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Portfolio Optimization: a Comparative Analysis a single Index and Markowitz Model

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ABSTRACT

This study compares portfolio optimization using the Single Index Model and the Markowitz Model for companies in the IDXLQ45LCL Index (2022–2024). The Single Index Model simplifies calculations with market index variables, while the Markowitz Model emphasizes diversification to balance risk and return. The analysis identifies optimal stocks based on expected returns, risk, and excess return to beta ratios, aiming to guide investors in maximizing returns with minimal risk. Focused on environmentally sustainable companies, this research addresses gaps in prior studies regarding the models' effectiveness. By offering a comprehensive analysis, it contributes to better investment decisions and enriches the academic literature on portfolio optimization in sustainable markets.

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INTRODUCTION

Economic growth plays a crucial role in national development, and Indonesia is among the developing countries actively pursuing economic progress. Higher economic growth often signifies a nation's success, contributing to improved public welfare, job creation, and economic stability. The global economy is projected to grow by 3.0% in 2024, while Indonesia's domestic economy is expected to expand by 4.7–5.5%, driven by robust domestic demand, including private consumption and investment. A stable and sustainable economy attracts both domestic and foreign investors, as they tend to favor countries with promising economic prospects. This positive trend is evident in Indonesia's capital market, which surpassed 13 million Single Investor Identifications (SIDs) in 2024, with over 863,000 new SIDs registered during the year (RRI.co.id, 2024). In response, the Indonesian government continues to foster a conducive investment climate, reflecting improved investor confidence and a stronger investment environment in 2024.

Mingka and Lubis (2023) define investment as a pledge to forgo present spending in order to increase future consumption in the hopes of turning a profit. Both the financial (foreign exchange, deposits, securities, etc.) and real (property, buildings, gold, etc.) sectors are available for investment. In Indonesia today, investing in shares is fairly common. An investor can invest their money in investment items with the hope of making money later on. But making a decision is not always simple, particularly when there is uncertainty. Investors can select investment products with different risk profiles and return levels through the capital market. Investors now have easier access to company information because to technological advancements. Technology advancements have made it simpler for people to invest in the capital market, which has raised interest in investing among the general population. Stock investments conducted on the stock exchange or capital market are one type of financial sector investment. You always seek the highest possible return on your investment activities as an investor. However, there must be a high degree of risk involved if you want a high return. Systematic risk and unsystematic risk are the two categories of risk. Systematic risk, or market risk, impacts the entire market and cannot be mitigated through diversification, as stock price movements align with overall market trends. Conversely, unsystematic risk, or specific risk, arises from company-specific events like management or financial failures. This type of risk can be minimized through stock portfolio diversification (Ramadhan et al., 2020). Effective wealth management is essential to safeguard assets from inflation, taxes, and other factors. Since all investments involve risk, investors must adopt proper risk management, including identifying, analyzing, and mitigating risks. Diversifying stocks is a key strategy to reduce potential losses.

Stock diversification is a strategy to reduce investment risk by spreading funds across various financial instruments, industries, and categories (Ramadhan et al., 2020). This approach not only mitigates the risks associated with stock investments but also enhances the potential for profit by selecting stocks from diverse sectors and companies. To minimize risk and maximize returns, investors should opt for investments with varying rates of return and diversify across multiple industries. (Tandelilin 2010) highlights that the Markowitz approach emphasizes portfolio selection based on investors' preferences for the expected return and risk of each option. The principle of diversification is often encapsulated in the saying, "Don't put all your eggs in one basket," underscoring the importance of spreading investments across different assets to avoid complete loss if one asset underperforms. In the context of investments, diversification is a critical strategy for constructing an optimal portfolio and safeguarding against unforeseen risks.

Portfolio according to Zubir (2011:1) is a combination of various investment instruments. Meanwhile, according to (Tandelilin 2010) optimal portfolio is a combination or a set of assets, both in the form of real assets and financial assets owned by investors. From the two explanations above, it can be said that a portfolio is a combination of various investment instruments either accidentally or indeed decided through planning supported by rational calculations and considerations to maximize profits and minimize investment risk. Fittria et al (2024) stated that portfolio construction is important for investors to diversify stocks and achieve an optimal portfolio. This process helps in choosing the right combination of stocks to minimize risk. Therefore, experts continue to develop this research model to find the best way to form an optimal portfolio. So that investors can make more profitable investment decisions. There are several ways to form an optimal portfolio, including the Markowitz Model and Single Index.

Markowitz Theory, also known as Modern Portfolio Theory (MPT), is an investment theory developed by Harry Markowitz in 1952. It focuses on how to create an optimal investment portfolio concerning assets and diversification. The application of MPT helps investors identify and find suitable portfolio combinations according to each investor's risk profile. The basis of the Markowitz method is to provide input to investors to avoid risk and provide the maximum possible returns on each investment decision. The Markowitz model is a portfolio determination model that emphasizes the relationship between return and investment risk. The Markowitz method portfolio theory is also known as the mean variance model, which focuses on maximizing expected return (mean) and minimizing uncertainty/risk (variance) to select and compile the optimal portfolio. Markowitz's theory assumes that investors are risk averse. They tend to choose portfolios with lower risk for a given level of return. However, they are also willing to invest in high-risk instruments if they can get a greater return. The best investment is the one that is away from risk, Harry Markowitz recommends diversifying investment (Mingka and Lubis 2023).

The single most significant contributor to the creation of the Single Index Model was William Sharpe. This model was created by Sharpe in 1963 as a substitute for the more intricate Markowitz model. Sharpe's wish to streamline the Markowitz model's computations by supplying the parameters required for the Markowitz model's computation served as the inspiration for the Single Index Model concept. Sharpe demonstrated that a security's price tends to move in the same direction as the market price index. As a result, the beta coefficient, which represents the market return variable as one of the factors influencing the stock price, can be used to relate a security's return to the market return (Syaipullah 2013). The estimation of variables that relate changes in stocks to changes in market index returns is made easier by the Single Index Theory. It is predicated on the observation that general stock prices frequently shift in tandem with shifts in the market. Stock returns often rise when the market improves, and vice versa.

This study uses two models for comparison, namely the Single Index Model and the Markowitz Model to form an optimal portfolio based on several reasons. First, in optimizing return and risk each model has its advantages such as the Markowitz model, this model is designed to maximize expected return with minimum risk, while this model is simpler and uses the market index as a reference. This model can provide higher returns and lower risk. Second, in the diversification model, Markowitz allows investors to choose a diverse combination of stocks to minimize risk. By increasing the number of stocks in the portfolio, investors can minimize unsystematic risk. The Single Index model uses the market index as a reference, so investors can choose stocks that fluctuate in line with the market index. Thus, the comparison between the Markowitz Model and the Single Index Model is very important for investors in optimizing returns and minimizing investment risk. That way investors can choose the model that best suits their preferences and investment goals.

Based on several previous studies that used the Single Index Model and the Markowitz Model. Research conducted (Wijayanto et al 2023) The formation of the Optimal Portfolio of Shares based on the Markowitz Model and the Single Index Model in IDX BUMN20 companies in 2017-2021 concludes the discussion of the results of the two portfolio models, namely the Markowitz Model and the Single Index Model, giving the result that the Single Index Model has higher returns and risks than the Markowitz Model. According to Dewi & Ardianingsih (2023) Through research entitled Optimal Portfolio Analysis of the Markowitz Model and Single Index Model in Companies Listed in the ESG-Leader Index on the Indonesia Stock Exchange in 2020-2022 states that the optimal portfolio results that can be used by investors to invest are the Single Index Model because it has a higher return than the risk so that it is able to get more profit than the risk obtained.

According to Rachmatullah et al (2021) in the research of the Markowitz Optimal Portfolio Analysis and Single Index Model on the Jakarta Islamic Index which states that the Markowitz model produces a more favorable rate of return. In contrast to the research results (Wijayanto et al 2023) which compares the calculation results with the Markowitz model and the Single Index model, which states that the Single Index model is better than the Markowitz model because it has a higher portfolio return value and lower risk. While research (Nurdianingsih & Suryadi 2021) entitled Comparative Analysis of Optimal Portfolios Using the Single Index Model and Markowitz Model in Determining Stock Investments states that the results of the calculation of optimal portfolio formation using the Single Index Model and the Markowitz Model show that there is a difference between the two models, the difference is seen in the expected return value generated from each model, the Markowitz Model has an advantage in the expected return value generated compared to the Single Index Model.

Investors looking to enter the capital market must approach decision-making with rationality. Investment decisions involve a complex process of analyzing various factors to select the best option from multiple alternatives. This process is crucial for both individual and institutional investors to optimize returns while minimizing risks. Therefore, developing an optimal portfolio serves as a vital guideline for managing the balance between returns and risks in investment assets. Previous studies reveal the existence of a research gap in this area. Motivated by this, researchers aim to explore and analyze in greater detail the optimal portfolio formation for companies listed in the IDXLQ45LCL index from 2022 to 2024, utilizing both the Markowitz Model and the Single Index Model as methodological frameworks.

LITERATURE REVIEW

Investment: Definition, Objectives, and Types

According to Nurdianingsih & Suryadi (2021) investment involves committing funds in the present with the aim of generating profits in the future. The primary objective of investors is to achieve maximum returns on their ownership shares, which also drives their motivation to participate in the capital market. Similarly, (Tandelilin 2010) defines investment as the allocation of funds or resources at present to obtain future gains or as a deferral of current consumption to support efficient production over time. From the definitions provided, investment encompasses several key aspects: (1) a present sacrifice, whether financial or otherwise, (2) an investment period, and (3) expected returns. In essence, investment can be understood as the act of allocating and saving funds into productive assets for a specific duration, with the anticipation of earning returns or profits in the future.

The purpose of investing is simply to make some money in the future. In addition to making a certain amount of money, investment also has a more specific purpose that is useful for improving investor welfare. The investor's welfare in this case is monetary welfare, which can be measured by the sum of current income plus the value of income earned in the future. There are several reasons why individuals choose to invest. One key reason is to improve their quality of life. By investing, individuals aim to secure a better future and, at the very least, maintain or grow their current level of income over time. Additionally, investment serves as a way to mitigate the impact of inflation, helping individuals preserve the value of their wealth against potential decreases caused by rising prices. Furthermore, in some countries, investment is encouraged through tax incentives. Policies often provide tax benefits to individuals who invest in specific sectors, motivating people to allocate their resources into productive investments. These factors collectively highlight the importance of investment in achieving financial stability and growth.

According to Hartono (2019) Investment into financial assets either in the form of single asset investment or in the form of a portfolio can be done directly or indirectly. Direct investing can be done by buying financial assets directly, while indirect investing is done by buying financial assets through investment companies. Direct and indirect investments represent two primary approaches to allocating funds in financial markets. Direct investment involves purchasing financial assets directly in markets such as the money market, capital market, or derivatives market, without relying on an investment company. For example, investors can place funds in money market deposits or purchase stocks and bonds in the capital market. While stock transactions require a broker, this broker does not function as an investment company. Additionally, direct investments can include buying options or futures in the derivatives market, with each financial market offering a variety of asset types.

In contrast, indirect investment entails acquiring financial assets through investment companies. These companies are licensed entities specializing in creating, managing, and selling portfolios to investors. In this approach, investors do not directly purchase or manage financial assets; instead, they buy shares or portfolios from the investment company and later sell them back when desired. This method offers a more hands-off alternative for individuals looking to invest in diverse financial instruments.

Capital Market: Definition, Benefits, and Functions

According to the Republic of Indonesia Law Number 8 of 1995 on Capital Markets, the capital market is a platform for trading various long-term financial instruments with a maturity period of over one year, including stocks, bonds, mutual funds, and other derivative instruments related to securities. Nurdianingsih & Suryadi (2021) describe the capital market similarly as a marketplace for trading long-term financial instruments, such as bonds, stocks, mutual funds, derivatives, and other related assets. The capital market plays a crucial role in a country's economy, serving two main functions: providing a

channel for businesses to raise funds and offering a means for companies to acquire capital from the public for investment in financial instruments.

The capital market plays several key roles in the economy. First, it creates investment opportunities for investors, facilitating diversification of their portfolios. Additionally, the capital market serves as a major indicator of a country's economic trends, reflecting the overall health and direction of the economy. It also contributes to the optimal allocation of funding sources, ensuring that capital is directed to its most productive uses. Furthermore, the market provides an alternative investment option, offering potential profits along with measurable risks that can be assessed through transparency, liquidity, and diversification of investments. Moreover, the capital market acts as a gauge for economic development, functioning as a leading indicator of the economy. The activity in the stock exchange, as measured by market indices, reflects the broader economic condition of the country.

According to Suratna et al (2020), the capital market functions as a meeting place for those with excess funds (lenders) and those in need of long-term funds (borrowers). It serves two key roles: economic and financial. The economic function facilitates the transfer of funds from lenders to borrowers, where lenders invest their money with the expectation of earning a return, while borrowers use the funds to support business development without relying on internal company resources. The financial function, on the other hand, enables borrowers to obtain necessary funds from lenders without requiring them to directly own real assets. This dual role of the capital market ensures efficient allocation of resources, benefiting both lenders and borrowers in achieving their respective financial goals.

Stock Investment in the Capital Market

The capital market is a platform for buying and selling financial instruments with a maturity period longer than one year, including stocks, bonds, and mutual funds. It serves as an intermediary between those in need of funds and those who have excess capital. The core principle of the capital market is the trading of long-term securities, which can be in the form of debt or equity (ownership capital), as well as various derivative instruments. Securities in the capital market are categorized into several types, one of which is the equity market.

Securities are financial instruments that hold specific value and represent ownership of an asset by an individual or a business entity. In the realm of investment, securities serve as documents of value that signify ownership of either capital or debt, and come in various forms such as stocks, bonds, and deposits. Also referred to as "effects," securities are the primary assets traded in the capital market to generate returns for investors. The buying and selling of securities typically occur through a licensed securities company authorized by the Financial Services Authority, either directly or via intermediaries. Thus, stock investment can be understood as the act of allocating current funds by purchasing securities in the form of shares, with the expectation of earning profits in the future from stock trading on the stock exchange.

IDX LQ45 Low Carbon Leaders Index (IDXLQ45LCL)

A stock index is a statistical tool that measures the overall price movements of a selected group of stocks, chosen according to specific criteria and methodologies, and assessed on a regular basis. Stock indices play a crucial role in the development of the Indonesian Capital Market, serving as an essential benchmark for both market performance and investment products (IDX, 2024). PT. Indonesia Stock Exchange (IDX) continuously strives to innovate by developing and offering various stock indices for the use of capital market participants, either independently or in collaboration with other entities. Currently, IDX provides 46 different stock indices, including notable examples such as IHSG, LQ45, Jakarta Islamic Index (JII), IDX BUMN 20, IDX30, IDXLQ45LCL, and several others.

The IDXLQ45LCL index is designed to reduce the carbon emission intensity of its portfolio by at least 50% compared to the LQ45 index, its benchmark, after adjusting sector weights according to carbon intensity and excluding companies from the coal sector, based on the IDX-IC classification. Established on November 11, 2022, the IDXLQ45LCL Index is calculated using the Adjusted Market Capitalization Weighted method, factoring in the free float ratio and carbon emission intensity. It also applies a stock weighting cap of 15%, which is adjusted during periodic evaluations. The index has been calculated since its base date of November 2, 2020, with an initial value of 100. The IDXLQ45LCL aims to reduce carbon exposure in the portfolio by at least 50% compared to the LQ45 Index, after making adjustments for carbon intensity and excluding coal industry companies. The constituents of the LQ45 Index must also disclose their Scope 1 and Scope 2 greenhouse gas (GHG) emissions data in their Sustainability Reports.

The IDXLQ45LCL Index has selection criteria used to select stocks that will be included in the IDXLQ45LCL index, the following are the selection criteria for the IDXLQ45LCL Index:

1. Issue universal shares that enter the coal industry based on IDX-IC.
2. Adjust the weight in each sector according to carbon intensity.
3. Exclude constituents with the highest carbon intensity value if the Weighted Carbon Intensity Portfolio has not reached a minimum of 50% compared to LQ45 (parent index).

Modern Finance

Modern finance began in the 1950s. The previous era was called the traditional finance era. The development of this era lies in its approach method. The modern finance era uses an analytical technique approach based on statistics and mathematics. The modern approach began with the publication of a seminal article in the Journal of Finance in 1952 by Harry M. Markowitz, a lecturer at the University of Chicago, entitled Portfolio Selection: Efficient Diversification of Investment. His work provides the basis for a statistical approach to calculating the risk and return of a security and portfolio. The modern era was strengthened by the development of a parsimonious model by William Sharpe together with Lintner and Mossin in the 1960s. This model was later known as the Capital Assets Pricing Model, or abbreviated as CAPM. With this model, investors can

easily calculate the expected return of an asset or portfolio. Professor Sharpe developed CAPM based on Markowitz's modern portfolio theory which also uses statistical and mathematical approaches. In the 1970s, Black and Sholes strengthened the modern financial era by publishing an article on calculating the price of stock options. With financial concepts modern, now it will be easier to approach financial problems more accurately and robustly with a quantitative approach.

Portfolio Theory

Portfolio theory is a concept focused on understanding the expected returns of a portfolio and the acceptable level of risk, outlining how to construct an optimal portfolio. This theory is closely linked to capital market theory, which examines how investor decisions impact security prices and illustrates the relationship between returns and risk when investors build a portfolio based on portfolio theory principles. The foundation for portfolio calculations was established by Markowitz in 1952, with further developments in portfolio performance measurement contributed by Treynor (1965), Sharpe (1966), and Jensen (1968). Portfolio theory, developed by Harry Markowitz, highlights the significance of diversification in reducing risk while aiming to maximize returns. By assessing various assets and their risk-return relationships, investors can create a well-balanced portfolio. This theory describes how different combinations of assets can help achieve investment goals, and allows investors to make better decisions in the face of market uncertainty. The following are the differences between Markowitz's (1952) and Treynor's (1965), Sharpe's (1966), Jensen's (1968) portfolio theories:

a. Markowitz method
   Calculating the optimal risk of the smallest risk (minimum variance portfolio) or MVP. The optimal measurement concept used is the smallest risk with the expected return that follows it.
b. Sharpe Ratio Method
   This method calculates the optimal portfolio by optimizing the angle of the excess return ratio and the standard deviation risk of the portfolio. The optimal measurement concept used is the best combination of the highest excess return with the smallest risk.
c. Single Index Model Method
   The Single Index Model method calculates the optimal portfolio by optimizing the angle of the excess return ratio and portfolio risk measured by the Single Index Model. The optimal measurement concept used is the best combination of the highest excess return with the smallest risk.

Single Index Model

The Single Index Model, introduced by William Sharpe in the early 1960s, was developed to simplify risk analysis in investment. Sharpe's concept aimed to demonstrate how the returns of individual securities could be predicted based on the broader market's returns. By focusing on the relationship between security returns and market returns, this model streamlines systematic risk evaluation, enabling investors to make better-informed decisions. Over time, the Single Index Model has become a widely adopted tool among investors and analysts for assessing security performance and constructing optimal portfolios.

From various expert perspectives, the Single Index Model assumes that stock return movements are closely linked to market index movements. This analysis compares the excess return to beta (ERB) with a predefined cut-off point (Ci). ERB represents the additional return generated per unit of non-diversifiable risk, as measured by beta. The cut-off points act as a threshold to identify stocks with the highest ERB values, which are then considered as portfolio candidates.

Markowitz Model

The Markowitz method, also known as Modern Portfolio Theory, was developed by Harry Markowitz in the early 1950s. Markowitz introduced an analytical approach to optimizing investment portfolios by minimizing risk and maximizing returns. Markowitz published an article titled "Portfolio Selection" in 1952 in the Journal of Finance. In the article, Markowitz argued that investors should not only consider the return on an investment, but also the risk involved in that investment. Markowitz introduced the concept of the "efficient frontier" which is a graph that shows the optimal combination of portfolios that provide high returns for a given level of risk. Markowitz's theory became the basis for much subsequent financial research and theory. The Markowitz method will remain one of the cornerstones of modern investment theory and is used by portfolio managers around the world to make better investment decisions.

Determining an Efficient Portfolio Quantitatively

The depiction of efficient sets in general can be done as explained previously. However, the depiction of efficient sets, especially for n assets that are based quantitatively, needs to be determined, especially if this efficient set will be drawn by computer, for example using Excel. To be able to draw an efficient set of many assets in Excel, the formula for the relationship between expected return and portfolio risk needs to be known. For example, there are n risky assets, where wi is the proportion of the i-th asset that forms a portfolio. For n assets in a portfolio, then $\sum_{i=1}^{n} wi = 1$ which means the total of all proportions is 100% or 1 part and the expected return of each asset in the portfolio. The following steps can be taken to create an efficient portfolio, as follows:

1. The amount of return obtained.
2. Calculating expected return.
3. Calculating the level of variance and standard deviation of each stock.
4. Determination of shares for portfolio formation.
5. Calculating the correlation coefficient.

6. Determine the weight of each share, by using random numbers to produce a diverse combination of share portfolios.
7. Calculating the expected return on the portfolio.
8. Calculating portfolio risk.

Research Model

Based on the theoretical study and previous research findings related to the creation of an optimal portfolio, a research model was developed for each share.

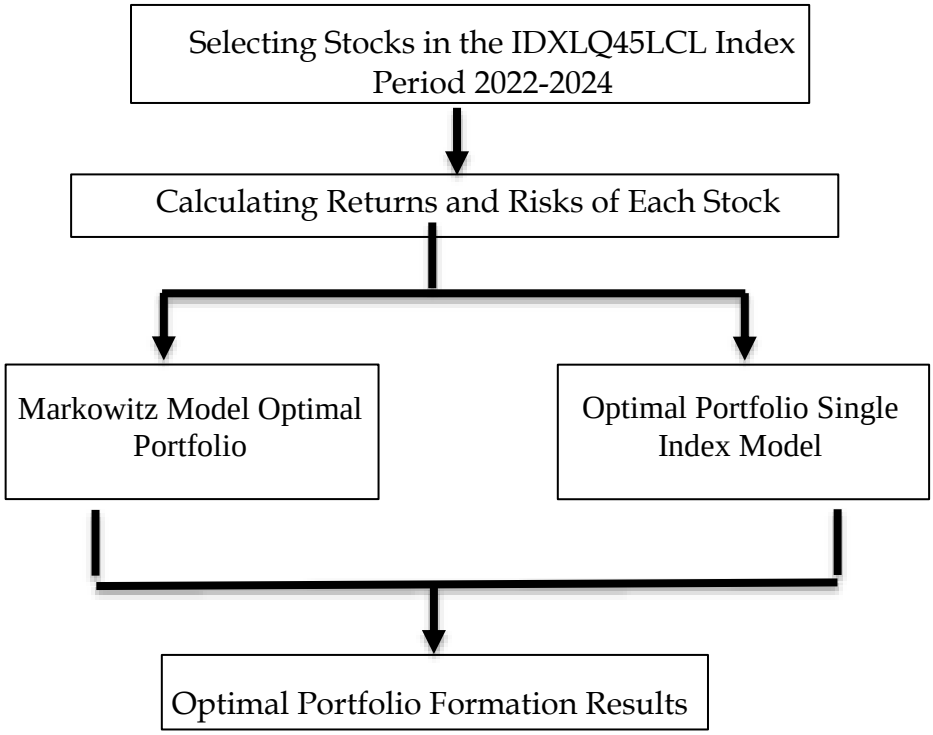

Figure 1. Research Model

METHODOLOGY

Research Design

Research is a systematic process of collecting, analyzing, and interpreting data to answer questions, solve problems, or develop knowledge. It employs scientific methods such as observation, experimentation, or case studies tailored to specific objectives. According to Sugiyono, research aims to discover, develop, and validate theories, while Creswell highlights it as an organized process for data collection and analysis to address inquiries. Essentially, research involves structured data analysis to produce informed conclusions. A well-designed research plan minimizes bias and ensures clarity and focus. This study uses a descriptive quantitative approach to analyze investment decisions based on optimal portfolio compositions derived from the Markowitz and Single Index Models, focusing on the IDXLQ45LCL stock index for the 2022–2024 period.

Quantitative research, characterized by numerical data analysis, emphasizes objectivity and provides measurable insights (Syahrizal and Jailani 2023). It complements applied research, which applies tested theories to solve practical problems, creating a synergy that bridges theoretical and real-world applications.

The integration of these two approaches yields evidence-based solutions to challenges faced by society and investors. Applied research emphasizes using findings from fundamental research to address specific issues, often prioritizing practical applications. This type of research typically targets real-world problems, providing actionable insights. Meanwhile, quantitative research offers a robust methodological and analytical framework to test and apply theories effectively in practical contexts. The interplay between foundational and applied research ensures the development of efficient and evidence-backed solutions for societal challenges. The rationale behind employing a descriptive quantitative applied research design is detailed as follows:

1. The results of this study can be used to solve problems related to predicting the formation of an optimal stock portfolio on the IDXLQ45LCL index.
2. To overcome the problem of forming an optimal stock portfolio for companies included in the IDXLQ45LCL index, this study will analyze and determine which stocks can form an optimal portfolio using the Markowitz Model and the Single Index Model.

Method of Collecting Data

The data collection method used in this study uses the documentation method. The documentation method is a data collection technique that is not directly submitted to the research subject, but rather to certain documents (Echdar, 2017). In the process of collecting data to conduct research sourced from published historical documents, namely data on the closing price of shares of companies listed and consistently included in the IDXLQ45LCL index for the 2022-2024 period published by the Indonesia Stock Exchange, interest rates from Bank Indonesia reports (SBI), and the Composite Stock Price Index.

Population and Sample

The population in this study consists of companies included in the IDXLQ45LCL index and listed on the Indonesia Stock Exchange during the 2022-2024 period. To conduct the analysis, a sample is selected, which represents a subset of individuals or objects from the larger population. This approach allows researchers to make generalizations about the population's characteristics without examining every member. In this study, the purposive sampling technique is employed, a method that involves selecting samples based on specific characteristics aligned with the research objectives (Echdar, 2017).

The criteria for determining the sample in this study are outlined as follows:

1. Companies in the IDXLQ45LCL Index are listed on the Indonesia Stock Exchange and are included in the IDXLQ45LCL Index continuously during the 2022-2024 period.
2. The companies on IDXLQ45LCL issued stock prices and were still operating during the research period in the 2022-2024 period.
3. Companies in IDXLQ45LCL that published annual financial reports and other supporting data available during the 2022-2024 research period.

Data Analysis Method

Markowitz Model

Optimal portfolio calculation using the Markowitz Model with the help of the Solver program in Excel. Solver is a tool to help find the optimal stock weight for determining the optimal portfolio. The following are the steps that will be taken to form an optimal portfolio using the Markowitz Model.

1. Calculating the return of each share using the formula (Hartono, 2019)

$$Ri = \frac{(Pt - Pt - 1) + Dt}{Pt - 1}$$

2. Calculate the expected monthly stock return for each stock using the formula (Hartono, 2019)

$$E(Ri) = \frac{\sum_{t-1}^{n} Rit}{n}$$

3. Calculate the variance and standard deviation of each stock using the formula (Hartono, 2019)

$$SD = \frac{\sum_{t-1}^{n} [Rit - E(Ri)]^2}{n}$$

4. Calculating the coefficient of variation value

$$Cvi = \frac{Risk}{Expected\ Return}$$

5. Calculating the covariance between sample company shares using the formula (Hartono, 2019)

$$\sigma ij = \frac{\sum[(Rit - E(Rit)).(Rjt - E(Ri))]}{n}$$

6. Calculating the correlation between sample company stocks with the formula.

$$\rho AB = \frac{Cov(Ra.Rb)}{\sigma A.\sigma B}$$

7. Determining the proportion of funds from candidate portfolio stocks

$$\sigma p^2 = \sum_{i=1}^{n}\sum_{i=1}^{n} Wi.Wj.\sigma ij$$

8. Determining return and risk with the help of Excel Solver in Ms. Excel with the help of this application, the sample weight can be known to form an optimal portfolio.

Single Index Model

1. Calculate the return and expected return of each stock.

$$Ri = \frac{pt - pt - 1 + Dt}{Pt - 1}$$

2. Calculate returns and expected market returns

$$Rmt = \frac{IHSGt - IHSGt - 1}{IHSG - 1}$$

3. Calculating the variance and standard deviation of stocks and markets (IHSG).

$$\sigma i^2 = \frac{\sum_{i=1}^{n}\left(Rit - E(Ri)\right)^2}{n - 1}$$

4. Calculating the alpha and beta of each stock

$$\beta i = \frac{\sigma Ri\ Rm}{\sigma^2 m}$$

5. Calculate the variance of the residual errors.

$$\sigma ei^2 = \sigma i^2 - (\beta i^2 x \sigma m^2)$$

6. Calculate the Excess Return to Beta (ERB) of each stock.

$$ERBi = \frac{E(Ri) - RBR}{\beta i}$$

7. Calculating the Cut-off rate (C_i)

$$Ai = \frac{[E(Ri) - RBR]\beta i}{\sigma ei}$$

$$Bi = \frac{\beta i^2}{\sigma ei}$$

8. Determining the Cut-off Point (C*)
   The cut-off point value is the largest Ci value.
9. Determining optimal portfolio candidates
   The optimal portfolio is determined by the criteria if the stock ERB > C*.
10. Calculate the proportion of each stock in the portfolio.
    Calculating the proportion of funds is done after the portfolio is formed, and is calculated using the formula:

$$Wi = \frac{Zi}{\sum_{j=1}^{k} Zj}$$

RESEARCH RESULT

Markowitz Model Stock Portfolio Formation

An optimal portfolio consists of a selection of assets designed to achieve expected returns while maintaining a risk acceptable to investors. The Markowitz approach employs a quantitative method to construct efficient portfolios, linking risk—represented by the standard deviation or variance—to expected returns, typically referred to as the mean. Consequently, this approach is widely recognized as the mean-variance method (Hartono, 2019).

Hartono, (2019) stated that the Markowitz Model is the formation of an optimal portfolio by considering the risk with its expected return. Therefore, the optimal portfolio should not be calculated from the sum of the risks in the portfolio, but it is also necessary to consider the asset return in the risk estimation. In addition to calculating the expected return results, variance and standard deviation of each stock, 7 (seven) stocks were selected with a positive expected return value and 10 (ten) stocks with a negative expected return value. Stocks with a negative expected return value cannot be included in the calculation of the formation of the optimal portfolio. Because there is a possibility that the stock is not profitable or experiences losses, so investors temporarily do not choose stocks with negative expected return values. The 7 (seven) stocks with positive expected return values include BBNI, BBRI, BMRI, JSMR, ICBP, PGAS.

Table 1. Optimal Portfolio Proportion

ASSETS	PROPORTION
BBCA	40%
BBNI	0%
BMRI	37%
BBRI	0%
JSMR	10%
ICBP	13%
PGAS	0%
TOTAL	100%

Source: Secondary Data Processed, 2024

Based on table 1 above, it is known that the optimal portfolio calculation using Microsoft Excel solver can create stock proportions with the following proportions: BBCA of 40%, BMRI of 37%, JSMR of 10%, and ICBP of 13% with a total of 100%.

Formation of a Single Index Model Stock Portfolio

The Single Index Model assumes that securities will be correlated if they have the same response to market returns, meaning that securities tend to move in the same direction if they have the same relationship with market returns. If the return increases, most stocks will also increase, and vice versa. The Single Index Model is used to form an optimal portfolio containing assets that have high ERB values, with the help of a cut-off point. ERB is used to determine the limits of the ERB value. Excess Return Beta (ERB) is the difference between the expected return and the risk-free asset return, which is called the return premium per unit of risk, measured by beta. The Cut-off Point (C*) is the largest value of the Cut Off Rate (Ci). The Cut Off Rate (Ci) itself is the result of market variance and return premium against stock variance error. The market variance used is the sensitivity of individual stocks to stock variance error. After knowing the results of the expected return, variance, and standard deviation of each stock. 7 (seven) stocks were selected with positive expected returns and 10 (ten) stocks with negative expected returns. Stocks that have negative expected returns cannot be included in the calculation, because it is possible that these stocks do not provide returns.

Table 2. Stock Candidates for Forming an Optimal Portfolio

No	Stock Code	ERB	Ci	C*	DECISION
1	BMRI	0,0396	0,000209	0,000431	Optimal
2	BBCA	0,0095	0,000324	0,000431	Optimal
3	JSMR	0,0088	0,000387	0,000431	Optimal
4	BBNI	0,0068	0,000404	0,000431	Optimal
5	BBRI	0,0018	**0,000431**	0,000431	Optimal
6	PGAS	0,0001	0,000400	0,000431	Not Optimal
7	ICBP	-0,0065	0,000383	0,000431	Not Optimal

Source: Secondary Data Processed, 2024

Based on table 2 above, it can be explained that the stocks included in the optimal portfolio are BMRI, BBCA, JSMR, BBNI, and BBRI. This is because the 5 (five) stocks have an ERB value > ERB value at point C*.

DISCUSSION

Based on the results of data processing for portfolio formation using the Markowitz Model and the Single Index Model, the results of portfolio formation from the two models can be seen in table 3 below:

Table 3. Portfolio Formation Results

No	Description	Markowitz Model	Single Index Model
1	Optimal Portfolio and Proportion	BBCA (40%), BMRI (37%), JSMR (10%), and ICBP (13%)	BMRI (30,80%), BBCA (41,43%), JSMR (8,14%), BBNI (16,33%), and BBRI (3,30%)
2	Expected Return Portfolio	0,218%	0,0158%
3	Portfolio risk	2%	0,0008%
4	Coefficient of Variation	917,43%	5,06%

Source: Secondary Data Processed, 2024

Referring to Table 3, the comparison of optimal portfolios formed using the Markowitz Model and the Single Index Model during the 2022-2024 period reveals that the Markowitz Model outperforms the Single Index Model in terms of returns and risks. The Markowitz Model achieves a return of 0.218% with a risk level of 2%, while the Single Index Model generates a return of 0.0158% with a risk of 0.0008%. These findings support the theory that returns and risk move in the same direction higher returns are accompanied by higher risks. The construction of an optimal stock portfolio within the IDXLQ45LCL index for the 2022-2024 period using the Markowitz Model results in a portfolio comprising four stocks: BBCA (40%), BMRI (37%), JSMR (10%), and ICBP (13%). In contrast, employing the Single Index Model for the same index and period yields a portfolio consisting of five stocks: BMRI (30.80%), BBCA (41.43%), JSMR (8.14%), BBNI (16.33%), and BBRI (3.30%).

The coefficient of variation (CV) measures relative risk by comparing risk to expected return, with a smaller CV indicating better portfolio performance. A CV < 1 suggests low risk relative to return, while CV > 1 indicates high risk. Using the Markowitz Model, the CV is 917.43%, significantly higher than the Single Index Model's CV of 5.06%. This indicates that the Single Index Model carries less relative risk compared to the Markowitz Model. Investors require portfolio simulations with sample capital to evaluate optimal portfolio growth from both models. This simulation uses the composition of each model with an initial capital of IDR 1,000,000,000, resulting in the average portfolio growth over the research period. The portfolio with the highest average growth is categorized as optimal. Portfolio growth calculations are presented in Tables 4 and 5.

Table 4. Markowitz Model Optimal Portfolio Growth

Share Proportion	Period		
	2022	2023	2024
BBCA (40%)	Rp 400,000,000	Rp 390,909,091	Rp 473,863,636
BMRI (37%)	Rp 370,000,000	Rp 402,019,231	Rp 473,173,077
JSMR (10%)	Rp 100,000,000	Rp 122,647,059	Rp 140,588,235
ICBP (13%)	Rp 130,000,000	Rp 141,973,684	Rp 165,578,947
Capital	Rp 1,000,000,000	Rp 1,057,549,065	Rp 1,253,203,896
Growth		6%	19%
Average Growth	12%		

Source: Secondary Data Processed, 2024

Table 5. Optimal Portfolio Growth Single Index Model

Share Proportion	Period		
	2022	2023	2024
BMRI (30,80%)	Rp 308,000,000	Rp 334,653,846	Rp 393,884,615
BBCA (41,43%)	Rp 414,300,000	Rp 404,884,091	Rp 490,804,261
JSMR (8,14%)	Rp 81,400,000	Rp 99,834,706	Rp 114,438,824
BBNI (16,33%)	Rp 163,300,000	Rp 167,469,362	Rp 180,672,340
BBRI (3,30%)	Rp 33,000,000	Rp 34,650,000	Rp 33,717,391
Capital	Rp 1,000,000,000	Rp 1,041,492,005	Rp 1,213,517,432
Growth		4%	17%
Average Growth	10%		

Source: Secondary Data Processed, 2024

CONCLUSIONS AND RECOMMENDATIONS

Based on table 4 and table 5, it shows that the average portfolio growth results of the Markowitz Model are better than the Single Index Model. By simulating and assuming capital in each proportion, namely Rp1,000,000,000, it produces an average portfolio growth of 12% for the Markowitz Model. While for the Single Index Model, it has an average portfolio growth of 10%, the difference between the Single Index Model and the Markowitz Model is 2%. If based on portfolio growth with the same capital, the Markowitz Model produces a more optimal portfolio than using the Single Index Model. With a high portfolio growth value, the level of profit obtained by investors will also be higher.

The conclusion of the discussion of the results of the two optimal portfolio formation models, namely the Markowitz Model is better in terms of growth, with a growth of 12%. Viewed from the coefficient of variation of the two models, the Markowitz Model has a coefficient of variation of 917.43%, while the Single Index Model has a coefficient of 5.06%, the coefficient of variation of the Single Index Model is lower than the Markowitz Model, which means that the risk borne by investors with the Single Index Model is smaller than the Markowitz Model. In terms of optimal portfolio growth, using the Markowitz Model is more optimal because the growth results are greater in proportion to the higher coefficient of variation due to the suitability with the actual situation. With asset allocation only placed on instruments in the form of stocks, it has a high-risk profile and

high returns. The choice of model as a recommendation for investment decisions is in accordance with investor preferences in dealing with the risks and returns received.

ADVANCED RESEARCH

As explained in the results of this study, this study has limitations that can be caused by the following factors:

1. The IDXLQ45LCL index list changes every 6 (six) months, so it is necessary to find out which companies have survived during the research period and are included in the index.
2. This study only compares the performance of two optimal portfolio formation models, namely the Markowitz Model and the Single Index Model.
3. The use of the Markowitz Model and the Single Index Model does not take into account the transaction costs borne by investors when making investments.

Based on the limitations of this research, here are 3 (three) further research agendas that can be carried out:

1. Further research can evaluate the optimal portfolio every 6 (six) months.
2. Further studies can expand the scope of research by comparing other optimal portfolio formation models such as the Capital Asset Pricing Model (CAPM), Arbitrage Pricing Theory (APT), or the Black-Litterman Model, in order to provide alternative investment strategies for investors.
3. Further research can integrate transaction cost analysis into the formation of optimal portfolios, including broker commission costs, taxes, and bid-ask spreads, to provide a more realistic picture of the actual returns that investors can obtain after taking into account all related costs.

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