
BMRI	7,69%
BBNI	7,69%
BBRI	7,69%
INDF	7,69%
UNVR	7,69%
JSMR	7,69%
TLKM	7,69%
WIKA	7,69%
KLBF	7,69%
SMGR	7,69%
SUM	100%
Expected Return (Weekly)	-0,02%
Expected Return (Annually)	-1,01%
Variance (Weekly)	0,05%
Variance (Annually)	2,73%
Sharpe Ratio (Weekly)	-6,98%
Sharpe Ratio (Annually)	-46,90%
Std. Dev. (Weekly)	2,29%
Std. Dev (Annually)	16,53%

The author's findings revealed that the portfolio consisting of 13 stocks with consistent constituents has a negative expected return and negative Sharpe ratio. Specifically, the expected return yielded a negative result of (-0.02%) on a weekly basis and (-1.01%) annually. Similarly, the Sharpe ratio showed negative figures of (-6.98%) on a weekly and (-46.90%) annually. These results indicate that the portfolio does not meet the demands of investors and is not considered favorable for investment.

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Table 4. Equally Weight of Most Recent Constituents

Stocks	Weights
KLBF	4,00%
SILO	4,00%
UNTR	4,00%
ASII	4,00%
AUTO	4,00%
INTP	4,00%
SMGR	4,00%
ANTM	4,00%
INCO	4,00%
TINS	4,00%
JSMR	4,00%
PTPP	4,00%
WIKA	4,00%
TLKM	4,00%
ICBP	4,00%
INDF	4,00%
UNVR	4,00%
DSNG	4,00%
SMSS	4,00%
JPFA	4,00%
BBCA	4,00%
BBNI	4,00%
BBRI	4,00%
BMRI	4,00%
BBTN	4,00%
SUM	100%
Expected Return (Weekly)	-0,05%
Expected Return (Annually)	-2,59%
Variance (Weekly)	0,06%
Variance (Annually)	3,02%
Sharpe Ratio (Weekly)	-7,89%
Sharpe Ratio (Annually)	-53,66%
Std. Dev (Weekly)	2,41%
Std. Dev. (Annually)	17,39%

Using 25 stocks data, the author discovered a negative expected return and Sharpe ratio. In this case, the expected return on 13 stocks is slightly better compared to 25 stocks, which have differences of (-0,03%) weekly and (-1,58%) annually. While the Sharpe ratio is better on 13 stocks, the differences are (-0,91%) weekly and (-6,76%) annually.

D. Maximum Sharpe Portfolio

The maximum Sharpe ratio is the best or highest Sharpe ratio that can be obtained for a specific investment or portfolio. It denotes the optimal risk-return tradeoff, where the investment generates the highest risk-adjusted returns. Determine the maximum Sharpe ratio, consider a variety of asset allocations or investment strategies and calculate the Sharpe ratios for each. The optimal allocation or strategy is the one that produces the highest Sharpe ratio.

Table 5. Maximum Sharpe for Consistent Constituents

Maximum Sharpe (Weekly)		Maximum Sharpe (Annually)	
Stocks	Weights	Stocks	Weights
ASII	0,00%	ASII	0,00%
UNTR	0,00%	UNTR	0,00%
BBCA	0,00%	BBCA	0,00%
BMRI	62,33%	BMRI	61,66%
BBNI	0,00%	BBNI	0,00%
BBRI	0,00%	BBRI	0,00%
INDF	0,00%	INDF	0,00%
UNVR	0,00%	UNVR	0,00%
JSMR	0,00%	JSMR	0,00%
TLKM	0,00%	TLKM	0,00%
WIKA	0,00%	WIKA	0,00%
KLBF	37,67%	KLBF	38,34%
SMGR	0,00%	SMGR	0,00%
SUM	100%	SUM	100%
Expected Return	0,44%	Expected Return	23,02%
Variance	0,08%	Variance	3,89%
Sharpe Ratio	11,05%	Sharpe Ratio	82,50%
Std. Dev.	2,74%	Std. Dev.	19,73%

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Based on te table above, we obtain a portfolio consisting of two stocks, BMRI and KLBF. Using the solver Sharpe ratio, weekly is 11,05% and annually is 82,5%. We obtained a higher Sharpe ratio when compared to equally weighted portfolio, but as a result, the standard deviation increased slightly, which is approximately (0,45%) weekly and (3,20%) annually.

Table 6 Maximum Sharpe of Most Recent Constituents

Maximum Sharpe (Weekly)		Maximum Sharpe (Annually)	
Optimal Portfolio		Optimal Portfolio	
Stocks	Weights	Stocks	Weights
KLBF	19,74%	KLBF	16,52%
SILO	28,18%	SILO	30,31%
UNTR	0,00%	UNTR	0,00%
ASII	0,00%	ASII	0,00%
AUTO	5,20%	AUTO	9,31%
INTP	0,00%	INTP	0,00%
SMGR	0,00%	SMGR	0,00%
ANTM	0,00%	ANTM	0,00%
INCO	0,00%	INCO	0,00%
TINS	0,00%	TINS	0,00%
JSMR	0,00%	JSMR	0,00%
PTPP	0,00%	PTPP	0,00%
WIKA	0,00%	WIKA	0,00%
TLKM	0,00%	TLKM	7,32%
ICBP	0,00%	ICBP	0,00%
INDF	0,00%	INDF	0,00%
UNVR	0,00%	UNVR	0,00%
DSNG	0,00%	DSNG	0,00%
SMSS	0,00%	SMSS	0,00%
JPFA	0,00%	JPFA	0,00%
BBCA	0,00%	BBCA	0,00%
BBNI	0,00%	BBNI	0,00%
BBRI	0,00%	BBRI	0,00%
BMRI	46,89%	BMRI	36,53%
BBTN	0,00%	BBTN	0,00%
SUM	100,00%	SUM	100,00%
Expected Return	0,46%	Expected Return	22,06%
Variance	0,06%	Variance	2,64%
Sharpe Ratio	12,90%	Sharpe Ratio	94,27%
Std. Dev.	2,45%	Std. Dev.	16,25%

Based on table above we got 4 stocks on weekly calculation which are; KLBF (19,74%), SILO (28,18%), AUTO (5,20%) and BMRI (46,89%). Meanwhile 5 stocks on annually calculation which are; KLBF (16,52%), SILO (30,31%), AUTO (9,31%), TLKM (7,32%), BMRI (36,53%). If we compare to Equally weight portfolio the differences of expected return are (0,41%) Weekly and (19,47%) Yearly. Sharpe ratio on the other hand is higher with the differences (5,01%) Weekly and (40,60%) Yearly.

E. Minimum Variance Portfolio

A minimum variance portfolio is an investment portfolio with the lowest level of volatility or risk for a specific set of securities or assets. The goal of building a minimum variance portfolio is to achieve the best possible balance of risk and return by reducing the portfolio's overall variance or standard deviation. The concept of a minimum variance portfolio is based on Harry Markowitz's Modern Portfolio Theory (MPT). Diversification is emphasized by MPT as a means of reducing portfolio risk. According to MPT, combining assets with low or negative correlation can result in a more efficient portfolio with a higher risk-adjusted return.

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Table 7. Minimum Variance of Consistent Constituents

Minimum Variance (Weekly)		Minimum Variance (Annually)	
Stocks	Weights	Stocks	Weights
ASII	0,00%	ASII	0,00%
UNTR	1,05%	UNTR	1,05%
BBCA	25,43%	BBCA	25,42%
BMRI	0,00%	BMRI	0,00%
BBNI	0,00%	BBNI	0,00%
BBRI	0,56%	BBRI	0,56%
INDF	30,63%	INDF	30,64%
UNVR	0,85%	UNVR	0,85%
JSMR	1,33%	JSMR	1,33%
TLKM	21,66%	TLKM	21,66%
WIKA	0,00%	WIKA	0,00%
KLBF	17,46%	KLBF	17,46%
SMGR	1,04%	SMGR	1,04%
SUM	100,00%	SUM	100,00%
Expected Return	0,17%	Expected Return	9,00%
Variance	0,03%	Variance	1,52%
Sharpe Ratio	1,91%	Sharpe Ratio	18,32%
Std. Dev.	1,71%	Std. Dev.	12,31%

Based on the table above, there are 9 stocks chosen for the weekly calculation, which are UNTR (1,05%) and BBCA (25,43%). BBRI (0,56%), INDF (30,63%), UNVR (0,85%), JSMR (1,33%), TLKM (21,66%), KLBF (17,46%), SMGR (1,04%) On the yearly calculation, the chosen stocks and proportion are the same as on the weekly calculation. If we compare maximum Sharpe and minimum variance, we find that the maximum Sharpe ratio has a higher return on weekly and annually with the differences of (9,14%) and (64,57%). Even though the Sharpe ratios are bigger, the standard deviation is bigger with the differences of 1,04% weekly and 7,42% annually. This matches the concept of high risk, high return.

Table 8. Minimum Variance of Most Recent Constituents

Minimum Variance (Weekly)		Minimum Variance (Yearly)	
Optimal Portfolio		Optimal Portfolio	
Stocks	Weights	Stocks	Weights
KLBF	5,77%	KLBF	5,77%
SILO	13,76%	SILO	13,76%
UNTR	0,26%	UNTR	0,26%
ASII	0,00%	ASII	0,00%
AUTO	4,96%	AUTO	4,96%
INTP	0,05%	INTP	0,05%
SMGR	0,00%	SMGR	0,00%
ANTM	0,51%	ANTM	0,51%
INCO	0,00%	INCO	0,00%
TINS	0,00%	TINS	0,00%
JSMR	0,00%	JSMR	0,00%
PTPP	0,00%	PTPP	0,00%
WIKA	0,00%	WIKA	0,00%
TLKM	20,16%	TLKM	20,16%
ICBP	19,80%	ICBP	19,80%
INDF	14,92%	INDF	14,92%
UNVR	0,00%	UNVR	0,00%
DSNG	0,42%	DSNG	0,42%
SMSS	0,00%	SMSS	0,00%
JPFA	0,00%	JPFA	0,00%
BBCA	19,07%	BBCA	19,07%
BBNI	0,00%	BBNI	0,00%
BBRI	0,31%	BBRI	0,31%
BMRI	0,00%	BMRI	0,00%
BBTN	0,00%	BBTN	0,00%
SUM	100,00%	SUM	100,00%
Expected Return	0,21%	Expected Return	10,87%
Variance	0,03%	Variance	1,34%
Sharpe Ratio	4,27%	Sharpe Ratio	35,66%
Std. Dev.	1,60%	Std. Dev.	11,57%

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DOI: 10.47191/ijcsrr/V6-i8-45, Impact Factor: 6.789
IJCSRR @ 2023

Based on table above there are 12 stocks on weekly and annually calculation that are choosen which are; KLBF (5,77%), SILO (13,76%). UNTR (0,26%), AUTO (4,96%), INTP (0,05%), ANTM (0,51%), TLKM (20,16%), ICBP (19,80%), INDF (14,92%), DSNG (0,42%), BBCA (19,07%), BBRI (0,31%). When compared to the maximum Sharpe calculation, the minimum variance has a lower Sharpe, with differences of (8.63%) weekly and (58.61%) annually. Even though the return is lower, the standard deviation is lower, which is the difference between (0,85%) weekly and (4,68%) annually. When the Sharpe ratio and standard deviation are both lower, it generally indicates lower risk and potential returns. When both the Sharpe ratio and the standard deviation are lower, it indicates that the investment is associated with lower risk and is likely to provide lower potential returns than investments with higher Sharpe ratios and standard deviations. It may be better suited to conservative investors seeking stability and capital preservation as opposed to aggressive growth or higher returns.

F. Maximum Expected Returns

The maximum return in portfolio optimization refers to the highest expected return that can be achieved for a given level of risk or constraints. It represents the portfolio allocation that offers the highest potential return among the set of feasible portfolios. The concept of maximum return is derived from the efficient frontier, which is a key component of portfolio optimization. The efficient frontier represents the set of portfolios that offer the highest expected returns for each level of risk or the lowest risk for each level of expected returns. The portfolio corresponding to the highest point on the efficient frontier represents the maximum return portfolio within the feasible set of portfolios. The author used Microsoft Excel's Solver Add-in to determine the allocation of weights with the highest Sharpe ratio.

Table 9. Maximum Return of Consistent Constituents

Maximum Expected Return			
Weekly		Annually	
Stocks	Weights	Stocks	Weights
ASII	0,00%	ASII	0,00%
UNTR	0,00%	UNTR	0,00%
BBCA	0,00%	BBCA	0,00%
BMRI	100,00%	BMRI	100,00%
BBNI	0,00%	BBNI	0,00%
BBRI	0,00%	BBRI	0,00%
INDF	0,00%	INDF	0,00%
UNVR	0,00%	UNVR	0,00%
JSMR	0,00%	JSMR	0,00%
TLKM	0,00%	TLKM	0,00%
WIKA	0,00%	WIKA	0,00%
KLBF	0,00%	KLBF	0,00%
SMGR	0,00%	SMGR	0,00%
SUM	100,00%	SUM	100,00%
Expected Return	0,49%	Expected Return	25,42%
Variance	0,12%	Variance	6,31%
Sharpe Ratio	10,02%	Sharpe Ratio	74,39%
Std. Dev.	3,48%	Std. Dev.	25,11%

The result show that to get maximum expected return, we should invest 100% into BMRI. If we look at the risk and return of each single assets, BMRI has the highest return among others. But, if we put all our money into BMRI, we got bigger standard deviation compare to maximum Sharpe ratio and minimum variance result.

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 06 Issue 08 August 2023
DOI: 10.47191/ijcsrr/V6-i8-45, Impact Factor: 6.789
IJCSRR @ 2023

Table 10. Maximum Return of Most Recent Constituents

Maximum Return			
Weekly		Annually	
Stocks	Weights	Stocks	Weights
KLBF	100,00%	KLBF	100%
SILO	0,00%	SILO	0%
UNTR	0,00%	UNTR	0%
ASII	0,00%	ASII	0%
AUTO	0,00%	AUTO	0%
INTP	0,00%	INTP	0%
SMGR	0,00%	SMGR	0%
ANTM	0,00%	ANTM	0%
INCO	0,00%	INCO	0%
TINS	0,00%	TINS	0%
JSMR	0,00%	JSMR	0%
PTPP	0,00%	PTPP	0%
WIKA	0,00%	WIKA	0%
TLKM	0,00%	TLKM	0%
ICBP	0,00%	ICBP	0%
INDF	0,00%	INDF	0%
UNVR	0,00%	UNVR	0%
DSNG	0,00%	DSNG	0%
SMSS	0,00%	SMSS	0%
JPFA	0,00%	JPFA	0%
BBCA	0,00%	BBCA	0%
BBNI	0,00%	BBNI	0%
BBRI	0,00%	BBRI	0%
BMRI	0,00%	BMRI	0%
BBTN	0,00%	BBTN	0%
SUM	100,00%	SUM	100%
Expected Return	0,53%	Expected Return	28%
Variance	0,37%	Variance	19%
Sharpe Ratio	8,77%	Sharpe Ratio	48%
Std. Dev.	6,08%	Std. Dev.	43,84%

From table above, resulted 100% on KLBF to get maximum return. But if we compare to maximum Sharpe ratio and minimum variance the standard deviation is the biggest, resulting investment with highest risk among those two.

G. Efficient Frontier

In modern portfolio theory (MPT), the efficient frontier refers to a set of optimal portfolios that offer the highest expected return for a given level of risk or the lowest risk for a given level of expected return. It is the collection of portfolios that maximize expected returns while minimizing risk. The efficient frontier is calculated by plotting the expected return on the y-axis and the standard deviation (a risk measure) on the x-axis for various portfolios built from a set of available assets. Each point on the efficient frontier corresponds to a portfolio with a particular asset allocation. The efficient frontier illustrates the risk-return trade-off in portfolio construction. It demonstrates how diversifying investments across asset classes can help investors achieve a higher level of return for a given level of risk or reduce risk while maintaining a desired level of return.

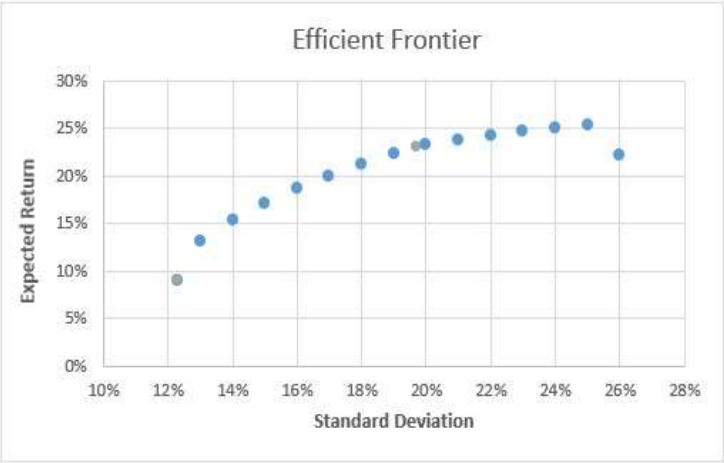

Figure 1. Efficient Frontier of Consistent Constituents

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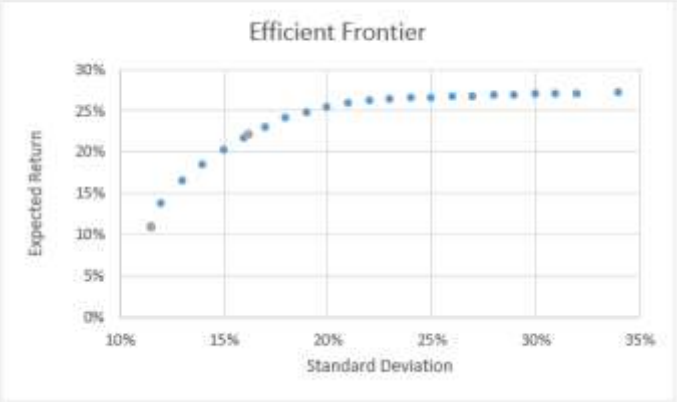

Figure 2. Efficient Frontier of Most Recent Constituents

H. Capital Allocation Line

The Capital Allocation Line (CAL) is a financial concept that represents the graphical representation of the risk-return tradeoff for a portfolio that includes both risk-free and risky assets. It depicts the various risk-free and risky asset combinations from which an investor can choose to achieve a specific level of return. The CAL is calculated by plotting the expected return (or risk) on the y-axis and the standard deviation (or risk) on the x-axis. The risk premium, which is the additional return an investor receives for taking on more risk, is represented by the slope of the CAL. The CAL begins with the risk-free rate of return and progresses to the point where the investor holds a portfolio entirely comprised of risky assets.

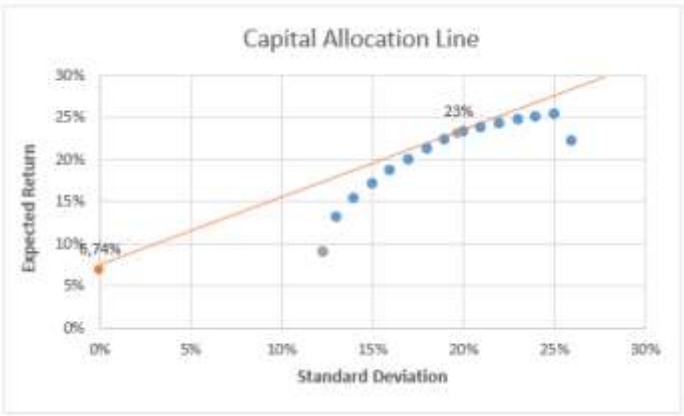

Figure 3. Graph of Capital Allocation Line of Consistent Constituents

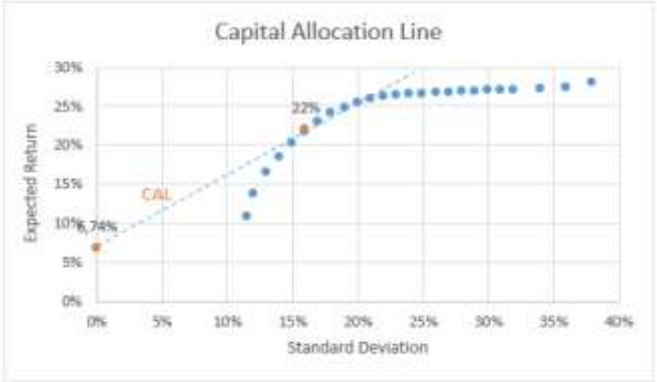

Figure 4. Graph of Capital Allocation Line Most Recent Constituents

International Journal of Current Science Research and Review
ISSN: 2581-8341
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IJCSRR @ 2023

I. PESTLE Analysis of Financial Sector

Political

- As of November 2021, the combined market worth of Indonesia's Green, Social, and Sustainability Bond (GSS) reached USD 7.7 billion. Green bonds constituted USD 6.3 billion, comprising 81% of the overall GSS bond issuance, indicating that they were the most frequently issued type among them.
- From 2019 to 2022, the Green Retail Sukuk issuance demonstrated consistent growth each year, while the Global Green Sukuk (GGS) issuance remained steady over the same three-year period but with extended maturity periods. The upward trend in the Green Retail Sukuk issuance value and the longer tenor of GGS highlight the expansion of the domestic Green Sukuk Market and the appeal of Indonesian GGS in the global Green Sukuk market. This indicates the local market's development and the attractiveness of Indonesian GGS on the global stage.
- In 2021, Indonesia became a participant in the Climate Investment Fund (CIF) Accelerating Coal Transition (ACT) investment initiative, which is set to be in effect from March 2022 until 2047. This program will receive support from six multilateral development banks, offering a comprehensive financial toolkit and technical assistance. The funds provided by the ACT program will aid in implementing initiatives that strengthen countries' capabilities to manage the energy transition away from coal, repurpose or decommission coal assets, and foster sustainable economic opportunities and social protection for communities that heavily rely on coal.

Economy

- The main factors behind the growth in credit were an enhanced perception of risk within the banking sector and an upswing in financing demands from the real sector. In 2022, credit experienced a substantial increase of 11.35% (year-on-year), surpassing the 5.24% (year-on-year) growth rate recorded in 2021 across all economic sectors. This credit expansion was accompanied by a positive growth in Third Party Funds (DPK), which amounted to 9.01% (year-on-year)
- In the reporting period, a total of 98 companies conducted Bond/Sukuk issuances, surpassing the previous year's count of 77 companies. The Financial sector constituted the largest proportion of bond issuers, making up 40.3%, followed by the Basic Materials sector with 29%. The notable increase in Bonds/Sukuk issuances can be attributed to the ongoing substantial corporate requirements for refinancing and securing working capital

Social

- At the end of 2022, households experienced a notable growth in net financial wealth, reaching 15.84% (yearon-year), which was a significant increase compared to the previous year's growth of 9.98% (year-on-year). This growth was driven by the expansion of household financial assets by 12.25% (year-on-year), accelerating from the 9.21% (year-on-year) growth in the preceding year. The increase was primarily influenced by higher ownership of stocks, savings, and bonds, contributing annual growth of 5.28%, 1.30%, and 0.85% to their respective total assets. Additionally, non-financial assets also experienced growth, rising from 3.94% (yearon-year) in 2021 to 11.34% (year-on-year) in 2022. On the other hand, household liabilities also increased by 9.67% (year-on-year), slightly higher than the previous year's growth rate of 8.66% (year-on-year).

Technology

- According to PwC's Sustainable Information report for Indonesia, there has been a significant improvement in internet access in the country over the past decade. As of 2020, nearly three-quarters of Indonesians had internet connectivity, which surpasses the global average of 60%. Despite this progress, internet connectivity in remote areas still presents challenges. However, there is optimism that the increasing adoption of smartphones can help overcome this issue through leapfrogging.

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 06 Issue 08 August 2023
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IJCSRR @ 2023

- The COVID-19 pandemic played a crucial role in accelerating Indonesia's digitalization. Consumers, businesses, and governments turned to digital solutions to fulfill their daily tasks and needs. The digital economy in Indonesia is projected to nearly triple in value between 2020 and 2025, with significant untapped opportunities in remote regions. Consequently, Indonesia's thriving digital economy is expected to continue being a key driver of growth in 2022 and beyond.

Legal

- In Indonesia, the absence of strict policies and regulations that restrict financial support to the fossil fuel sector has led to continued involvement of financial institutions. The only sustainable financing regulation in place, POJK No.51/2017, does not impose requirements on stakeholders in the financial sector to limit their financing towards fossil fuels. This lack of regulatory frameworks mandating divestment from fossil fuels, coupled with market unpredictability, creates obstacles for financial institutions in devising plans and setting targets for the value of credits issued for sustainable sectors annually.

Environment

- In May 2022, Bank BRI made an official declaration stating that it would discontinue providing credit to the fossil fuel sector. Additionally, the bank committed to maintaining its fossil fuel sector credit portfolio share below 3%, limited to existing credit agreements. According to our analysis, out of Bank BRI's total corporate credit portfolio amounting to IDR 177.6 trillion in Q1 2022, only 3% was directed towards coal, representing IDR 5.3 trillion.
- Bank Negara Indonesia (BNI) has taken steps to restrict the amount of credit allocated to the mining sector. In Q1 2022, the credit allocation for this sector accounted for 3.23% of their total credit portfolio, which amounted to IDR 19.1 trillion out of their corporate credit portfolio (IDR 193.2 trillion) during the same period. Among the four major commercial banks in Indonesia that finance fossil fuels, only BNI and BRI have publicly announced measures to limit credit allocation to the sector.

CONCLUSION

In conclusion, portfolio optimization using the Markowitz model provides a systematic approach to constructing an optimal investment portfolio. By considering the expected returns, risks, and correlations among different assets, the Markowitz model aims to find the portfolio with the highest expected return for a given level of risk or the lowest risk for a given level of return. However, it is important to note that portfolio optimization using the Markowitz model has certain limitations:

1. Assumptions: The model relies on assumptions such as normal distribution of asset returns, constant correlations, and stable risk measures. These assumptions may not hold in real-world scenarios, leading to potential inaccuracies in portfolio optimization results.
2. Data Reliance: The model heavily depends on historical data for asset returns, volatilities, and correlations. If the underlying data is not representative of future market conditions, the optimization results may not accurately reflect future portfolio performance.
3. Sensitivity to Inputs: The Markowitz model is sensitive to changes in input parameters such as expected returns and correlation estimates. Small changes in these inputs can significantly impact the resulting optimal portfolio allocation.

In summary, while portfolio optimization using the Markowitz model provides a valuable framework for constructing diversified and efficient investment portfolios, it should be used as a tool in conjunction with other qualitative and quantitative analyses. Investors should also consider their individual risk tolerance, investment objectives, and incorporate ongoing monitoring and adjustment to adapt to changing market conditions. Based on the provided table, the following observations can be made for different investment strategies using both the most recent and consistent constituents data:

1. Most Recent Constituents Data:
    - Maximum Expected Return: If an investor does not consider associated risks, the optimal choice is to pursue the portfolio with the maximum expected return. This results in a weekly return of 0.53% and an annual return of 27.73%.

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IJCSRR @ 2023

- Maximum Sharpe Ratio: For investors aiming to achieve the highest risk-adjusted returns, the recommended option is the portfolio with the maximum Sharpe ratio. This strategy yields a weekly return of 12.9% and an annual return of 94.27%.
- Minimum Variance: The minimum variance approach is particularly suitable for risk-averse investors who prioritize capital preservation and aim to minimize downside risk. This approach produces a weekly return of 0.21% and an annual return of 10.87% with minimal standard deviation.

2. Consistent Constituents Data:
   - Maximum Sharpe Ratio: If an investor does not consider associated risks, the preferred choice is the portfolio with the maximum Sharpe ratio. This strategy results in a weekly return of 11.07% and an annual return of 82.5%.
   - Minimum Variance: The minimum variance approach remains beneficial for risk-averse investors seeking capital preservation and downside risk mitigation. This approach generates a weekly return of 0.17% and an annual return of 9% with minimized standard deviation.
   - Maximum Expected Return: Investors aiming for higher returns can opt for the portfolio with the maximum expected return, resulting in a weekly return of 0.49% and an annual return of 25.42%.
3. Equally Weighted: Allocating funds equally across all stocks results in a negative return for both the most recent and consistent constituents data.

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IJCSRR @ 2023

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Cite this Article: Muhammad Iqbal Irfani, Oktofa Yudha Sudrajad (2023). Portfolio Optimization Using Markowitz Model on Sri-Kehati Index. International Journal of Current Science Research and Review, 6(8), 5778-5792