INTERNATIONAL JOURNAL OF APPLICATION ON ECONOMICS AND BUSINESS

IJAEB

Graduate Program of Universitas Tarumanagara

Address:
Graduate Program of Universitas Tarumanagara
Universitas Tarumanagara
Kampus 1, Jl. Letjen S. Parman No. 1
Jakarta 11440, Indonesia

ISSN 2987-1972

INTERNATIONAL JOURNAL OF APPLICATION ON ECONOMICS AND BUSINESS

IJAEB

VOL. 4 NO. 2
MAY 2026

INTERNATIONAL JOURNAL OF APPLICATION ON ECONOMICS AND BUSINESS
IJAEB E-ISSN 2987-1972
UNTAR Universitas Tarumanagara

Editorial Team

Editor in Chief

Executive Editor

Managing Editor

Section Editor

TOOLS

use APA style, download here

(https://csl.mendeley.com/styleInfo/?styleId=http%3A%2F%2Fwww.zotero.org%2Fstyles%2Fapa)

Template

(https://docs.google.com/document/d/1b14ZM9LhreVEtxDg2HL4BRiXJLwnku2s/edit?usp=sharing&ouid=113036177340782085542&rtpof=true&sd=true)

PROFILE MENU

- Contact
- Editorial Team (/index.php/ijaeb/about/editorialTeam)
- Focus and Scope (/index.php/ijaeb/about#focusAndScope)
- Indexing (https://journal.untar.ac.id/index.php/ijaeb/indexing)

(https://statcounter.com/p12907097/summary/)

View My Stats (https://statcounter.com/p12844469/?guest=1)

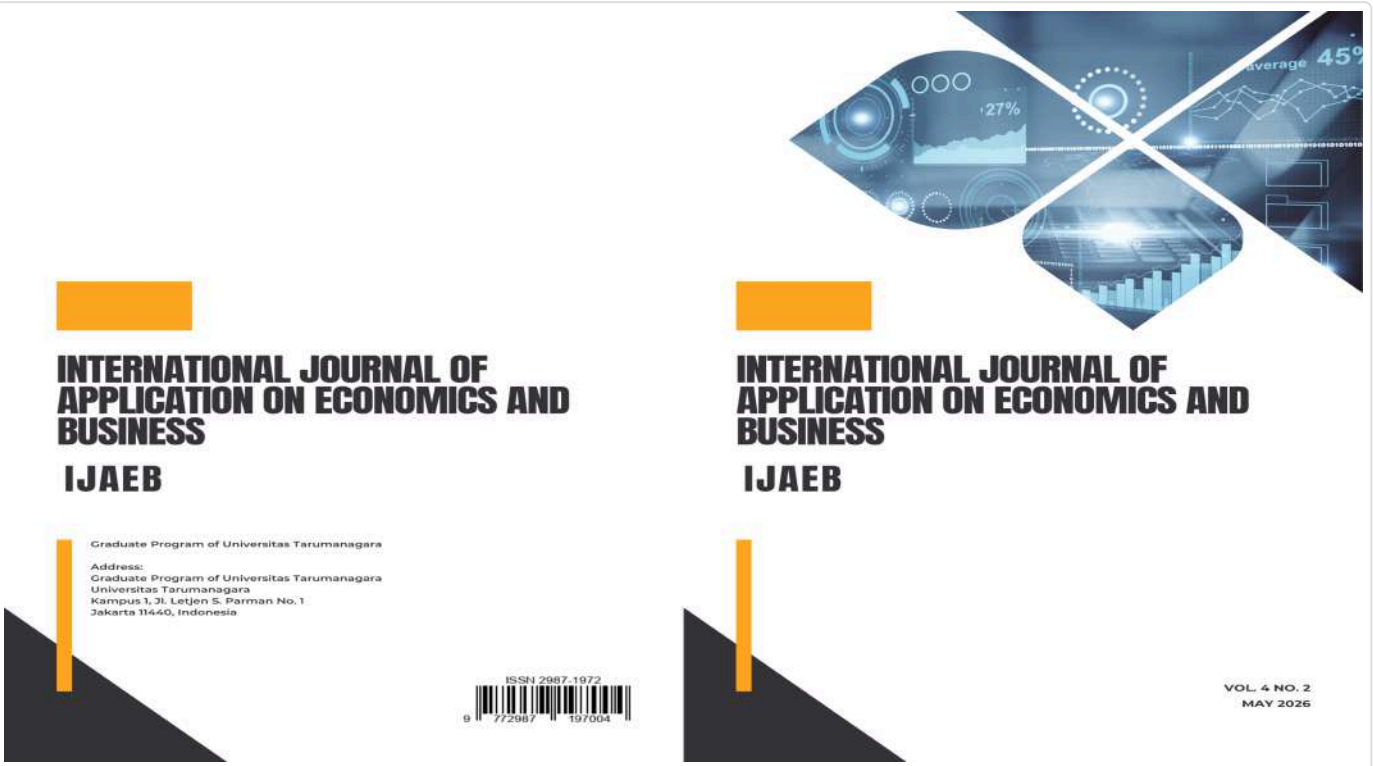
ISSN

(https://issn.brin.go.id/terbit/detail/20230426411707807)

ISSN PUSAT NASIONAL ISSN INDONESIA (https://issn.brin.go.id/terbit/detail/20230426411707807)

(https://journal.untar.ac.id/index.php/ijaeb/about/aboutThisPublishingSystem)

INTERNATIONAL JOURNAL OF APPLICATION ON ECONOMICS AND BUSINESS
IJAEB E-ISSN 2987-1972
UNTAR Universitas Tarumanagara



(https://journal.untar.ac.id/index.php/ijaeb/issue/view/1000)

Published: 2026-05-29

Articles

https://doi.org/10.24912/ijaeb.v4i2.349-360%20 (https://doi.org/10.24912/ijaeb.v4i2.349-360%20)

PDF (https://journal.untar.ac.id/index.php/ijaeb/article/view/37953/23253)

FACTORS AFFECTING AUDIT QUALITY (https://journal.untar.ac.id/index.php/ijaeb/article/view/37954)

Selviana Ayu Wulandari, Andreas Bambang Daryatno

https://doi.org/10.24912/ijaeb.v4i2.361-369%20 (https://doi.org/10.24912/ijaeb.v4i2.361-369%20)

PDF (https://journal.untar.ac.id/index.php/ijaeb/article/view/37954/23254)

THE IMPACT OF GENERATIVE AI–INTEGRATED TEACHING ON UNIVERSITY STUDENTS' KEY COMPETENCIES (https://journal.untar.ac.id/index.php/ijaeb/article/view/37955)

Min Hui Lee, Linda Lin Chin Lin

https://doi.org/10.24912/ijaeb.v4i2.370-376%20 (https://doi.org/10.24912/ijaeb.v4i2.370-376%20)

PDF (https://journal.untar.ac.id/index.php/ijaeb/article/view/37955/23255)

THE EFFECT OF ATTITUDE, SUBJECTIVE NORMS, AND SELF- EFFICACY ON ENTREPRENEURIAL INTEREST WITH ENTREPRENEURSHIP EDUCATION AS A MODERATION IN STUDENTS AT TARUMANAGARA UNIVERSITY (https://journal.untar.ac.id/index.php/ijaeb/article/view/37956)

Kent Darren, Andi Wijaya

https://doi.org/10.24912/ijaeb.v4i2.377-386%20 (https://doi.org/10.24912/ijaeb.v4i2.377-386%20)

PDF (https://journal.untar.ac.id/index.php/ijaeb/article/view/37956/23256)

THE INFLUENCE OF NCT DREAM AS A BRAND AMBASSADOR AND E-WOM ON PURCHASE INTENTION OF TOSTOS PRODUCTS IN DKI JAKARTA THROUGH BRAND IMAGE (https://journal.untar.ac.id/index.php/ijaeb/article/view/37957)

Roslyn Brenda Haslimin, Galuh Mira Saktiana

https://doi.org/10.24912/ijaeb.v4i2.387-396%20 (https://doi.org/10.24912/ijaeb.v4i2.387-396%20)

PDF (https://journal.untar.ac.id/index.php/ijaeb/article/view/37957/23257)

THE EFFECT OF CAPITAL STRUCTURE, FIRM SIZE, GROWTH AND INVESTMENT OPPORTUNITY SET ON EARNINGS QUALITY (https://journal.untar.ac.id/index.php/ijaeb/article/view/37958)

Harris Wibowo, Sufiyati Sufiyati

397-406

https://doi.org/10.24912/ijaeb.v4i2.397-406%20 (https://doi.org/10.24912/ijaeb.v4i2.397-406%20)

PDF (https://journal.untar.ac.id/index.php/ijaeb/article/view/37958/23258)

DETERMINANTS OF CAPITAL STRUCTURE IN CONSUMER NON-CYCLICALS COMPANIES LISTED ON IDX FOR 2021-2024 (https://journal.untar.ac.id/index.php/ijaeb/article/view/37959)

Davin Edrick, Merry Susanti
407-419

https://doi.org/10.24912/ijaeb.v4i2.407-419%20 (https://doi.org/10.24912/ijaeb.v4i2.407-419%20)

PDF (https://journal.untar.ac.id/index.php/ijaeb/article/view/37959/23259)

CHARACTERISTICS OF AUDIT COMMITTEES AND SUSTAINABILITY REPORTING (https://journal.untar.ac.id/index.php/ijaeb/article/view/37960)

Rosmita Rasyid, Sparta, Billy Billy
420-432

https://doi.org/10.24912/ijaeb.v4i2.420-432%20 (https://doi.org/10.24912/ijaeb.v4i2.420-432%20)

PDF (https://journal.untar.ac.id/index.php/ijaeb/article/view/37960/23260)

THE EFFECT OF BRAND IMAGE, EWOM, PRODUCT QUALITY, AND PRICE ON PURCHASE INTENTION OPPO SMARTPHONE IN JAKARTA (https://journal.untar.ac.id/index.php/ijaeb/article/view/37961)

Pramudya Gusti Kelana, Galuh Mira Saktiana
433-440

https://doi.org/10.24912/ijaeb.v4i2.433-440%20 (https://doi.org/10.24912/ijaeb.v4i2.433-440%20)

PDF (https://journal.untar.ac.id/index.php/ijaeb/article/view/37961/23261)

THE IMPACT OF ESG DISCLOSURE, LEVERAGE, AND FIRM SIZE ON THE COMPANIES' FINANCIAL PERFORMANCE (https://journal.untar.ac.id/index.php/ijaeb/article/view/37962)

Michelle Gracella, Yanti Yanti
441-453

https://doi.org/10.24912/ijaeb.v4i2.441-453%20 (https://doi.org/10.24912/ijaeb.v4i2.441-453%20)

PDF (https://journal.untar.ac.id/index.php/ijaeb/article/view/37962/23262)

STRENGTHENING REPURCHASE INTENTION THROUGH PERCEIVED VALUE: EMPIRICAL EVIDENCE FROM JAKARTA'S ORGANIC FOOD CONSUMERS (https://journal.untar.ac.id/index.php/ijaeb/article/view/37969)

Cindy Carysta, Tommy Setiawan Ruslim

504-515

https://doi.org/10.24912/ijaeb.v4i2.504-515%20 (https://doi.org/10.24912/ijaeb.v4i2.504-515%20)

PDF (https://journal.untar.ac.id/index.php/ijaeb/article/view/37969/23269)

FACTORS INFLUENCING REVISIT INTENTION IN AQUARIUM ATTRACTION: THE MEDIATING ROLE OF TOURIST SATISFACTION (https://journal.untar.ac.id/index.php/ijaeb/article/view/37970)

Vannie Setiady, Miharni Tjokrosaputro

516-526

https://doi.org/10.24912/ijaeb.v4i2.516-526%20 (https://doi.org/10.24912/ijaeb.v4i2.516-526%20)

PDF (https://journal.untar.ac.id/index.php/ijaeb/article/view/37970/23270)

FACTORS EFFECTING GENERATION Z' FINANCIAL WELL-BEING IN EAST KALIMANTAN (https://journal.untar.ac.id/index.php/ijaeb/article/view/37971)

Angelina Pilipus, Joyce A. Turangan

527-533

https://doi.org/10.24912/ijaeb.v4i2.527-533%20 (https://doi.org/10.24912/ijaeb.v4i2.527-533%20)

PDF (https://journal.untar.ac.id/index.php/ijaeb/article/view/37971/23271)

DETERMINING FINANCIAL PERFORMANCE: THE EFFECT OF GREEN INTELLECTUAL CAPITAL AND COMPANY SIZE (https://journal.untar.ac.id/index.php/ijaeb/article/view/37972)

Go Cecilia Claudia Pratama, Rini Tri Hastuti

534-544

https://doi.org/10.24912/ijaeb.v4i2.534-544 (https://doi.org/10.24912/ijaeb.v4i2.534-544)

PDF (https://journal.untar.ac.id/index.php/ijaeb/article/view/37972/23272)

COGNITIVE FACTORS OF RECOMMENDATION SYSTEMS AND THEIR INFLUENCE IN BUILDING TRUST TO DRIVE CONSUMER PURCHASE INTENTION: A SYSTEMATIC LITERATURE REVIEW (https://journal.untar.ac.id/index.php/ijaeb/article/view/38077)

Desi Arisandi, Dyah Erny Herwindiati, Cokki Cokki

545-555

https://doi.org/10.24912/ijaeb.v4i2.545-555 (https://doi.org/10.24912/ijaeb.v4i2.545-555)

PDF (https://journal.untar.ac.id/index.php/ijaeb/article/view/38077/23361)

DETERMINANTS GREEN MARKETING AND CSR ON GREEN PURCHASE INTENTION THROUGH GREEN BRAND IMAGE AT FORE COFFEE JABODETABEK REGION (https://journal.untar.ac.id/index.php/ijaeb/article/view/38225)

Kayla Lyzandra, Elkunny Dovir Siratan

556-568

https://doi.org/10.24912/ijaeb.v4i2.556-568%20 (https://doi.org/10.24912/ijaeb.v4i2.556-568%20)

Abstract : 26 | PDF : 8

PDF (https://journal.untar.ac.id/index.php/ijaeb/article/view/38225/23460)

DRIVING THE PROPENSITY FOR GREEN ENTREPRENEURSHIP (https://journal.untar.ac.id/index.php/ijaeb/article/view/38226)

Kartika Nuringsih, Nuryasman MN, Harry Kristanto

569-580

https://doi.org/10.24912/ijaeb.v4i2.569-580%20 (https://doi.org/10.24912/ijaeb.v4i2.569-580%20)

Abstract : 16 | PDF : 4

PDF (https://journal.untar.ac.id/index.php/ijaeb/article/view/38226/23461)

THE INFLUENCE OF CHATBOT QUALITY ON SATISFACTION USE CHATBOT: THE ROLES OF EASE AND USEFULNESS (https://journal.untar.ac.id/index.php/ijaeb/article/view/38227)

Catherine Christiana Tjandra, Haris Maupa, Cokki Cokki

581-594

Abstract : 9 | PDF : 11

PDF (https://journal.untar.ac.id/index.php/ijaeb/article/view/38227/23462)

THE EFFECT OF ACTIVITY, PROFITABILITY, LIQUIDITY, AND SALES GROWTH ON THE FINANCIAL DISTRESS OF PROPERTY AND REAL ESTATE COMPANIES (https://journal.untar.ac.id/index.php/ijaeb/article/view/38228)

Herni Kurniawati, Sriwati Sriwati , Verawati Verawati

595-607

https://doi.org/10.24912/ijaeb.v4i2.595-607%20 (https://doi.org/10.24912/ijaeb.v4i2.595-607%20)

Abstract : 20 | PDF : 3

PDF (https://journal.untar.ac.id/index.php/ijaeb/article/view/38228/23463)

A STUDY ON THE RELATIONSHIPS AMONG BRAND IMAGE, SERVICE INNOVATION, WORD OF MOUTH, AND PURCHASE INTENTION: THE CASE OF ALIGN UNMANNED AERIAL VEHICLES (https://journal.untar.ac.id/index.php/ijaeb/article/view/38229)

Linda Lin-Chin Lin, Tai-Wei Huang, Fu-Tang Chen, Yu-Hui Cheng

608-620

https://doi.org/10.24912/ijaeb.v4i2.608-620%20 (https://doi.org/10.24912/ijaeb.v4i2.608-620%20)

Abstract : 21 | PDF : 8

PDF (https://journal.untar.ac.id/index.php/ijaeb/article/view/38229/23464)

GOVERNANCE IMPACTS OF NATIONAL PARK POLICIES ON TRADITIONAL SETTLEMENT DEVELOPMENT: A CASE STUDY OF QIONGLIN VILLAGE, KINMEN, TAIWAN (https://journal.untar.ac.id/index.php/ijaeb/article/view/38230)

Yu-Ting Hung, Kan-Chung Huang , Yao-Lin Chang

621-631

https://doi.org/10.24912/ijaeb.v4i2.621-631%20 (https://doi.org/10.24912/ijaeb.v4i2.621-631%20)

PDF (https://journal.untar.ac.id/index.php/ijaeb/article/view/38230/23465)

TRANSFORMING BUSINESS MODELS: INNOVATIONS FROM AGRICULTURE TO AQUACULTURE (https://journal.untar.ac.id/index.php/ijaeb/article/view/38231)

Jia-Ru Lin, Te-Tsai Lu

632-637

https://doi.org/10.24912/ijaeb.v4i2.632-637%20 (https://doi.org/10.24912/ijaeb.v4i2.632-637%20)

PDF (https://journal.untar.ac.id/index.php/ijaeb/article/view/38231/23466)

A CASE STUDY OF TRADITIONAL MANUFACTURING INDUSTRY TRANSFORMATION TO TECHNICAL SERVICES INDUSTRY (https://journal.untar.ac.id/index.php/ijaeb/article/view/38232)

Liang-Te Chiang, Chin-Chiuan Lin, Te-Tsai Lu

638-647

https://doi.org/10.24912/ijaeb.v4i2.638-647%20 (https://doi.org/10.24912/ijaeb.v4i2.638-647%20)

PDF (https://journal.untar.ac.id/index.php/ijaeb/article/view/38232/23467)

A PRELIMINARY EXPLORATION of BLUE ECONOMY DEVELOPMENT and GOVERNANCE MODELS in TAIWAN'S OFFSHOR ISLANDS (https://journal.untar.ac.id/index.php/ijaeb/article/view/38233)

Kan-Chung Huang , Yu-Ting Hung, Chao-Li Tai , Ching-Yun Lee

648-659

https://doi.org/10.24912/ijaeb.v4i2.648-659%20 (https://doi.org/10.24912/ijaeb.v4i2.648-659%20)

PDF (https://journal.untar.ac.id/index.php/ijaeb/article/view/38233/23468)

Template

(https://docs.google.com/document/d/1b14ZM9LhreVEtxDg2HL4BRiXJLwnku2s/edit?usp=sharing&ouid=113036177340782085542&rtpof=true&sd=true)

PROFILE MENU

- Contact
- Editorial Team (/index.php/ijaeb/about/editorialTeam)
- Focus and Scope (/index.php/ijaeb/about#focusAndScope)
- Indexing (https://journal.untar.ac.id/index.php/ijaeb/indexing)

(https://statcounter.com/p12907097/summary/)

View My Stats (https://statcounter.com/p12844469/?guest=1)

ISSN

(https://issn.brin.go.id/terbit/detail/20230426411707807)

ISSN PUSAT NASIONAL ISSN INDONESIA (https://issn.brin.go.id/terbit/detail/20230426411707807)

(https://journal.untar.ac.id/index.php/ijaeb/about/aboutThisPublishingSystem)

International Journal of Application on Economics and Business (IJAEB)
Volume 4, Issue 2, 2026. ISSN: 2987-1972

ASSESSING PORTFOLIO EFFICIENCY THROUGH RISK-ADJUSTED MEASURES: A COMPARATIVE ANALYSIS OF MARKOWITZ AND SINGLE INDEX MODELS

Steven Imanuel[1*], Rousilita Suhendah[2]

[1] Faculty of Economics & Business, Universitas Tarumanagara, Jakarta, Indonesia*
Email: steven.125220003@stu.untar.ac.id
[2] Faculty of Economics & Business, Universitas Tarumanagara, Jakarta, Indonesia
Email: rousilitas@fe.untar.ac.id

*Corresponding Author

Submitted: 12-03-2026, Revised: 27-03-2026, Accepted: 17-04-2026

ABSTRACT

This study is conducted to evaluate and compare the effectiveness of portfolios formed using the markowitz model along with the single index model based on return, risk, and investment performance evaluation ratios. The research method uses data from IDX80 companies. The results show that the portfolio formed using the markowitz model yield a return of 0.06% in one day, accompanied by a risk level of 0.007%, while the single index model generates an elevated return of 0.24% with a risk of 1.51%. In terms of performance, based on the sharpe ratio, the highest value was obtained in the markowitz portfolio at 0.059330, while the highest treynor ratio and jensen ratio were found in the single index model, yielding values of 0.002264 and 0.002142, respectively. These results indicate that the markowitz model is more efficient in minimizing risk, while the single index model is superior in maximizing returns. Thus, the markowitz model is better suited for investors who are risk-averse, while the single index model is fitted for moderate to aggressive investors who prioritize higher potential returns despite greater risk.

Keywords: *Markowitz Model, Single Index Model, Sharpe Ratio, Treynor Ratio, Jensen Ratio*

1. INTRODUCTION

According to Gunawan *et al*., (2024) and Rudianto (2023), investment is an activity of investing capital in a particular financial instrument to grow its value in the future. A collection of investment assets owned by an individual or entity is called a portfolio. When investing, investors usually hope to maximize their rate of return (Andawaningtyas, 2024). According to Tandelilin (2017), there are two types of returns in investing, namely yield and capital gain (loss). Yield is the income or cash flow obtained periodically from investing (e.g., interest and dividends), while capital gain (loss) is obtained by finding the difference between the purchase price of an investment instrument and its current price/selling price, or what can be referred to as a price increase/decrease. According to Suputra (2021), risk is an event that can harm investment analysts due to the possibility of deviations between actual results and expected results. The purpose of an investor forming a portfolio is to manage risk and optimize potential returns in accordance with the investor's risk profile so that by having a diversified portfolio, investors can offset losses from one investment asset with gains from other investment assets (Osman *et al*., 2022) & (Irhamni, 2024). Portfolio optimization is the process of determining the combination of investment assets with the aim of obtaining the expected rate of return with a certain level of risk or obtaining low risk to obtain a certain rate of return. The Markowitz portfolio theory concept was introduced by Harry Markowitz in 1952, explaining that Markowitz is a portfolio variance concept in measuring and evaluating portfolio risk (Laila, 2025). Markowitz (1952) explained that portfolio diversification is necessary to spread risk across many assets so that the overall risk level of the portfolio can be significantly reduced. The Markowitz model is based on the premise that the risk in a portfolio cannot be calculated

simply by adding up the risks of each asset in it, but also by taking into account the contribution of each asset to the overall portfolio through covariance calculations (Nurhakim *et al*., 2024) and (Yusup, 2022). Determination of assets to be included in the portfolio based on the estimated average return on shares and covariance derived from historical data (González & Vazquez, 2020). The single index model was first created by William Sharpe in 1963 as an alternative to the Markowitz model because it was considered too complicated in estimating the return and risk of each stock, especially in calculating the correlation between different stocks in a portfolio (Sharpe, 1963). Sharpe simplified Markowitz's calculations based on the assumption that the movement of an asset will move in line with the market index so that the correlation between returns or yields from stocks arises as a result of reactions to the same changes in the market. Therefore, a market index is used to reflect how the movement of stock returns are interrelated (Zhang, 2022). The Sharpe Ratio is a concept introduced by William F. Sharpe, which is a tool for measuring portfolio performance that aims to assess how efficiently a portfolio can provide a certain rate of return based on the level of risk taken. According to Yunita (2023), the Sharpe Ratio measures the excess return obtained by investors based on the risk incurred. The Treynor ratio is a model developed by Jack L. Treynor in 1965 and is one of the portfolio performance evaluation methods that focuses on measuring the return of a portfolio relative to the systematic risk faced, assuming that the relevant risk in investment is systematic risk that cannot be eliminated through asset diversification and using beta (β) as a measure of portfolio risk (Lu *et al*., 2021). The Jensen ratio, better known as Jensen's Alpha, is a method of measuring portfolio performance introduced by Michael Jensen in 1968. This model is based on the Capital Asset Pricing Model (CAPM) framework, which calculates the relationship between portfolio returns and systematic market risk. The Jensen ratio measures the extent to which a portfolio generates actual returns compared to the returns it should have earned according to CAPM (Jensen, 1968). This study was conducted with the aim of determining the optimal portfolio formation between the Markowitz model and the single index model, then calculating the portfolio return and risk for each model and evaluating performance using the Sharpe Ratio, Treynor Ratio, and Jensen's Alpha Ratio to see if there are differences between each model used.

2. RESEARCH METHOD

This study is a quantitative descriptive study. This study's population is IDX80 firms that are listed on the IDX (Indonesia Stock Exchange) in the second quarter of 2025. The sampling method used was purposive sampling. The criteria set in this study are as follows: (1) IDX80 firms in the second quarter of 2025 that are uniformly mentioned on the Indonesia Stock Exchange; (2) IDX80 companies in the second quarter of 2025 that were uniformly mentioned on the IDX (Indonesia Stock Exchange) from June 1, 2023 to June 1, 2025; and (3) IDX80 companies in the second quarter of 2025 that did not conduct a stock split or reverse stock split from the date from June 1, 2023 to June 1, 2025.

Markowitz Model

Markowitz (1952) explained that the risk of a portfolio cannot be determined simply by adding each asset to the portfolio but must be obtained from the risk correlation (covariance) between assets. Several stages are needed to calculate the optimum Markowitz Model (Tandelilin, 2017):

Compute the return of each asset:

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

Compute the expected return of each asset::

$$E(R_i) = \frac{\sum_{t=1}^{n} R_{it}}{n} \quad (2)$$

Compute the standard deviation and variance of each asset:

$$\sigma_i = \sqrt{\frac{\sum_{t=1}^{n} \left(R_{it} - E(R_i)\right)^2}{n-1}} \quad (3)$$

$$\sigma_i^2 = \frac{\sum_{t=1}^{n} \left(R_{it} - E(R_i)\right)^2}{n-1} \quad (4)$$

Compute the covariance between assets:

$$\sigma_{ij} = \frac{\sum_{t=1}^{n} \left(R_{it} - E(R_i)\right)\left(R_{jt} - E(R_j)\right)}{n-1} \quad (5)$$

Compute the portfolio return:

$$E(R_p) = \sum_{i,j=1}^{n} W_i \cdot E(R_i) + W_j \cdot E(R_j) \quad (6)$$

Compute the standard deviation and risk of the portfolio:

$$\sigma_p = \sqrt{\sum_{i,j=1}^{n} W_i W_j \sigma_{ij}} \quad (7)$$

$$\sigma_p^2 = \sum_{i,j=1}^{n} W_i W_j \sigma_{ij} \quad (8)$$

Single Index Model

Sharpe (1963) calculated the single index model with the assumption that the price movement of an asset would follow market movements. According to Tandelilin (2017), the single index model measurement is carried out in several stages, namely:

Calculating asset returns and market returns:

$$R_{it} = \frac{P_{it} - P_{it-1}}{P_{it-1}} \quad (9)$$

$$R_{mt} = \frac{I_{mt} - I_{mt-1}}{I_{mt-1}} \quad (10)$$

Calculating expected asset returns and expected market returns:

$$E(R_i) = \frac{\sum_{t=1}^{T} R_{it}}{T} \quad (11)$$

$$E(R_m) = \frac{\sum_{t=1}^{T} R_{mt}}{T} \quad (12)$$

Calculating asset risk and market risk:

$$\sigma_i^2 = \frac{\sum_{t=1}^{T} \left(R_{it} - E(R_i)\right)^2}{T} \quad (13)$$

$$\sigma_m^2 = \frac{\sum_{t=1}^{T} \left(R_{mt} - E(R_m)\right)^2}{T} \quad (14)$$

Calculating the beta and alpha of each asset:

$$\beta_i = \frac{\sigma_i^2}{\sigma_m^2} \quad (15)$$

$$\alpha_i = E(R_i) - \beta_i E(R_m) \quad (16)$$

Calculating residual variance:

$$\sigma_{ei}^2 = \frac{1}{T} \sum_{t=1}^{T} [R_{it} - (\alpha_i + \beta_i R_{mt})]^2 \quad (17)$$

Calculating excess return to beta (ERB):

$$ERB_i = \frac{E(R_i) - R_f}{\beta_i} \quad (18)$$

Determining the cut-off point (C*):

$$C_i = \frac{\sigma_m^2 \sum_{j=1}^{i} A_j}{1 + \sigma_m^2 \sum_{j=1}^{i} B_j} \quad (19)$$

$$A_j = \frac{(E(R_j)-R_f)\beta_j}{\sigma_{ej}^2} \quad (20)$$

$$B_j = \frac{\beta_j^2}{\sigma_{ej}^2} \quad (21)$$

Determining the selection of assets for the portfolio if ERB > C*

Determining the allocation of each asset:

$$W_i = \frac{Z_i}{\sum_{i=1}^{n} Z_i} \quad (22)$$

$$Z_i = \frac{\beta_i^2}{\sigma_{ei}^2}(ERB_i - C^*) \quad (23)$$

Calculating the portfolio's beta and alpha:

$$\beta_p = \sum_{i=1}^{n} W_i \ \beta_i \quad (24)$$

$$\alpha_p = \sum_{i=1}^{n} W_i \ \alpha_i \quad (25)$$

Calculating portfolio return, expected portfolio return, and portfolio risk:

$$R_p = \sum_{i=1}^{n} W_i \ E(R_i) \quad (26)$$

$$E(R_p) = \alpha_p + \beta_p \, E(R_m) \quad (27)$$

$$\sigma_p = \sqrt{\beta_p^2 \, \sigma_m^2 + \sum_{i=1}^{n} W_i^2 \ \sigma_{ei}^2} \quad (28)$$

Sharpe Ratio

According to Tandelilin (2017), the Sharpe ratio, usually addressed as the reward-to-variability ratio, is a ratio used to measure the risk premium for each unit of risk borne based on the capital market line. The formulation to compute the Sharpe ratio is presented below:

$$S_i = \frac{R_p - R_f}{SD_i} \quad (29)$$

Treynor Ratio

According to Tandelilin (2017), the Treynor ratio, also commonly known as the reward-to-volatility ratio, is a portfolio performance evaluation that determines the portfolio's return relative to its systematic risk. It can be calculated using the following equation:

$$T_i = \frac{R_p - R_f}{\beta_i} \quad (30)$$

Jensen Ratio

The Jensen ratio is a metric for portfolio evaluation that quantifies how the actual return deviates from the expected return on the capital market line (Tandelilin, 2017). The The formulation to compute the Jensen ratio is presented below:

$$\alpha_p = R_p - \left(R_f + \beta_p\left(R_m - R_f\right)\right) \quad (31)$$

3. RESULTS AND DISCUSSIONS

Stock Performance

Table 1. Individual Stock Performance
Source: Data processed, Author

Stock	E(Ri)	Var	Std dev	Beta	Alpha
ACES	0.000210	0.000817	0.028575	0.768258	0.000044
ADMR	0.000977	0.000965	0.031068	1.075626	0.000745
ADRO	0.000558	0.000876	0.029600	0.985223	0.000345
AKRA	0.000162	0.000609	0.024686	0.904894	-0.000034
AMRT	-0.000002	0.000477	0.021849	0.874202	-0.000191
ANTM	0.001288	0.000640	0.025304	0.958157	0.001080
ARTO	0.000052	0.001465	0.038281	1.608914	-0.000296
ASII	-0.000588	0.000280	0.016726	0.813292	-0.000764
AUTO	0.000289	0.000580	0.024093	0.848971	0.000105
AVIA	-0.000692	0.000485	0.022020	0.507907	-0.000802
BBCA	0.000155	0.000219	0.014784	0.950610	-0.000051
BBRI	-0.000227	0.000391	0.019770	1.388336	-0.000527
BBTN	0.000200	0.000474	0.021773	1.197499	-0.000059
BFIN	-0.000539	0.000597	0.024439	0.870270	-0.000727
BMRI	0.000302	0.000418	0.020440	1.405763	-0.000003
BNGA	0.000555	0.000221	0.014873	0.736598	0.000395
BRIS	0.001497	0.000664	0.025759	1.206157	0.001236
BRMS	0.003070	0.001488	0.038569	1.166524	0.002817
BRPT	0.002062	0.001833	0.042809	1.995619	0.001630
BSDE	-0.000204	0.000398	0.019961	1.023745	-0.000426
BTPS	-0.000513	0.000685	0.026173	1.286900	-0.000792
BUKA	-0.000417	0.000884	0.029735	0.995658	-0.000632
CMRY	0.000496	0.000486	0.022055	0.388131	0.000412
CPIN	0.000193	0.000441	0.021005	0.874289	0.000004
CTRA	0.000008	0.000528	0.022969	1.043644	-0.000218
DSNG	0.001217	0.000795	0.028193	0.510358	0.001106
ELSA	0.001015	0.000422	0.020541	0.785477	0.000845
EMTK	0.000358	0.001016	0.031875	1.260960	0.000085
ENRG	0.000512	0.000921	0.030344	1.108365	0.000272
ERAA	0.000708	0.000855	0.029243	1.236295	0.000440
ESSA	0.000708	0.000855	0.029243	1.236295	0.000440
EXCL	0.000409	0.000382	0.019533	0.416075	0.000319
GGRM	-0.002054	0.000360	0.018973	0.877108	-0.002244
GJTL	0.001201	0.001182	0.034373	1.378349	0.000903
GOTO	-0.000712	0.001439	0.037932	1.479562	-0.001032
HEAL	0.000595	0.000528	0.022973	0.444326	0.000499
HRUM	-0.000812	0.000839	0.028961	1.159458	-0.001063
ICBP	0.000034	0.000316	0.017779	0.500940	-0.000074
INCO	-0.000937	0.000763	0.027614	1.029180	-0.001159
INDF	0.000298	0.000244	0.015611	0.496389	0.000191

INDY	0.000007	0.000937	0.030608	1.305108	-0.000275
INKP	0.000144	0.000663	0.025751	1.107343	-0.000096
INTP	-0.000993	0.000444	0.021060	0.894024	-0.001186
ITMG	0.000119	0.000268	0.016385	0.589686	-0.000009
JPFA	0.000920	0.000531	0.023046	0.604294	0.000789
JSMR	0.000505	0.000465	0.021559	0.812171	0.000329
KLBF	-0.000420	0.000451	0.021242	0.634989	-0.000558
LSIP	0.000696	0.000394	0.019843	0.833186	0.000516
MAPI	-0.000235	0.000855	0.029232	1.059018	-0.000464
MBMA	-0.001099	0.001163	0.034108	1.213432	-0.001361
MDKA	-0.000260	0.001219	0.034908	1.578082	-0.000601
MEDC	0.001054	0.000885	0.029756	0.819991	0.000876
MIKA	0.000240	0.000452	0.021252	0.355318	0.000163
MNCN	-0.001575	0.000667	0.025819	1.066880	-0.001806
MTEL	0.000042	0.000390	0.019753	0.757072	-0.000121
MYOR	-0.000121	0.000416	0.020402	0.689096	-0.000271
NCKL	-0.000172	0.000709	0.026618	1.027309	-0.000394
NISP	0.000715	0.000209	0.014444	0.564476	0.000593
PANI	0.004957	0.002030	0.045052	1.639698	0.004602
PGAS	0.000687	0.000375	0.019365	0.599068	0.000557
PGEO	0.001316	0.000978	0.031277	0.881121	0.001125
PNLF	0.000747	0.000991	0.031472	1.138572	0.000500
PTBA	0.000032	0.000422	0.020554	0.731182	-0.000126
PWON	-0.000217	0.000344	0.018540	0.916656	-0.000416
SCMA	0.000762	0.000885	0.029747	0.863665	0.000575
SIDO	-0.000525	0.000380	0.019491	0.552885	-0.000644
SMGR	-0.001230	0.000649	0.025483	1.255555	-0.001502
SMRA	-0.000840	0.000540	0.023234	1.117741	-0.001082
SRTG	0.000827	0.001151	0.033928	1.492501	0.000504
SSIA	0.002222	0.001155	0.033986	0.889241	0.002029
TAPG	0.001457	0.000462	0.021495	0.521744	0.001344
TKIM	0.000394	0.000627	0.025031	1.053651	0.000166
TLKM	-0.000621	0.000333	0.018255	0.799755	-0.000794
TOWR	-0.000898	0.000494	0.022215	1.056672	-0.001126
UNTR	0.000143	0.000358	0.018914	0.839050	-0.000038
UNVR	-0.001670	0.000736	0.027126	0.942271	-0.001874
Mean	0.000244	0.000675	0.025028	0.960998	0.000036

According to Table 1. the company with the highest expected return is PANI with an average daily return of 0.5% according to the return probability over the last 2 years, while the company with the lowest expected return is GGRM with a return of -0.2% based on the probability of return over the last 2 years, resulting in an average average expected return obtained for IDX80 companies is 0.02% per day, which is quite good when compared to the market return of 0.02% per day, meaning that the average return of IDX80 companies almost follows the overall market return. The variance calculation results in Table 1 proofs that the highest variance value is in

PANI at 0.002030, so there is a risk of deviation of actual return from expected return of 0.2% and the lowest variance is at NISP at 0.000209, so the risk of deviation of actual returns from expected returns is 0.02%, where the average IDX80 company has a variance of 0.000675, which is quite large compared to the market variance of 0.000097. The results in Table 1 also show that the highest standard deviation is at PANI at 0.045052, indicating that there is volatility or fluctuation in returns of 4.5%, while the smallest standard deviation is at NISP at 0.014444, resulting in volatility or fluctuation in returns of 1.4%. All IDX80 companies have an average of 0.025028, which is quite large when compared to the market standard deviation of only 0.009857. The calculations in Table 1 also show that the largest beta value is BRPT at 1.995619, meaning that BRPT has a volatility or sensitivity to market movements of 199.5%. For example, if the IHSG rises by 1%, BRPT will rise by 1.995%. Meanwhile, the lowest beta is found in MIKA at 0.355318, meaning that MIKA has a volatility or sensitivity to market movements of 35.53%. The calculations in Table 1 also show that the largest alpha value is in PANI at 0.004602, so that PANI shares are able to provide an actual return of 0.4% higher than market performance. while the smallest alpha is found in GGRM at -0.002244, meaning that GGRM shares are able to provide an actual return of 0.2% lower than market performance.

Optimal Portfolio Markowitz Model

In calculating a Markowitz portfolio, it is necessary to calculate the covariance between stocks, which is a benchmark for describing the movement of risk between stocks. Covariance or correlation coefficients with values close to 1 (one) indicate that the risk in stocks cannot be diversified, while a covariance value of 0 (zero) means that there is no correlation between stocks. Conversely, a covariance close to -1 (negative one) indicates that stocks can be diversified. Next, an optimal model calculation was performed based on the Markowitz model with equal asset weights of 2.632% (100% divided by 38), and the results obtained using Markowitz were a standard deviation of 0.011211, a variance of 0.000126, and a return of 0.000953. After that, solv er in Microsoft Excel is used to evaluate the optimal portfolio with the following requirements: (1) The standard deviation/variance value is close to 0 (zero); (2) Each stock's weight must not be less than 0 (zero); and (3) The total of all stocks is 100% (one hundred percent). Based on the solver results, the portfolio weights are as follows:

Table 2. Optimal Portfolio Markowitz
Source: Data processed, Author

Optimal Portfolio			
ADMR	0.86%	HEAL	5.36%
ADRO	0.99%	INDF	12.92%
ANTM	1.77%	JPFA	3.59%
AUTO	1.27%	JSMR	1.75%
BNGA	10.92%	MEDC	0.68%
BRMS	1.48%	MIKA	7.87%
CMRY	7.34%	NISP	17.11%
CPIN	1.88%	PGAS	6.40%
DSNG	0.31%	PGEO	0.64%
ELSA	0.81%	SSIA	0.50%
EXCL	8.77%	TAPG	6.79%
Return Portfolio			0.000657
Standard Deviation Portfolio			0.008327
Varians Portfolio			0.000069
Beta Portfolio			0.571553

According to the results of the solver with Excel, the optimal portfolio with the largest weight is NISP at 17.11% and the smallest weight is SSIA at 0.5%. The results from Table 2. with the

formation of an optimal portfolio using the Markowitz model on risk-free assets obtained a portfolio return of 0.000657, a portfolio standard deviation of 0.008327, a portfolio variance of 0.000069, and a portfolio beta of 0.571553.

Optimal Portfolio Single Index Model

Optimum portfolio formation utilizing the single index model is done by finding the return of assets and markets, the expected return of assets and markets, the risk of assets and markets, the beta and alpha of each asset, residual variance, and excess return to beta. The findings of these calculations are explained in the following:

Table 3. ERB Calculation
Source: Data processed, Author

Stock	Residual Var	ERB	Stock	Residual Var	ERB
PANI	0.00176	0.00292	AKRA	0.00053	0.00000
BRMS	0.00135	0.00249	BBCA	0.00013	-0.00001
TAPG	0.00043	0.00248	INKP	0.00054	-0.00002
SSIA	0.00108	0.00231	UNTR	0.00029	-0.00002
DSNG	0.00077	0.00206	ARTO	0.00121	-0.00007
PGEO	0.00090	0.00131	ITMG	0.00023	-0.00008
JPFA	0.00049	0.00125	INDY	0.00077	-0.00012
ANTM	0.00055	0.00117	CTRA	0.00042	-0.00015
BRIS	0.00052	0.00111	MTEL	0.00033	-0.00016
MEDC	0.00082	0.00109	PTBA	0.00037	-0.00018
ELSA	0.00036	0.00108	AMRT	0.00040	-0.00019
NISP	0.00018	0.00098	ICBP	0.00029	-0.00026
HEAL	0.00051	0.00097	MDKA	0.00097	-0.00027
BRPT	0.00144	0.00095	BBRI	0.00020	-0.00028
PGAS	0.00034	0.00087	NCKL	0.00060	-0.00033
CMRY	0.00047	0.00086	BSDE	0.00030	-0.00036
ADMR	0.00085	0.00076	MAPI	0.00074	-0.00038
GJTL	0.00099	0.00075	MYOR	0.00037	-0.00041
SCMA	0.00081	0.00069	PWON	0.00026	-0.00042
LSIP	0.00033	0.00064	BTPS	0.00052	-0.00053
EXCL	0.00036	0.00059	BUKA	0.00079	-0.00058
BNGA	0.00017	0.00053	GOTO	0.00122	-0.00059
PNLF	0.00086	0.00051	BFIN	0.00052	-0.00081
SRTG	0.00093	0.00044	HRUM	0.00071	-0.00084
ERAA	0.00071	0.00044	SMRA	0.00042	-0.00090
ESSA	0.00071	0.00044	KLBF	0.00041	-0.00092
JSMR	0.00040	0.00042	ASII	0.00022	-0.00092
ADRO	0.00078	0.00040	TLKM	0.00027	-0.00098
ENRG	0.00080	0.00031	TOWR	0.00038	-0.00100
INDF	0.00022	0.00027	MBMA	0.00102	-0.00104
TKIM	0.00052	0.00022	INCO	0.00066	-0.00107
MIKA	0.00044	0.00022	SMGR	0.00050	-0.00111
EMTK	0.00086	0.00015	SIDO	0.00035	-0.00124
AUTO	0.00051	0.00015	INTP	0.00037	-0.00129
BMRI	0.00023	0.00010	MNCN	0.00055	-0.00163
ACES	0.00076	0.00006	AVIA	0.00046	-0.00168
CPIN	0.00037	0.00003	UNVR	0.00065	-0.00195
BBTN	0.00033	0.00003	GGRM	0.00028	-0.00253

According to the results in Table 3. the stock with the highest ERB value is PANI and the lowest is GGRM. Excess return to beta is to determine the excess return relative to undiversifiable risk and shows the relationship between return and risk. After calculating the excess return to beta, calculations were performed to determine the cut-off point, which require

the calculation of Aj and Bj to determine the cut-off point, and a cut-off point value of 0.00091 was obtained. Assets with excess return to beta values above the cut-off point were selected to be optimal assets for the formation of a single index model portfolio, resulting in 14 assets with ERB values above the cut-off point, namely PANI, BRMS, TAPG, SSIA, DSNG, PGEO, JPFA, ANTM, BRIS, MEDC, ELSA, NISP, HEAL, and BRPT. After obtaining the stocks included in the optimal single index model portfolio, Zi calculations are performed to determine the Wi value (stock weight) with the following results:

Table 4. Optimal Portfolio Single Index Model
Source: Data processed, Author

Optimal Portfolio					
Stock	**Zi**	**Wi**	**Stock**	**Zi**	**Wi**
PANI	1.87229	0.19355	ANTM	0.46138	0.04770
BRMS	1.36523	0.14113	BRIS	0.45699	0.04724
TAPG	1.88524	0.19489	MEDC	0.17783	0.01838
SSIA	1.16201	0.12012	ELSA	0.38260	0.03955
DSNG	0.76776	0.07937	NISP	0.21850	0.02259
PGEO	0.39091	0.04041	HEAL	0.05483	0.00567
JPFA	0.41915	0.04333	BRPT	0.05873	0.00607
Alpha Portfolio					0.002147
Beta Portfolio					0.969000
Systematic Risk					0.000091
Residual Var Error Portfolio					0.000136
Total Risk					0.015059
E(Rp)					0.002357
Std Dev					0.122714

According to the results of Table 4. the assets included in the total asset optimal single index model portfolio are PANI at 19.36%, BRMS at 14.11%, TAPG at 19.49%, SSIA at 12.01%, DSNG at 7.34%, PGEO at 4.04%, JPFA at 4.33%, ANTM at 4.77%, BRIS at 4.27%, MEDC at 1.84%, ELSA at 3.96%, NSIP at 2.26%, HEAL at 0.57%, and BRPT at 0.61%. The results of portfolio formation using the single index model obtained a portfolio alpha value of 0.002147, a portfolio beta of 0.969000, systematic risk of 0.000091, unique risk of 0.000136, total risk of 0.015059, portfolio return of 0.002357, portfolio angle of 0.145670, and portfolio standard deviation of 0.122714.

In addition to creating an optimal portfolio based on total assets, this study also categorizes assets into five types: total assets, risk-free assets, risky assets, assets with positive and negative expected returns. Total assets consist of all IDX80 companies included in the research sample, while risk-free assets are assets with expected returns above the risk-free rate set by Bank Indonesia from BI7DDR. risky assets are assets with expected returns below the risk-free rate set by Bank Indonesia, assets with positive expected returns are assets with expected returns greater than 0, and assets with negative expected returns are assets with expected returns less than 0. The overall portfolio calculation results are as described below:

Table 5. Summary of Optimal Portfolio
Source: Data processed, Author

Group	Markowitz		Single Index Model	
	Return	Risk	Return	Risk
Total Assets	0.000221	0.000060	0.002357	0.015059
Risk-Free Assets	0.000657	0.000069	0.002357	0.015059
Risky Assets	-0.000258	0.000076	0.000162	0.024660
E(Rp) +	0.000481	0.000063	0.002357	0.015059
E(Rp) -	-0.000627	0.000095	-0.000002	0.021826

After each asset was established, the performance of each portfolio was reviewed as shown in the following results:

Table 6. Portfolio Evaluation
Source: Data processed, Author

Group	Sharpe		Treynor		Jensen	
	Markowitz	SIM	Markowitz	SIM	Markowitz	SIM
Total Assets	0.007517	0.017876	0.000098	0.002264	0.000026	0.002142
Risk-Free Assets	0.059330	0.017876	0.000864	0.002264	0.000464	0.002142
Risky Assets	-0.048248	-0.000010	-0.000609	-0.000002	-0.000458	-0.000050
E(Rp) +	0.040156	0.017876	0.000547	0.002264	0.000287	0.002142
E(Rp) -	-0.081006	-0.001115	-0.001051	-0.000189	-0.000830	-0.000211

According to Sharpe ratio calculations in Table 6, the highest Sharpe ratio was obtained in the formation of a portfolio using the Markowitz model with a risk-free asset of 0.059330, and the lowest was in the formation of a portfolio using Markowitz with assets with a negative expected return of -0.081006. Thus, the use of the Markowitz portfolio for risk-free assets is the most appropriate model for forming a portfolio that is not yet fully diversified because it is able to provide a higher rate of return of 5.93% per risk borne. Referring to the results from Table 6, the highest Treynor ratio was found in the single index model portfolio for total assets, risk-free assets, and risky assets at 0.002264, while the lowest was found in the Markowitz portfolio for assets with negative expected returns. Based on these results, the formation of a portfolio using the single index model can be used for portfolios that are already fully diversified. Based on the results in Table 6, the highest Jensen ratio was found in the single index model portfolio for total assets, risk-free assets, and assets with a positive expected return of 0.002142, while the lowest was found in Markowitz for assets with a negative expected return of -0.000830. Based on these results, the portfolio formation with a single index model can provide a higher return compared to the market expected return.

The Mann-Whitney test is a nonparametric test utilized to find a distinction between two samples with a significance level of 0.05. If the significance value is below 0.05, there is a prominent difference between the Markowitz model and the single index model, whereas if the significance value is above 0.05, there is no prominent difference between the Markowitz model and the single index model. The results of the Mann-Whitney test are as follows:

Table 7. MannWhitney Test
Source: Data processed using SPSS

Model	Sig.	Conclusion
Return	0.169	There is no prominent difference
Risk	0.008	There is a prominent difference
Sharpe	0.916	There is no prominent difference
Treynor	0.169	There is no prominent difference
Jensen	0.169	There is no prominent difference

Based on the results in Table 7, it is concluded that there are no prominent differences in portfolio formation using the Markowitz and single index models in terms of return, Sharpe, Treynor, and Jensen results, while there is a prominent difference in risk results between the Markowitz model and single index model.

4. CONCLUSIONS AND SUGGESTIONS

This test was conducted to determine the findings of portfolio formation using the Markowitz model and single index model and testing of performance using Sharpe ratio, Treynor ratio, and Jensen ratio, followed by a difference test. This study's sample consists of 76 companies listed on the IDX80 in the second quarter of 2025, with an observation period from June 1, 2023, to June 1, 2024. According to the results of the analysis and discussion, it is concluded that portfolio formation using the Markowitz model produces a return rate of 0.06% per day with a risk of 0.007%. This portfolio consists of various stocks that have low correlation between assets, thereby minimizing the overall risk level. Conversely, portfolio formation using the Single Index model results in a higher return of 0.24% with a risk of 1.51%. This is because the Single Index model emphasizes the selection of stocks with the highest expected return that has a direct relationship with market returns. The fundamental difference between these two models lies in their objectives, whereby the Markowitz model focuses on risk efficiency while the Single Index Model focuses on return maximization. The results of the portfolio performance evaluation show that based on the Sharpe Ratio, the highest performance was obtained from the Markowitz portfolio in the risk-free asset group at 0.059330, followed by assets with a positive expected return at 0.040156, and the Single Index Model at 0.017876. Meanwhile, the Treynor Ratio shows the highest value in the Single Index Model at 0.002264, which means that this model is more effective for portfolios with diversified systematic risk. Referring to the Jensen Ratio, the Single Index Model also provides the best results with a value of 0.002142, indicating the ability of this model to generate excess returns beyond CAPM predictions. Based on the results of testing the differences between the two models, a significant difference was found in the level of risk, where the Markowitz Model has a much lower risk in comparison to the Single Index Model. It's in line with the basic theory of the two models, where markowitz takes into account the correlation between assets in reducing the total risk of the portfolio, while the Single Index Model emphasizes on the correlation of stock returns and market returns. Overall, the results of this study indicate that the Single Index Model is more suitable for investors who want high returns with greater risk, while the Markowitz Model is more suitable for investors who prioritize stability and risk avoidance with relatively safe results but still provide positive performance.

REFERENCES

Andawaningtyas, K., Luthfi, M., Marjono, M., Handamari, E. W., S'adah, U., & Ardiyani, E. (2024). Portfolio Optimization of Sharia and Non-Sharia Stocks Using Single index model (Case Study: Jakarta Sharia Index and Kompas 100 Index). *The Australian Journal of Mathematical Analysis and Applications, 21*(2).

González, A. P., & Vazquez, O. H. Z. (2020). Designing an optimal electricity supply portfolio based on the Markowitz model: The case of a user in Mexico. *Contaduria y Administracion, 65*(1), 1–20. https://doi.org/10.22201/FCA.24488410E.2019.1833

Gunawan, A., Fajriyah, R., Bimakasa, M. A., & Untari, S. N. (2024). Analysis of Portfolio Formation on the LQ45 Stocks Index, Using the Markowitz and Single index models. *BAREKENG: Journal of Mathematics and Its Applications*, 18(4), 2363–2374. https://doi.org/10.30598/barekengvol18iss4pp2363-2374

Irhamni, F. (2024). Constructing Portfolio Optimization : Analysis in Indonesia Non-Cyclical Industry (Markowitz Approach and Skewness and Kurtosis). *Revista de Gestao Social e Ambiental (RGSA), 18*(5). https://doi.org/10.24857/rgsa.v18n5-099

Jensen, M. C. (1968). The Performance of Mutual Funds in The Period 1945–1964. *The Journal of Finance*, 23(2), 389–416. https://doi.org/10.1111/j.1540-6261.1968.tb00815.x

Laila, A., & Janitha, A. P. (2025). Comparison of Islamic and Conventional Bank Stock Portfolio Performance Using the Markowitz Model: Risk and Return Analysis on Four Selected Issuers. *International Journal of Quantitative Research and Modeling, 6*(3), 391–397.

Lu, R., Cheung, A. (Wai K., Hoang, V. T., & Islam, S. M. N. (2021). Which measure of systematic risk should we use? An empirical study on systematical risk and Treynor measure using the economic index of riskiness and operational measure of riskiness. *International Journal of Finance and Economics*, 26(2), 1739–1744. https://doi.org/10.1002/ijfe.1875

Markowitz, H. (1952). Portfolio Selection. *The Journal of Finance*, 7(1), 77–91. https://doi.org/10.1111/j.1540-6261.1952.tb01525.x

Nurhakim, E. S., Soma, A. M., & Yunita, I. (2024). Constructing Optimal Portfolios Using the Single index model and Markowitz Model: A Study on Cryptocurrencies. *Journal of Accounting and Strategic Finance, 7*(2), 200–218. https://doi.org/10.33005/jasf.v7i2.485/

Osman, I. R., Krismantoro, K., & Khoiruzadi, S. (2022). Optimal Portfolio Creation Using Markowitz Model on Food and Beverage Companies in Indonesian Stock Exchange. *East African Scholars Journal of Economics, Business and Management, 5*(2), 40–47. https://doi.org/10.36349/easjebm.2022.v05i02.002

Rudianto, D. (2023). Optimization of the LQ45 Index Stock Portfolio on the Indonesian Stock Exchange Using the Single index model. *International Journal of Economics and Finance Studies, 15*(3), 246–262. https://doi.org/10.34109/ijefs.202315311

Sharpe, W. F. (1963). A Simplified Model for Portfolio Analysis. *Management Science*, 9(2), 277–293. https://doi.org/https://www.jstor.org/stable/2627407

Suputra, G. A. (2021). Analisis Perbandingan Risiko Saham Sebelum dan Saat Krisis Pandemic Covid19 pada Tahun 2020 (Studi Kasus: Harga Penutupan Saham Perbankan yang Tergabung dalam Indeks LQ45). *Jurnal Ilmu Manajemen (JUIMA)*, 11(1), 73–86. https://doi.org/https://doi.org/10.36733/juima.v11i1.2064

Tandelilin, E. (2017). *Pasar Modal Manajemen Portofolio & Investasi*. PT Kanisius.

Yunita, I. (2023). Evaluasi Kinerja Investasi Saham Syariah menggunakan Indeks Sharpe, Treynor dan Jensen Periode 2021-2022. *Jurnal Ilmiah Ekonomi Islam*, 9(1), 435–442. https://doi.org/10.29040/jiei.v9i1.7348

Yusup, A. K. (2022). Mean-Variance and Single-Index Model Portfolio Optimisation: Case in the Indonesian Stock Market. *Asian Journal of Business and Accounting, 15*(2), 79–109. https://doi.org/10.22452/ajba.vol15no2.3

Zhang, Z. (2022). The Optical Portfolio of the Markowitz Model and the Index Model-Under Ten Stocks from S&P 500. *Advances in Economics, Business and Management Research*, 211, 1519–1524. https://doi.org/https://doi.org/10.2991/aebmr.k.220307.248