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Market Efficiency and Technical Trading Profitability: A 20-Year Empirical Investigation of the Indonesian Equity Market

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Abstract

This study examines whether selected technical trading strategies outperform the Buy-and-Hold strategy using 20 years of daily data from the Indonesia Stock Exchange within the frameworks of the Efficient Market Hypothesis and technical analysis. Five technical strategies—Simple Moving Average (SMA), Exponential Moving Average (EMA), Relative Strength Index (RSI), Moving Average Convergence Divergence (MACD), and and Bollinger Bands—were evaluated against Buy-and-Hold. Daily adjusted closing prices were used to calculate mean daily returns, cumulative returns, final wealth, annualized volatility, and Sharpe ratios. Paired t-tests and Wilcoxon signed-rank tests were employed for parametric and non-parametric comparisons. EMA achieved the highest cumulative return (1404.57%), final wealth (15.05), and Sharpe ratio (0.8435). However, paired t-tests showed that neither EMA nor SMA generated significantly higher mean daily returns than Buy-and-Hold. MACD also showed no significant superiority, while RSI and Bollinger Bands performed significantly worse than the benchmark. Technical trading strategies did not consistently outperform Buy-and-Hold, although EMA demonstrated comparatively strong cumulative and risk-adjusted performance. Investors should not rely solely on technical trading strategies for superior returns. EMA may be considered alongside appropriate risk-management practices, while future studies should test these strategies across different markets and periods.

Keywords: Analysis; Efficiency; Indonesia; Investment; Markets; Performance; Profitability; Trading

Efisiensi Pasar dan Profitabilitas Perdagangan Teknikal: Investigasi Empiris Selama 20 Tahun di Pasar Saham Indonesia

Abstrak

Penelitian ini menguji apakah strategi perdagangan teknikal tertentu mengungguli strategi beli dan tahan (Buy-and-Hold) dengan menggunakan data harian selama 20 tahun dari Bursa Efek Indonesia, dalam kerangka Hipotesis Pasar Efisien dan analisis teknikal. Lima strategi teknikal, yaitu Simple Moving Average (SMA), Exponential Moving Average (EMA), Relative Strength Index (RSI), Moving Average Convergence Divergence (MACD), dan Bollinger Bands, dibandingkan dengan Buy-and-Hold. Harga penutupan yang telah disesuaikan digunakan untuk menghitung rata-rata imbal hasil harian, imbal hasil kumulatif, kekayaan akhir, volatilitas tahunan, dan rasio Sharpe. Uji t berpasangan dan uji peringkat bertanda Wilcoxon digunakan untuk perbandingan parametrik dan nonparametrik. EMA menghasilkan imbal hasil kumulatif tertinggi (1404,57%), kekayaan akhir (15,05), dan rasio Sharpe (0,8435). Namun, uji t berpasangan menunjukkan bahwa EMA maupun SMA tidak menghasilkan rata-rata imbal hasil harian yang secara signifikan lebih tinggi daripada Buy-and-Hold. MACD juga tidak menunjukkan keunggulan signifikan, sedangkan RSI dan Bollinger Bands berkinerja secara signifikan lebih buruk daripada strategi acuan. Strategi perdagangan teknikal tidak secara konsisten mengungguli Buy-and-Hold, meskipun EMA menunjukkan kinerja kumulatif dan kinerja setelah penyesuaian risiko yang relatif kuat. Investor sebaiknya tidak hanya mengandalkan strategi perdagangan teknikal untuk memperoleh imbal hasil yang lebih tinggi. EMA dapat dipertimbangkan bersama praktik pengelolaan risiko yang tepat, sedangkan penelitian selanjutnya perlu menguji strategi tersebut pada pasar dan periode yang berbeda.

Kata kunci: Analisis; Efisiensi; Indonesia; Investasi; Kinerja; Pasar; Perdagangan; Profitabilitas

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INTRODUCTION

Investment decisions in financial markets depend largely on investors' ability to identify profitable strategies while effectively managing risk and preserving wealth over time. Among the most widely used approaches are passive Buy-and-Hold investing and active technical trading strategies. The Buy-and-Hold strategy involves purchasing an asset and maintaining the position over a long investment horizon regardless of short-term price fluctuations. In contrast, technical trading strategies rely on historical price movements, trends, momentum, and volatility to generate systematic buy and sell signals. Whether such technical rules can consistently outperform passive investment remains an important question in financial economics, particularly in emerging capital markets where market efficiency may differ from that of developed markets.

The theoretical foundation of this debate is closely related to the Efficient Market Hypothesis (EMH). According to the EMH, security prices incorporate available information, making it difficult for investors to consistently earn abnormal risk-adjusted returns. The weak-form version of the EMH is particularly relevant to technical analysis because it argues that current market prices already reflect information contained in historical prices and trading activity. If a market is weak-form efficient, trading strategies based solely on historical price patterns should not consistently outperform a passive benchmark after considering risk and trading costs. Therefore, persistent profitability from technical trading rules would challenge the weak-form EMH by suggesting that historical price information contains exploitable patterns. Conversely, an inability of technical strategies to significantly outperform Buy-and-Hold would provide evidence broadly consistent with weak-form market efficiency.

Technical analysis nevertheless assumes that market prices may exhibit identifiable trends, momentum, mean reversion, and volatility patterns because investors do not always react instantaneously or uniformly to new information. Behavioral factors, information asymmetry, market frictions, and differences in investor sophistication may allow historical price patterns to persist, particularly in emerging markets. Technical indicators attempt to identify these patterns and transform them into trading signals. Consequently, comparing technical strategies with Buy-and-Hold provides an empirical assessment of whether active trading based on historical prices adds value beyond passive market participation.

This study examines five widely used technical indicators: Simple Moving Average (SMA), Exponential Moving Average (EMA), Relative Strength Index (RSI), Moving Average Convergence Divergence (MACD), and Bollinger Bands. These indicators are selected because they represent different and complementary dimensions of technical analysis. SMA provides a basic measure of price trends by smoothing short-term fluctuations, whereas EMA assigns greater weight to recent observations and may respond more rapidly to changing market conditions. RSI is a momentum oscillator designed to identify potential overbought and oversold conditions. MACD combines trend and momentum information through the relationship between moving averages, while Bollinger Bands incorporate price volatility and potential deviations from prevailing trends. Evaluating these five indicators together therefore provides a broader assessment than examining a single trading rule and enables comparison among trend-following, momentum-based, and volatility-based approaches.

Previous empirical research has produced mixed evidence regarding the profitability of technical trading strategies. Some studies suggest that technical indicators can identify market patterns, improve timing decisions, and generate superior returns under particular market conditions. Other studies find that their apparent advantages disappear after considering risk, transaction costs, changing market conditions, or statistical significance. These conflicting findings suggest that the effectiveness of technical trading rules is market- and period-specific and therefore requires empirical evaluation across different

financial environments. The issue is particularly relevant to emerging markets, where differences in liquidity, information dissemination, investor behavior, institutional development, and market structure may affect the degree of market efficiency.

The Indonesia Stock Exchange (IDX) provides an important setting for examining this issue. As a major emerging capital market in Southeast Asia, the Indonesian equity market has experienced substantial economic expansion, periods of financial uncertainty and market volatility, technological development, and increasing participation by domestic and international investors. These characteristics create an appropriate environment for examining whether historical price information can be transformed into trading strategies capable of outperforming passive investment. Despite the importance of the Indonesian market, relatively limited long-horizon evidence simultaneously compares several widely used technical indicators with Buy-and-Hold using both return and risk-adjusted performance measures.

The study also has implications for sustainability and long-term value creation in investment management. Sustainable investment performance is not determined solely by maximizing short-term returns; it also requires effective risk management, disciplined allocation of capital, and preservation and accumulation of wealth over longer horizons. Excessive trading can increase transaction costs and expose investors to additional market-timing risks, whereas systematic strategies may potentially improve risk-adjusted performance by controlling exposure during unfavorable market conditions. Comparing cumulative returns, final wealth, volatility, and Sharpe ratios therefore provides insight into whether active technical strategies contribute to durable value creation rather than merely generating short-term trading gains. This perspective connects trading-strategy evaluation with the broader objective of financially sustainable portfolio management and long-term investor wealth.

Against this background, the present study investigates whether selected technical trading strategies outperform the Buy-and-Hold strategy using approximately 20 years of daily market data from the Indonesia Stock Exchange. Specifically, it evaluates SMA, EMA, RSI, MACD, and Bollinger Bands using mean daily return, cumulative return, final wealth, annualized volatility, and the Sharpe ratio. Paired t-tests and Wilcoxon signed-rank tests are further employed to determine whether differences in returns between the technical strategies and the Buy-and-Hold benchmark are statistically significant.

This study contributes to both theory and practice. Theoretically, it provides long-horizon evidence relevant to the weak-form EMH by testing whether trading rules based on historical price information can consistently generate superior performance in an emerging equity market. It also contributes to the technical-analysis literature by comparing indicators representing trend, momentum, and volatility within a common analytical framework. Practically, the study provides evidence for individual investors, portfolio managers, financial analysts, and other market participants regarding whether the additional complexity of active technical trading is justified relative to a simple passive strategy. By considering both returns and risk-adjusted performance, the study further contributes to understanding how trading strategies may support disciplined investment decisions, sustainable wealth accumulation, and long-term value creation in the Indonesian capital market.

Research Problem

Although technical trading strategies are widely used by investors, there is no clear consensus on whether they consistently outperform the Buy-and-Hold strategy. Previous studies have produced mixed results, and evidence from emerging markets such as the Indonesia Stock Exchange remains limited. Moreover, most existing studies examine short time periods or only a few technical indicators. Therefore, this study compares the long-term performance of the Buy-and-Hold strategy with five widely used technical trading strategies (SMA, EMA, RSI, MACD, and Bollinger Bands) using daily data from the Indonesia Stock

Exchange covering the period from 4 January 2000 to 3 July 2026. The findings provide empirical evidence to support investment decision-making in an emerging market.

Research Questions

What are the return and risk characteristics of the Buy-and-Hold strategy in the Indonesia Stock Exchange over the 20-year study period?

How do the Simple Moving Average (SMA), Exponential Moving Average (EMA), Relative Strength Index (RSI), MACD, and Bollinger Bands trading strategies perform in terms of returns and risk?

Do technical trading strategies significantly outperform the Buy-and-Hold strategy in terms of profitability and risk-adjusted performance?

Which technical trading strategy provides the highest cumulative return and the best risk-adjusted performance in the Indonesia Stock Exchange?

General Objective

To examine whether selected technical trading strategies outperform the Buy-and-Hold strategy using 20 years of daily stock market data from the Indonesia Stock Exchange.

Specific Objectives

To evaluate the return and risk performance of the Buy-and-Hold strategy using 20 years of daily data from the Indonesia Stock Exchange.

To assess the performance of the Simple Moving Average (SMA), Exponential Moving Average (EMA), Relative Strength Index (RSI), MACD, and Bollinger Bands trading strategies.

To compare the performance of technical trading strategies with the Buy-and-Hold strategy using profitability and risk-adjusted performance measures.

To identify the technical trading strategy that delivers the highest cumulative return and the most favorable risk-adjusted performance over the study period.

Research Hypotheses

Null Hypotheses (H_0)

H_{01}: There is no significant difference between the performance of the Buy-and-Hold strategy and the selected technical trading strategies.

H_{02}: The SMA, EMA, RSI, MACD, and Bollinger Bands strategies do not generate significantly higher returns than the Buy-and-Hold strategy.

H_{03}: There is no significant difference in the risk-adjusted performance of the Buy-and-Hold strategy and the selected technical trading strategies.

Alternative Hypotheses (H_1)

H_{11}: Technical trading strategies perform significantly differently from the Buy-and-Hold strategy.

H_{12}: At least one of the technical trading strategies (SMA, EMA, RSI, MACD, or Bollinger Bands) generates significantly higher returns than the Buy-and-Hold strategy.

H_{13}: At least one technical trading strategy provides significantly superior risk-adjusted performance compared with the Buy-and-Hold strategy.

Literature Review

The debate over whether technical trading strategies can outperform a passive Buy-and-Hold strategy remains an important issue in financial research. Existing studies provide mixed evidence: some

demonstrate that technical indicators can generate superior or risk-adjusted returns, particularly in emerging markets, while others find that their profitability weakens after transaction costs, changing market conditions, and out-of-sample testing are considered. These conflicting findings are closely related to the Efficient Market Hypothesis (EMH), differences in market development, and the specific technical indicators and evaluation periods employed.

Theoretical Foundation: Efficient Market Hypothesis and Technical Analysis

The theoretical debate surrounding technical trading strategies is strongly connected to the Efficient Market Hypothesis. Under the weak-form EMH, current security prices incorporate information contained in historical prices and trading activity. Consequently, investors should not be able to consistently earn abnormal risk-adjusted returns using trading rules based solely on past price movements. From this perspective, persistent outperformance by indicators such as SMA, EMA, RSI, MACD, and Bollinger Bands would constitute evidence against weak-form market efficiency.

Technical analysis takes a different perspective by assuming that prices can exhibit trends, momentum, mean reversion, and recurring volatility patterns. Such patterns may arise because information is not always incorporated into prices immediately and because investors may respond differently to market information. This possibility may be particularly relevant in emerging markets, where information asymmetry, liquidity constraints, behavioral biases, and differences in investor sophistication can create temporary market inefficiencies. Therefore, testing technical strategies against Buy-and-Hold provides not only a practical comparison of investment strategies but also an empirical assessment of weak-form market efficiency.

Evidence supporting greater market efficiency is provided by Kung and Wong (2009), who found that technical trading rules performed better in Singapore during 1988–1996 but lost their ability to outperform Buy-and-Hold during 1999–2007 following financial-market reforms. This suggests that the profitability of technical rules may decline as markets become more developed and efficient. Similarly, Rink (2023), after examining thousands of trading rules across developed and emerging markets, found that some technical rules historically generated superior returns, particularly in emerging markets, but their effectiveness declined over time and became considerably weaker after transaction costs are incorporated.

Evidence Supporting Technical Trading Strategies

A substantial part of the empirical literature nevertheless suggests that technical analysis can provide useful trading information. Metghalchi et al. (2019), for example, found that trading rules based on moving averages, RSI, MACD, and Rate of Change provided predictive information for an emerging-market index and could outperform Buy-and-Hold even after adjustments for risk and transaction costs. These findings challenge the strict interpretation of weak-form market efficiency and indicate that historical price information may contain exploitable patterns in some emerging markets.

Similar evidence is reported by de Souza et al. (2018) for BRICS markets. Their results indicated that technical trading systems could produce profitable returns and, in several cases, outperform Buy-and-Hold, although performance differed considerably across markets. Tzang et al. (2017) also found that moving-average strategies outperformed Buy-and-Hold in Taiwan, with the 10-day moving average performing particularly well for highly volatile stocks. M'ng (2018) showed that an adaptive moving-average strategy generated higher profits in Asian futures markets even after transaction costs.

Evidence from South Asian markets also supports the conditional usefulness of technical analysis. Khand et al. (2020) found that Variable Moving Average rules demonstrated predictive ability and generated higher profitability in Pakistan, particularly during non-crisis periods. Tadas et al. (2023),

examining Indian stocks, reported that a combined Bollinger Bands RSI strategy frequently outperformed Buy-and-Hold, whereas SMA and EMA–RSI strategies are less consistently successful. These findings indicate that the effectiveness of technical analysis depends not only on the market but also on the type and combination of indicators used.

Collectively, these studies suggest that technical strategies can sometimes generate useful signals, especially in emerging and relatively less efficient markets. However, their profitability is not universal. Differences in indicator specification, trading frequency, volatility, transaction costs, and market regimes appear to play an important role in determining their effectiveness.

Evidence Against Consistent Technical Outperformance

Other studies provide considerably less support for technical trading. Saivasan and Lokhande (2025), comparing stock indices in Indonesia, India, and Brazil from 2010 to 2022, found that Buy-and-Hold generally outperformed EMA-based strategies. Although moving averages remained useful for identifying trends and supporting risk-management decisions, they did not consistently provide superior investment returns.

Similarly, Rink (2023) demonstrated that even when technical rules perform well historically, their profitability may disappear during out-of-sample periods. This is particularly important because a strategy that performs well only on historical data may reflect data-snooping or parameter optimization rather than a persistent market inefficiency. Lohpetch and Corne (2010) likewise showed that although sophisticated trading rules generated through genetic programming could outperform Buy-and-Hold under some conditions, their robustness declined as trading frequency increased.

The importance of transaction costs is another recurring issue. Tharavanij et al. (2015), examining Indonesia and four other Southeast Asian markets, found evidence of profitable technical trading rules in several emerging markets. However, most strategies failed to maintain positive net returns once transaction costs are included. This distinction between gross and net profitability is important because frequent trading can generate costs that substantially reduce the apparent benefits of technical strategies.

Jakpar et al. (2018) further showed that both technical and fundamental approaches could provide useful information in Malaysia, but fundamental analysis is more reliable in predicting stock returns. Taken together, these studies suggest that evidence of technical profitability should be interpreted cautiously. Superior historical returns do not necessarily imply consistent future outperformance, particularly after accounting for risk, costs, market regimes, and model robustness.

Evidence from the Indonesian Stock Market

The Indonesian Stock Exchange is particularly relevant because emerging markets may provide different conditions for technical trading than highly developed markets. Existing Indonesian evidence, however, remains mixed.

Sulistiawan et al. (2020) examined EMA trading rules in the Indonesian stock market using data from 2008 to 2017. Their findings indicated that EMA-based strategies remained profitable after transaction costs and that longer EMA periods tended to perform better than shorter periods. This provides evidence that trend-following rules may capture useful information in the Indonesian market.

In contrast, Saivasan and Lokhande (2025) found that Buy-and-Hold generally outperformed EMA based strategies when Indonesia is considered alongside India and Brazil. This directly conflicts with the findings of Sulistiawan et al. (2020), indicating that the profitability of EMA strategies may be sensitive to the sample period, parameter selection, and broader market conditions.

Regional evidence also produces qualified support. Tharavanij et al. (2015) included Indonesia in their analysis of five Southeast Asian stock markets and found that technical trading rules could generate returns in emerging markets, but their profitability is substantially weakened by transaction costs. More recent evidence using the Indonesian LQ45 index also raises questions about the predictability of historical market information. Indra et al. (2025) found that machine-learning models incorporating technical indicators showed limited ability to outperform Buy-and-Hold once transaction costs are considered. Although some models improved prediction accuracy or risk-adjusted performance, these improvements did not consistently translate into superior trading profits.

More advanced research is increasingly combining traditional technical indicators with additional information. Wijaya et al. (2026), for example, developed a hybrid stock-prediction framework combining numerous technical indicators with news sentiment and machine-learning methods. Their findings suggest that integrating technical and non-price information may improve predictive accuracy. This development is important because it implies that technical indicators may have greater value when used alongside other information rather than as isolated trading rules.

Generally, Indonesian evidence is therefore inconclusive. Some studies support the profitability of moving-average strategies, whereas others show that passive investment remains difficult to outperform. This inconsistency provides a strong justification for further investigation using a broader range of technical indicators and a longer observation period.

Critical Synthesis and Research Gap

The reviewed literature reveals several important patterns. First, technical trading strategies appear to perform more favorably in some emerging markets than in developed markets, which may indicate differences in weak-form efficiency. Second, no individual technical indicator consistently dominates across countries, industries, time periods, and market conditions. Moving-average strategies such as SMA and EMA perform strongly in some studies, while RSI, MACD, and Bollinger Bands provide superior results only under particular conditions or when combined with other indicators. Third, transaction costs, market volatility, political and economic shocks, trading frequency, and parameter selection can substantially alter conclusions about technical profitability.

More importantly, the literature reveals a gap concerning the Indonesian market. Although previous studies have investigated technical trading in Indonesia, many focus on a single indicator, a particular index, relatively limited periods, regional comparisons, or predictive models rather than directly comparing several traditional strategies under one consistent framework. The contradictory Indonesian evidence—particularly between studies supporting EMA profitability and those favoring Buy-and-Hold—also demonstrates that the question remains unresolved.

The present study addresses these gaps by providing a long-horizon comparison of five widely used technical indicators—SMA, EMA, RSI, MACD, and Bollinger Bands—against a common Buy-and-Hold benchmark on the Indonesia Stock Exchange. The indicators represent different dimensions of technical analysis, including trend following, momentum, and volatility. Rather than evaluating performance solely through raw returns, the study compares mean daily returns, cumulative returns, final wealth, annualized volatility, and Sharpe ratios. Paired t-tests and Wilcoxon signed-rank tests are additionally employed to determine whether observed return differences are statistically meaningful rather than merely descriptive.

Accordingly, the study contributes to the literature in three ways. Theoretically, it provides additional evidence regarding the weak-form EMH by testing whether historical price-based trading rules can systematically outperform passive investment in an emerging market. Empirically, it compares several

major technical strategies over a common long-term dataset instead of examining one indicator in isolation. Practically, it identifies whether active technical trading provides sufficient return or risk-adjusted advantages to justify its use over a simple Buy-and-Hold strategy. In this way, the study helps reconcile conflicting evidence in the existing literature and provides a more comprehensive assessment of the effectiveness of technical analysis in the Indonesian stock market.

METHODS

This study employed a quantitative time-series research design to examine whether selected technical trading strategies outperform the Buy-and-Hold strategy on the Indonesia Stock Exchange (IDX). Secondary daily market data covering the period from 4 January 2000 to 3 July 2026 are used. The dataset contained daily opening, high, low, adjusted closing prices, and trading volume. After data screening, cleaning, and preparation, 6,425 daily observations are retained for empirical analysis.

Five widely used technical trading strategies are evaluated: Simple Moving Average (SMA), Exponential Moving Average (EMA), Relative Strength Index (RSI), Moving Average Convergence Divergence (MACD), and Bollinger Bands (BB). The Buy-and-Hold strategy served as the benchmark. These indicators are selected because they represent three major dimensions of technical analysis: trend identification (SMA and EMA), momentum (RSI and MACD), and price volatility (Bollinger Bands). This combination allows the study to compare different mechanisms of technical signal generation within the same market and sample period.

Buy-and-Hold Strategy

The Buy-and-Hold strategy assumes that an investor purchases the market at the beginning of the study period and remains invested throughout the entire period without responding to short-term price fluctuations. Daily returns are calculated as:

$$R_t = \frac{P_t - P_{t-1}}{P_{t-1}}$$

where Rt represents the daily return, Pt is the adjusted closing price on day t, and Pt−1 is the adjusted closing price on the preceding trading day. The Buy-and-Hold return serves as the benchmark against which the five technical strategies are evaluated.

Simple Moving Average (SMA)

The SMA measures the arithmetic mean of closing prices over a specified number of trading days:

$$SMA_{n,t} = \frac{1}{n}\sum_{i=0}^{n-1} P_{t-i}$$

where n represents the moving-average window. This study employs a 20-day short-term SMA and a 50-day medium-term SMA. A buy signal is generated when the 20-day SMA crosses above the 50-day SMA, indicating an upward trend. A sell/exit signal is generated when the 20-day SMA crosses below the 50-day SMA. The strategy remains invested while the short-term average is above the longer-term average and otherwise remains out of the market. The 20- and 50-day windows are selected because they are commonly used moving-average horizons and provide a balance between responsiveness and trend confirmation. Approximately 20 trading days represent one trading month, while 50 trading days capture a broader intermediate trend.

Exponential Moving Average (EMA)

Unlike the SMA, the EMA assigns greater weight to more recent observations and therefore responds more rapidly to changes in market prices. It is calculated as:

$$EMA_t = \alpha P_t + (1 - \alpha) EMA_{t-1}$$

where:

$$\alpha = \frac{2}{n+1}$$

and n represents the selected EMA period.

Consistent with the SMA specification, 20-day and 50-day EMA windows are employed. A buy signal occurs when the 20-day EMA crosses above the 50-day EMA, while a sell/exit signal occurs when the 20-day EMA crosses below the 50-day EMA. These windows are kept identical to those of the SMA to permit a direct comparison of whether assigning greater weight to recent observations improves trading performance.

Relative Strength Index (RSI)

The RSI is a momentum oscillator that measures the magnitude of recent price gains relative to recent price losses. It is calculated as:

$$RSI_t = 100 - \frac{100}{1 + RS_t}$$

where:

$$RS_t = \frac{\text{Average Gain over 14 days}}{\text{Average Loss over 14 days}}$$

A 14-day RSI is employed because it is the conventional specification widely used in technical analysis and provides a reasonable balance between short-term sensitivity and excessive signal noise.

The RSI ranges from 0 to 100. A buy signal is generated when RSI falls below 30, indicating an oversold market, while a sell/exit signal is generated when RSI rises above 70, indicating an overbought market. The 30 and 70 thresholds are conventional technical-analysis boundaries for identifying potential reversals.

Moving Average Convergence Divergence (MACD)

MACD measures momentum and trend changes through the difference between short- and long-term exponential moving averages:

$$MACD_t = EMA_{12,t} - EMA_{26,t}$$

A 9-day EMA of the MACD series is then calculated as the signal line:

$$Signal_t = EMA_9(MACD_t)$$

The conventional 12-day, 26-day, and 9-day specification is adopted to maintain comparability with established technical-analysis practice.

A buy signal is generated when the MACD line crosses above its signal line. A sell/exit signal occurs when the MACD line crosses below the signal line. The strategy therefore attempts to capture changes in both trend direction and market momentum.

Bollinger Bands

Bollinger Bands measure the position of the market price relative to its recent average and volatility. The middle band is defined as a 20-day SMA:

$$MB_t = SMA_{20,t}$$

The upper and lower bands are calculated as:

$$UB_t = SMA_{20,t} + 2\sigma_{20,t}$$

$$LB_t = SMA_{20,t} - 2\sigma_{20,t}$$

where σ20,t represents the standard deviation of prices over the previous 20 trading days.

A buy signal is generated when the price falls below the lower Bollinger Band, indicating a potentially oversold condition, while a sell/exit signal is generated when the price rises above the upper band, indicating a potentially overbought condition. The 20-day period and two-standard-deviation bands are selected because they constitute the conventional Bollinger Band specification and capture approximately one month of trading activity while adapting the bands to changing market volatility.

Trading Signal and Return Generation

To avoid look-ahead bias, trading decisions are based only on information available at the time the signal is generated. The position generated from day t's technical indicator is applied to the subsequent trading day's return. For each strategy, the position variable is coded as 1 when the strategy is invested in the market and 0 when it is outside the market.

Accordingly, strategy returns are calculated as:

$$R_{strategy,t} = Position_{t-1} \times R_t$$

where Position t-1 represents the trading position determined from information available on the previous trading day. This procedure ensures that the strategy does not use future price information when generating returns.

Performance Evaluation

Each technical strategy and the Buy-and-Hold benchmark are evaluated using several performance measures. Mean daily return is calculated as:

$$\bar{R} = \frac{1}{T}\sum_{t=1}^{T} R_t$$

Cumulative return is calculated through compounded daily returns:

$$CR = \prod_{t=1}^{T}(1 + R_t) - 1$$

Assuming an initial wealth of one monetary unit, final wealth is calculated as:

$$FW = \prod_{t=1}^{T}(1 + R_t)$$

Annualized volatility is estimated as:

$$\sigma_{annual} = \sigma_{daily}\sqrt{252}$$

where 252 represents the approximate number of trading days in one year.

Risk-adjusted performance is assessed using the annualized Sharpe ratio:

$$Sharpe = \frac{(\bar{R} - R_f)}{\sigma_R}\sqrt{252}$$

where R¯ is the mean daily strategy return, Rf is the corresponding daily risk-free rate, and σR is the standard deviation of daily strategy returns.

Statistical Tests and Robustness Checks

The empirical analysis is conducted using Stata. Paired t-tests are used to determine whether the mean daily returns generated by SMA, EMA, RSI, MACD, and Bollinger Bands differed significantly from the Buy-and-Hold benchmark. The hypotheses for each comparison are:

$$H_0 : \mu_{Technical} - \mu_{BH} = 0$$

$$H_1 : \mu_{Technical} - \mu_{BH} \neq 0$$

Statistical significance is assessed at the 5% level.

As a robustness check, the Wilcoxon signed-rank test is additionally employed. Unlike the paired t-test, the Wilcoxon test does not require the paired return differences to follow a normal distribution and therefore provides a useful non-parametric assessment of whether the technical strategies and Buy-and-Hold strategy differ systematically. Agreement between the paired t-test and Wilcoxon results is interpreted as stronger evidence regarding strategy performance.

In addition, performance is evaluated using both raw-return measures and risk-adjusted measures, particularly cumulative return, annualized volatility, and the Sharpe ratio. This reduces reliance on a single performance criterion and allows a strategy producing high returns at substantially greater risk to be distinguished from one providing superior risk-adjusted performance.

The methodology combines conventional technical-indicator specifications, clearly defined trading rules, multiple performance measures, and parametric and non-parametric statistical tests to provide a systematic comparison of active technical trading strategies with passive Buy-and-Hold investment on the Indonesia Stock Exchange.

RESULTS AND DISCUSSION

Results: Buy-and-Hold Strategy

Table 1. Return and Risk Performance of the Buy-and-Hold Strategy

Performance Indicator	Value
Mean Daily Return	0.000414
Final Wealth	8.3917
Cumulative Return (%)	739.17
Annualized Volatility (%)	20.28
Sharpe Ratio	0.5497

During the study period, the Buy-and-Hold strategy produced a positive mean daily return of 0.000414. An initial investment yielded a cumulative return of 739.17%, increasing to 8.39 times its starting value. The strategy demonstrated moderate risk-adjusted performance with an annualized volatility of 20.28% and a Sharpe ratio of 0.5497. The baseline for assessing technical trading methods is provided by these outcomes.

Performance of the Technical Trading Strategies

Table 2. Performance of the Buy-and-Hold, SMA, EMA, and RSI Strategies

Strategy	Mean Return	DailyFinal Wealth	Cumulative Return (%)	Annualized Volatility (%)	Sharpe Ratio
Buy-and-Hold	0.000414	8.3917	739.17	20.28	0.5497
SMA (20,50)	0.000427	11.8949	1089.49	13.88	0.7751
EMA (20,50)	0.000464	15.0457	1404.57	13.85	0.8435
RSI (14)	-0.000030	0.6221	-37.79	14.92	-0.0500

The EMA strategy performed the best overall out of all the strategies that are completed, with the highest cumulative return (1404.57%) and the highest Sharpe ratio (0.8435). Additionally, the SMA method produced larger cumulative returns with less volatility than the Buy-and-Hold strategy. The RSI strategy, on the other hand, generated negative returns and a negative Sharpe ratio, suggesting subpar investing performance over the research period.

Paired t-Test Results

Table 3. Paired t-Test Comparing Technical Trading Strategies with the Buy-and-Hold Strategy

Comparison	Mean Difference	Two-sided p-value	Decision
SMA vs. Buy-and-Hold	-0.0000155	0.8943	Not Significant
EMA vs. Buy-and-Hold	0.0000212	0.8561	Not Significant
RSI vs. Buy-and-Hold	-0.0004570	0.0000	Significant

The SMA and EMA strategies did not produce significantly greater mean daily returns than the Buy-and-Hold strategy, according to the paired t-test results ($p > 0.05$). However, the Buy-and-Hold strategy outperformed the RSI method, as seen by the much lower returns ($p < 0.001$).

Wilcoxon Signed-Rank Test Results

Table 4. Wilcoxon Signed-Rank Test Comparing Technical Trading Strategies with Buy-and-Hold

Comparison	*z*-statistic	p-value	Decision
SMA vs. Buy-and-Hold	-2.808	0.0050	Significant
EMA vs. Buy-and-Hold	-2.031	0.0423	Significant
RSI vs. Buy-and-Hold	-6.655	0.0000	Significant

The return distributions of the SMA, EMA, and RSI strategies differed significantly from those of the Buy-and-Hold strategy, according to the Wilcoxon signed-rank test. The Wilcoxon test indicates that the return distributions of the SMA and EMA methods differed considerably from the benchmark strategy, even though the paired t-test did not find any significant differences between their mean returns.

Performance of the MACD Trading Strategy

Table 5. Return and Risk Performance of the MACD Trading Strategy

Performance Indicator	Value
Number of Observations	6,398
Mean Daily Return	0.000272
Final Wealth	4.6270
Cumulative Return (%)	362.70
Annualized Volatility (%)	12.73
Sharpe Ratio	0.5377

The return and risk performance of the MACD trading technique throughout the course of the 20-year study period are shown in Table 5. The strategy had a 0.000272 positive mean daily return. A

cumulative return of 362.70% resulted from an initial investment growing to 4.6270 times its initial value. Compared to the Buy-and-Hold approach, the strategy's annualized volatility of 12.73% indicates comparatively lower investment risk. However, the MACD strategy's Sharpe ratio of 0.5377 is marginally lower than the Buy-and-Hold strategy's ratio of 0.5497, indicating that MACD did not offer better risk-adjusted performance.

Comparison of the MACD and Buy-and-Hold Strategies

Table 6. Statistical Comparison of the MACD and Buy-and-Hold Strategies

Statistical Test	Test Statistic	p-value	Decision
Paired t-test	t = -1.2698	0.2042	Not Significant
Wilcoxon Signed-Rank Test	z = -5.163	<0.001	Significant

The statistical comparison between the Buy-and-Hold and MACD strategies is shown in Table 6. At the 5% significance level, the paired t-test yielded a p-value of 0.2042, suggesting that there is no statistically significant difference between the two methods' mean daily returns. Consequently, it is not possible to reject the null hypothesis of equal mean returns. The Wilcoxon signed-rank test, on the other hand, yielded a statistically significant result ($z = -5.163$, $p < 0.001$), indicating that the MACD strategy's overall return distribution is substantially different from the Buy-and-Hold strategy's. The MACD method produced lower cumulative returns and did not exceed the Buy-and-Hold strategy in terms of average daily returns, despite having less volatility than the benchmark.

Performance of the Bollinger Bands Trading Strategy

Table 7. Performance of the Bollinger Bands Trading Strategy

Performance Indicator	Value
Number of observations	6,405
Mean daily return	0.000089
Final wealth	1.2686
Cumulative return (%)	26.86
Annualized volatility (%)	16.10
Sharpe ratio	0.1391
Number of entries	67
Number of exits	66

Table 7 presents the performance of the Bollinger Bands trading strategy. The strategy generated a positive mean daily return of 0.000089. An initial investment of one monetary unit increased to 1.2686 units by the end of the study period, representing a cumulative return of 26.86%. The annualized volatility of the strategy is 16.10%, which is lower than the volatility of the Buy-and-Hold strategy. However, its Sharpe ratio is only 0.1391, indicating weak risk-adjusted performance. Although the strategy reduced exposure to market risk by remaining invested during only 47.84% of the trading days, it generated substantially lower cumulative wealth than the Buy-and-Hold, SMA, EMA, and MACD strategies.

Statistical Comparison of Bollinger Bands and Buy-and-Hold

Table 8. Statistical Tests Comparing Bollinger Bands with Buy-and-Hold

Statistical test	Test statistic	p-value	Decision
Paired t-test	-3.5742	0.0004	Significant
Wilcoxon signed-rank test	-5.448	<0.001	Significant

With a mean difference of -0.000349, t = -3.5742, and p = 0.0004, the paired t-test revealed a statistically significant difference in the mean daily returns of the Buy-and-Hold and Bollinger Bands strategies. The Bollinger Bands approach produced substantially lower average daily returns than the Buy-and-Hold strategy, according to the negative mean difference. The hypothesis that Bollinger Band returns are less than Buy-and-Hold returns had a one-sided p-value of 0.0002. Consequently, the information clearly shows that the Buy-and-Hold strategy outperformed the Bollinger Bands technique. Additionally, a statistically significant result ($z = -5.448$, $p < 0.001$) is obtained via the Wilcoxon signed-rank test. This demonstrates the substantial difference between the distribution of Bollinger Bands returns and the distribution of Buy-and-Hold returns. In general, the Bollinger Bands approach is outperformed by the Buy-and-Hold benchmark.

Overall Comparison of the Six Strategies

Strategy	Mean Daily Return	Final Wealth	Cumulative Return (%)	Volatility (%)	Sharpe Ratio	Rank
Buy-and-Hold	0.000414	8.3917	739.17	20.28	0.5497	3
SMA	0.000427	11.8949	1089.49	13.88	0.7751	2
EMA	0.000464	15.0457	1404.57	13.85	0.8435	1
RSI	-0.000030	0.6221	-37.79	14.92	-0.0500	6
MACD	0.000272	4.6270	362.70	12.73	0.5377	4
Bollinger Bands	0.000089	1.2686	26.86	16.10	0.1391	5

Hypothesis Test Decisions

Hypothesis	Result	Decision
H_1: SMA vs Buy-and-Hold	$p = 0.8943$	Fail to reject H_0
H_2: EMA vs Buy-and-Hold	$p = 0.8561$	Fail to reject H_0
H_3: RSI vs Buy-and-Hold	$p < 0.001$	Reject H_0
H_4: MACD vs Buy-and-Hold	$p = 0.2042$	Fail to reject H_0
H_5: Bollinger Bands vs Buy-and-Hold	$p = 0.0004$	Reject H_0

technical trading strategies did not consistently outperform the Buy-and-Hold strategy. Although the EMA and SMA strategies generated higher cumulative returns and better risk-adjusted performance than the Buy-and-Hold strategy, these differences are not statistically significant. In contrast, the RSI and Bollinger Bands strategies performed significantly worse than the Buy-and-Hold strategy, while the MACD strategy showed no significant difference. Overall, the evidence suggests that the EMA strategy is the best-performing technical trading strategy over the 20-year period, but there is insufficient statistical evidence to conclude that technical trading strategies generally outperform the Buy-and-Hold strategy on the Indonesia Stock Exchange.

Discussion

Using 20 years of daily data from the Indonesia Stock Exchange, this study investigated whether technical trading tactics perform better than the Buy-and-Hold approach. The findings show that moving average-based strategies can enhance investment performance over time, with the EMA approach achieving the highest cumulative return, total wealth, and Sharpe ratio, followed by the SMA strategy. The greater average daily returns of EMA and SMA, however, are not statistically significant when compared to the Buy-and-Hold strategy, according to the paired t-test results. The MACD approach, on the other hand, demonstrated no statistically significant difference despite its comparatively reduced volatility, while the RSI and Bollinger Bands methods performed significantly worse than the Buy-and-Hold strategy. Overall, these results indicate that there is not enough statistical evidence to draw the conclusion that technical

trading strategies consistently outperform the Buy-and-Hold strategy in the Indonesian stock market during the study period, even though some technical trading strategies, especially EMA, may offer better descriptive performance.

CONCLUSION

According to the study's findings, throughout the course of the 20-year study period, the EMA method produced the highest cumulative return, total wealth, and Sharpe ratio of any technical trading technique. In descriptive performance measures, the SMA method also fared better than the Buy-and-Hold strategy, but the RSI and Bollinger Bands techniques yielded worse outcomes. The EMA and SMA strategies outperformed the Buy-and-Hold strategy in terms of risk-adjusted performance and cumulative returns, but statistical testing revealed that their mean daily returns are not significantly different. Overall, the results indicate that technical trading techniques do not always beat the Buy-and-Hold strategy on the Indonesia Stock Exchange, with the EMA strategy turning out to be the most successful method among those assessed. The study contributes to the existing literature by providing long-term empirical evidence from the Indonesian stock market and by comparing five widely used technical indicators—SMA, EMA, RSI, MACD, and Bollinger Bands against a common Buy-and-Hold benchmark using both return and risk-adjusted performance measures. The findings add to the debate surrounding the Efficient Market Hypothesis (EMH) by showing that certain trend-following strategies, particularly EMA, may offer practical performance advantages, but these advantages are not sufficiently consistent to establish statistically significant superiority over passive investment. Thus, the study extends the limited and mixed evidence from Indonesia and demonstrates that the effectiveness of technical analysis is strategy-dependent rather than universal, providing useful implications for investors, portfolio managers, and future research on trading strategies in emerging capital markets.

Recommendations

The Exponential Moving Average (EMA) method produced the highest cumulative return and the best risk-adjusted performance among the techniques analyzed, therefore investors in the Indonesia Stock Exchange may view it as a helpful technical trading strategy based on the study's findings. However, rather than depending solely on one trading strategy, investors should combine technical indicators with prudent risk management and fundamental analysis, as the statistical analysis did not show a significant performance advantage of the EMA and SMA strategies over the Buy-and-Hold strategy. Because they substantially underperformed the Buy-and-Hold benchmark during the study period, the RSI and Bollinger Bands techniques are not advised as stand-alone investment strategies. Future studies should look into other technical indicators, alternative parameter values, the impact of taxes and transaction costs, and the effectiveness of trading techniques in various market scenarios and emerging stock markets.

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