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MARKET EFFICIENCY AND TECHNICAL TRADING: AN EMPIRICAL STUDY OF MACD AND RSI INDICATORS IN MAJOR ASIAN STOCK INDICES

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Abstract

This study evaluates the effectiveness of the Moving Average Convergence Divergence (MACD) and Relative Strength Index (RSI) indicators in generating profitable trading strategies across ten major Asian stock markets from 2013 to 2023. Despite the Efficient Market Hypothesis (EMH) suggesting that technical analysis is ineffective due to all available information being reflected in asset prices, these indicators remain popular, especially in markets perceived as less efficient. We compare returns from four trading rules—MACD crosses zero, MACD crosses the signal line, RSI crosses the midline, and RSI enters oversold/overbought regions—against a buy-and-hold strategy. The results show that, in most Asian markets, MACD and RSI do not significantly outperform buy-and-hold, supporting weak-form market efficiency. However, the Singapore Exchange exhibits notable outperformance, particularly under MACD and RSI rules involving signal line crossings and extreme RSI levels. Even after optimizing trading rule parameters, these strategies rarely outperform buy-and-hold, with limited success in markets such as Hong Kong, Shenzhen, Shanghai, and Thailand. These findings suggest that while technical analysis may offer advantages in specific contexts, its overall effectiveness is constrained, particularly in more efficient markets. This research contributes to the debate on the viability of technical analysis and highlights the importance of market-specific considerations in applying trading strategies.

Keywords: Technical Analysis, Market Efficiency, and Asian Stock Markets

INTRODUCTION

Technical analysis has been a widely used approach in financial markets for decades, based on the idea that past market behavior can provide insights into future price movements. By examining historical prices, chart patterns, and statistical indicators, traders attempt to identify profitable strategies (Fama, 1998). However, according to the Efficient Market Hypothesis (EMH), asset prices in a fully efficient market already incorporate all available information, making it impossible for investors to consistently achieve above-average returns

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using technical analysis alone (Fama, 1970). Despite this, many studies on technical trading rules claim profitability, even though they often fall short of explaining why these strategies might work—particularly in markets that are not perfectly efficient. More recently, behavioral finance has provided an alternative perspective, suggesting that psychological biases and irrational investor behavior contribute to market inefficiencies, which technical analysis may be able to exploit (Shiller, 2003).

The effectiveness of technical trading rules in investment decision-making remains a topic of ongoing debate, particularly within the framework of the Efficient Market Hypothesis (EMH). Research on technical analysis has produced mixed findings. Proponents of EMH argue that historical price data cannot reliably predict future price movements, making it unlikely that technical analysis can consistently outperform the market. This view is supported by studies suggesting that price fluctuations exhibit characteristics of a random walk, rendering past trends ineffective for forecasting future returns (Jensen & Bennington, 1970). For example, some studies indicate that widely used indicators such as the Moving Average Convergence Divergence (MACD) and the Relative Strength Index (RSI) fail to effectively forecast intraday stock prices in the U.S. market. This finding aligns with EMH, which posits that past price data cannot be systematically used to generate abnormal returns (Tanaka-Yamawaki & Tokuoka, 2007).

However, despite the Efficient Market Hypothesis (EMH), some research suggests that technical analysis can still be profitable, particularly in markets that are not fully efficient. In certain cases, factors such as behavioral biases and the presence of non-public information create opportunities that skilled traders can exploit. Some studies even indicate that specific technical trading strategies can outperform a simple buy-and-hold approach, especially in markets where efficiency is lower, such as those in Asia (Bessembinder & Chan, 1995).

This research seeks to evaluate the profitability of the Moving Average Convergence Divergence (MACD) and Relative Strength Index (RSI) indicators within Asian stock indices, where market efficiency can vary significantly. The MACD, which gained widespread use in the 1980s, and the RSI, introduced by Wilder in 1978, have remained staples in technical analysis for decades. Despite their enduring popularity, studies on the effectiveness of these indicators have yielded mixed results. Some research suggests that these tools can generate substantial returns, particularly in emerging markets or when employed by experienced traders who can potentially exploit market inefficiencies that contradict the Efficient Market Hypothesis (Fama, 1970). However, other studies challenge the reliability of these indicators, especially when factoring in transaction costs, which may diminish any abnormal profits and reinforce the implications of the Efficient Market Hypothesis (Tanaka-Yamawaki & Tokuoka, 2007).

The importance of this paper lies in its potential to provide clarity in an area where the existing literature remains ambiguous and inconclusive (Park & Irwin, 2007). While some studies have supported the profitability of technical analysis, particularly in less efficient markets, others have questioned its viability, suggesting that transaction costs and market conditions might negate any potential gains. This ambiguity underscores the need for further empirical research, particularly in diverse markets such as those in Asia, which may exhibit different levels of efficiency compared to more developed markets.

LITERATURE REVIEW

For decades, technical analysis has been widely used by traders who believe that historical price movements, chart patterns, and statistical indicators can offer insights into future market behavior. Despite its popularity, the effectiveness of technical analysis remains a contentious issue in financial research, particularly in relation to the Efficient Market

Hypothesis (EMH) introduced by Fama (1970). The EMH argues that all available information is already incorporated into asset prices, making it impossible to achieve consistent excess returns through historical price patterns alone. Early empirical studies such as Jensen and Bennington (1970) and Fama and Blume (1966) provided strong support for the weak-form EMH, concluding that trading strategies based on historical price movements failed to outperform a simple buy-and-hold approach. Similarly, Malkiel (2003) reinforced the idea that stock price movements resemble a random walk, making technical analysis unreliable.

Despite its theoretical limitations, technical analysis remains widely used among traders and investors, with numerous studies examining its potential profitability. Early research largely dismissed its effectiveness, but more recent studies—particularly in emerging markets—suggest that technical trading strategies can sometimes generate excess returns. This has led some researchers to question the absolute validity of the Efficient Market Hypothesis (EMH), arguing that markets do not always operate with perfect efficiency. For instance, Lo and MacKinlay (1988) found evidence of serial correlation in stock prices, indicating that price patterns may exist and could be exploited by traders. Bessembinder and Chan (1995) further explored this idea, discovering that trading strategies based on moving averages and trading range breakouts were particularly profitable in Asian stock markets, where inefficiencies were more pronounced. Similarly, Gunasekarage and Power (2001) found that moving average strategies outperformed the buy-and-hold approach in the Sri Lankan stock market, reinforcing the notion that technical analysis tends to be more effective in less efficient markets. Chong and Ng (2008) supported this argument by demonstrating that MACD and RSI indicators generated significant excess returns in the Hong Kong and Malaysian stock markets, highlighting how market inefficiencies can create opportunities for technical traders. Conversely, studies in more developed markets present mixed results. Tanaka-Yamawaki and Tokuoka (2007) examined the Tokyo Stock Exchange, finding that once transaction costs were factored in, MACD and RSI provided little to no consistent advantage—aligning with EMH predictions. Similarly, Chaysiri et al. (2019) analyzed the Thai stock market, specifically the SET50 Index, finding that while moving averages performed well under certain conditions, they failed to deliver consistent profitability across different market environments. These findings suggest that technical analysis may be more effective in markets where inefficiencies persist, but remains unreliable in more efficient markets. While price patterns and trading signals can sometimes offer profitable opportunities, their effectiveness is highly dependent on market structure, liquidity, and the presence of inefficiencies.

One of the strongest challenges to the EMH comes from behavioral finance, which suggests that markets are influenced not only by rational decision-making but also by psychological biases, emotions, and irrational investor behavior. Kahneman and Tversky (1979) introduced Prospect Theory, showing that investors tend to overreact to losses and underreact to gains, which can lead to market inefficiencies. Shiller (2003) further explored the role of irrational exuberance, emphasizing that speculative bubbles and market overreactions could result in price trends that technical analysis might exploit. Jegadeesh and Titman (1993) provided empirical evidence supporting momentum strategies, where past winners continue to perform well in the short term, aligning closely with widely used indicators such as the Moving Average Convergence Divergence (MACD) and Relative Strength Index (RSI). Another influential study by De Bondt and Thaler (1985) found that investors tend to overreact to news, causing price reversals that could be exploited by contrarian trading strategies. These findings suggest that, while markets may be efficient in theory, real-world trading is often driven by behavioral biases, creating exploitable inefficiencies that technical traders may leverage.

A key limitation of technical analysis that must be considered is the impact of transaction costs. Even if technical strategies generate excess returns in some markets, trading fees can significantly erode or even eliminate profitability. Brock, Lakonishok, and LeBaron

(1992), found that certain technical trading rules could outperform buy-and-hold strategies, but later studies criticized their findings for potential data-snooping bias and failure to account for trading costs. Hudson, Dempsey, and Keasey (1996) demonstrated that, once transaction fees were factored in, any excess returns from technical trading disappeared in the UK stock market. Park and Irwin (2007) conducted a large-scale meta-analysis of technical trading studies, concluding that while some strategies appear profitable, most fail to consistently outperform the market when considering transaction costs. These findings reinforce the need for empirical research that not only evaluates the raw profitability of technical indicators but also accounts for real-world constraints that affect traders' bottom lines.

In summary, the literature on technical analysis presents a complex and evolving picture. While early studies aligned with the EMH and dismissed the predictive power of historical prices, later research—particularly in the context of behavioral finance and emerging markets—suggests that inefficiencies do exist and can be exploited under certain conditions. However, factors such as transaction costs, data-snooping bias, and evolving market structures make it difficult to draw definitive conclusions. This study seeks to provide further clarity by examining whether MACD and RSI remain profitable in Asian stock indices, considering the role of market efficiency, behavioral biases, and trading costs. Given the conflicting evidence in existing research, a deeper investigation into regional market conditions is essential in determining the true value of these technical trading strategies.

DATA

The ten largest Asian stock market indices of 2023 were selected based on their market capitalization and overall significance in the region. These indices represent the key financial markets across Asia, offering a broad perspective on the economic and investment landscape. The indices included in the study are presented in Table 1. Selection criteria were based on the prominence of the stock market within its respective country and its contribution to the collective ability of the selected markets to provide a comprehensive representation of the Asian market. This approach ensures that the study's analysis captures the most influential and relevant stock indices in the region, supported by current market data. We utilized data from Yahoo Finance, extracting the top ten Asian stock indices: ^BSESN, ^N225, ^HSI, 399001.SZ, 000001.SS, ^NSEI, ^KS11, ^TWII, ^STI, and ^SET.BK. The dataset covers a ten-year period, from September 30, 2013, to September 30, 2023, with daily measurement frequency.

Table 1: The 10 Largest Asian Stock Market Indices of 2023, Selected Based on Significance and Market Capitalization.

Stock Exchange	Country/Region	Index Name	Index Symbol
Bombay Stock Exchange	India	S&P BSE SENSEX	^BSESN
Tokyo Stock Exchange	Japan	Nikkei 225	^N225
Hong Kong Stock Exchange	Hong Kong	HANG SENG INDEX	^HSI
Shenzhen Stock Exchange	China	Shenzhen Index	399001.SZ
Shanghai Stock Exchange	China	SSE Composite Index	000001.SS
National Stock Exchange	India	NIFTY 50	^NSEI
Korea Exchange	South Korea	KOSPI Composite Index	^KS11
Taiwan Stock Exchange	Taiwan	TSEC Weighted Index	^TWII
Singapore Exchange	Singapore	STI Index	^STI
The Stock Exchange of Thailand	Thailand	SET Index	^SET.BK

RESEARCH HYPOTHESES

This research explores the concepts of technical analysis and the trading rules associated with it by focusing on two key technical indicators: the Moving Average Convergence Divergence (MACD) and the Relative Strength Index (RSI). These indicators are used to assess market trends and momentum, helping traders to make informed decisions about buying and selling. The study aims to evaluate the effectiveness of these indicators by comparing their performance against a simple buy-and-hold strategy, determining which approach yields higher average returns. Based on technical analysis using two indicators (Moving Average Convergence Divergence - MACD and Relative Strength Index - RSI) and comparing these strategies with the traditional buy-and-hold strategy, the following hypotheses can be set:

Null Hypothesis 1 H_0: Investment returns generated using the MACD (Moving Average Convergence Divergence) technical analysis strategy are less than or equal to those generated by the buy-and-hold strategy.

Alternative Hypothesis 1 H_1: Investment returns generated using the MACD technical analysis strategy are greater than those generated by the buy-and-hold strategy.

Null Hypothesis 2 H_0: Investment returns generated using the RSI (Relative Strength Index) technical analysis strategy are less than or equal to those generated by the buy-and-hold strategy.

Alternative Hypothesis 2 H_1: Investment returns generated using the RSI technical analysis strategy are greater than those generated by the buy-and-hold strategy.

RESEARCH METHODOLOGY

The Exponential Moving Average (EMA) is a technical indicator that places more weight on recent prices in its calculation, making it more responsive to new information compared to the Simple Moving Average (SMA). The EMA is used to identify the direction of a price trend.

The EMA is calculated as follows:

$$EMA_t = \frac{x_t + (1-\alpha)x_{t-1} + (1-\alpha)^2 x_{t-2} + \ldots + (1-\alpha)^t x_0}{1 + (1-\alpha) + (1-\alpha)^2 + \ldots + (1-\alpha)^t}$$

Where the smoothing factor α is defined as:

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

The Moving Average Convergence Divergence (MACD) is a momentum indicator that helps identify the direction and strength of a trend in a financial asset's price. It is calculated by subtracting the Exponential Moving Average (EMA) of a longer period from the EMA of a shorter period. The MACD is composed of two main elements: the MACD line, which represents the difference between the shorter-period EMA and the longer-period EMA; and the signal line, which is an EMA of the MACD line itself, typically calculated over a specified period. The MACD generates trading signals based on the interaction between these two lines. A "buy" signal is indicated when the MACD line crosses above the signal line, suggesting that the asset's momentum is shifting positively. Conversely, a "sell" signal is generated when the MACD line crosses below the signal line, indicating a potential downturn in momentum. The general formula for the MACD is:

$$MACD = EMA(P, \text{Shorter Period}) - EMA(P, \text{Longer Period})$$

The shorter period refers to an EMA that reacts more quickly to price changes, while the longer period EMA provides a smoother, more stable trend. The difference between these two EMAs helps traders identify shifts in momentum that may signal buying or selling opportunities.

In addition to these signals, the MACD's relationship with the zero line is also crucial for interpreting market trends. The zero line, or baseline, represents the point at which the shorter-period EMA and the longer-period EMA are equal, meaning the MACD line equals zero. When the MACD line crosses above the zero line, it indicates a shift towards a bullish trend, as the shorter-period EMA has moved above the longer-period EMA. This is a positive signal that momentum is increasing, and it may reinforce a buy signal. Conversely, when the MACD line crosses below the zero line, it suggests a bearish trend, where the shorter-period EMA falls below the longer-period EMA. This is a negative signal that momentum is decreasing, which can confirm a sell signal.

The Relative Strength Index (RSI) is a momentum oscillator that measures the speed and change of price movements. It ranges from 0 to 100, with a reading above 70 or 80 indicating that the asset is "overbought," and a reading below 30 or 20 indicating that it is "oversold." The RSI helps traders identify potential reversal points where an asset may change direction. The RSI is calculated as follows:

$$RSI = 100 - \left(\frac{100}{1 + \frac{\text{Average Gain}}{\text{Average Loss}}} \right)$$

Where: Average Gain = Moving Average of gains over a specified number of days, and
Average Loss = Moving Average of losses over a specified number of days

Following the methodology of Brock et al. (1992), later refined by Hudson, Dempsey, and Keasey (1996), Gunasekarage and Power (2001), and Kwon and Kish (2002), we implement a rule that disregards any additional buy or sell signals occurring within ten days of an initial signal. This approach provides a clearer evaluation of the MACD and RSI indicators in comparison to the buy-and-hold strategy by focusing specifically on ten-day returns. By filtering out frequent signals, this method reduces market noise, allowing for a more meaningful assessment of each strategy's short-term effectiveness.

The buy-and-hold strategy involves holding a position for a fixed period of 10 days without taking into account any buy or sell signals. As a result, the return from this strategy is effectively the average return over the 10-day period, providing a straightforward benchmark for comparison with our trading rule strategies.

$$r^{10}_{\text{buy and hold}} = \ln(P_{t+10}) - \ln(P_t)$$

In contrast to the buy-and-hold strategy, we place a buy order only when a buy signal is triggered by each indicator. The return is calculated by buying at the closing price on the day the signal occurs (t) and selling at the closing price 10 days later (t+10). The calculation of the 10-day return (r^{10}_{buy}) is based on the following equation:

$$r^{10}_{buy} = \ln\left(P_{t+10}\right) - \ln(P_t)$$

We also place a sell order only when a sell signal is triggered by each indicator. The return is calculated by selling at the closing price on the day the signal occurs (t) and buying at the closing price 10 days later (t+10). The calculation of the 10-day return (r^{10}_{sell}) is based on the following equation:

$$r_{sell}^{10} = \ln(P_t) - \ln(P_{t+10})$$

We use the MACD as a buy and sell signal according to the following rules:

MACD Rule 1

- **Buy Signal (Long Position)**: When the MACD line crosses the zero line from below to above.
- **Sell Signal (Short Position)**: When the MACD line crosses the zero line from above to below.

This rule applies the MACD with the settings (N1, N2,0), where N1 is the short-term EMA period, N2 is the long-term EMA period, and 0 indicates no signal line is used, focusing on the MACD line's crossing of the zero line instead. In our study, we use MACD (12,26,0) as the MACD (12,26,0) is well-known in technical analysis, with the standard settings of N1 as 12 days and N2 as 26 days being time-tested and widely used. These settings are considered a good balance for various market conditions, providing a reliable indicator for identifying potential trends and signals.

MACD Rule 2

- **Buy Signal (Long Position)**: When the MACD line crosses the signal line from below to above.
- **Sell Signal (Short Position)**: When the MACD line crosses the signal line from above to below.

This rule applies the MACD with the settings (N1, N2,N), where N1 is the short-term EMA period, N2 is the long-term EMA period, and N is the period for the signal line. In our study, we use MACD (12,26,9) because these parameters are the standard in technical analysis, offering a proven balance between sensitivity and accuracy. The 9-day signal line refines signals by smoothing out noise, making this combination reliable and effective across various market conditions.

We also use the RSI as a buy and sell signal according to the following rules:

RSI Rule 3

- **Buy Signal (Long Position)**: When the RSI line crosses above the midline (RSI = 50) from below.
- **Sell Signal (Short Position)**: When the RSI line crosses below the midline (RSI = 50) from above.

This rule applies the RSI with the settings (N,50), where N represents the number of periods used to calculate the Relative Strength Index (RSI). RSI (14,50) is used in this study because the 14-period is standard for momentum analysis, and the 50 level, as the midline, is commonly used to identify trend direction.

RSI Rule 4

- **Buy Signal (Long Position)**: When the RSI falls below 30 into the oversold region and then rises back above 30, it generates a buy signal.
- **Sell Signal (Short Position)**: When the RSI rises above 70 into the overbought region and then falls back below 70, it generates a sell signal.

This rule applies the RSI with the settings (N, N1/N2), where N represents the number of periods used to calculate the Relative Strength Index (RSI), N1 denotes the oversold level, and N2 signifies the overbought level. RSI (14, 30/70) is used in this study because the 14-period is the standard setting for calculating the Relative Strength Index, providing a balanced view of market momentum. The 30/70 levels are widely recognized thresholds for identifying oversold (below 30) and overbought (above 70) conditions, helping to pinpoint potential reversal points in market trends.

Table 2: Statistical Characteristics of 10-Day Returns for the Major Asian Stock Exchanges, Including the Mean, Standard Deviation (S.D.), Skewness, and Kurtosis.

Exchange	Symbol	Mean	S.D.	Skewness	Kurtosis
Bombay Stock Exchange	^BSESN	0.0049	0.03417	-1.9983**	16.9082**
Tokyo Stock Exchange	^N225	0.00342	0.03836	-0.7892**	3.8005**
Hong Kong Stock Exchange	^HIS	-0.00107	0.04012	-0.2896**	1.7275**
Shenzhen Stock Exchange	399001.SZ	0.00065	0.05323	-1.0859**	6.5168**
Shanghai Stock Exchange	000001.SS	0.00142	0.04305	-1.1281**	6.916**
National Stock Exchange	^NSEI	0.00492	0.03422	-2.0256**	16.9649**
Korea Exchange	^KS11	0.00095	0.03294	-1.3682**	13.2264**
Taiwan Stock Exchange	^TWII	0.00283	0.03187	-1.1064**	6.3968**
Singapore Exchange	^STI	0.00008	0.02954	-1.5724**	13.5074**
The Stock Exchange of Thailand	^SET.BK	0.00023	0.03115	-1.5286**	14.5991**

** Indicates Significance at the 95% Confidence Level. Returns Reflect a Buy-and-Hold Strategy, Serving as A Benchmark for Trading Rule Comparisons.

Table 2 summarizes the key descriptive statistics of 10-day returns across the major Asian stock exchanges, covering the mean, standard deviation (S.D.), skewness, and kurtosis. The Bombay Stock Exchange (BSE) and the National Stock Exchange (NSE) show the highest average returns, at 0.0049 and 0.00492, respectively. Most markets exhibited negative skewness, indicating that large losses tend to be more frequent than large gains. This is particularly evident in BSE and NSE, where skewness values of -1.9983 and -2.0256 indicate a strong tendency toward downside risk. At the same time, kurtosis values suggest that returns are highly leptokurtic, especially in BSE and NSE, where kurtosis exceeds 16. In simple terms, this indicates that returns in these markets experience more extreme ups and downs than a typical bell-shaped distribution would predict. When negative skewness and high kurtosis occur together, they signal an increased likelihood of severe losses, making risk management crucial. These patterns reflect how returns behave under a buy-and-hold strategy, providing a baseline for comparing trading rule strategies.

T-tests were conducted to assess whether the average returns from buy and sell signals differed significantly from those of the buy-and-hold strategy. As the buy and sell executions were analyzed separately, we could directly compare their performance against each other and the buy-and-hold approach. Additionally, we also evaluated the combined results of buy and sell trades based on the trading rules, providing a more comprehensive view of their overall effectiveness.

The differences between the average 10-day returns from buy signals only and the average 10-day returns from the buy-and-hold strategy were tested.

$$H_0 : \mu_{buy} - \mu_{buy\&hold} = 0$$

$$H_A : \mu_{buy} - \mu_{buy\&hold} > 0$$

The target level of significance was set at 0.05 and 0.10 and the variances σ^2_{buy} and $\sigma^2_{buy\&hold}$ were assumed to be constant across different samples. The t-statistic was calculated as:

$$t_{buy-buy\&hold} = \frac{\mu_{buy} - \mu_{buy\&hold}}{\sqrt{\frac{\sigma^2_{buy}}{N_{buy}} + \frac{\sigma^2_{buy\&hold}}{N_{buy\&hold}}}}$$

Additionally, the differences between the average 10-day returns from sell signals only and the average 10-day returns from the buy-and-hold strategy were tested.

$$H_0 : \mu_{sell} - \mu_{buy\&hold} = 0$$

$$H_A : \mu_{sell} - \mu_{buy\&hold} > 0$$

The target level of significance was set at 0.05 and 0.10 and the variances σ^2_{sell} and $\sigma^2_{buy\&hold}$ were assumed to be constant across different samples. The t-statistic was calculated as:

$$t_{sell-buy\&hold} = \frac{\mu_{sell} - \mu_{buy\&hold}}{\sqrt{\frac{\sigma^2_{sell}}{N_{sell}} + \frac{\sigma^2_{buy\&hold}}{N_{buy\&hold}}}}$$

Additionally, the difference between the combined average 10-day returns from both buy and sell signals and the average 10-day returns from the buy-and-hold strategy were tested.

$$H_0 : \mu_{buy+sell} - \mu_{buy\&hold} = 0$$

$$H_A : \mu_{buy+sell} - \mu_{buy\&hold} > 0$$

The target level of significance was set at 0.05 and 0.10 and the variances $\sigma^2_{buy+sell}$ and $\sigma^2_{buy\&hold}$ were assumed to be constant across different samples. The t-statistic was calculated as:

$$t_{(buy+sell)-(buy\&hold)} = \frac{\mu_{buy+sell} - \mu_{buy\&hold}}{\sqrt{\frac{\sigma^2_{buy+sell}}{N_{buy+sell}} + \frac{\sigma^2_{buy\&hold}}{N_{buy\&hold}}}}$$

Where:

μ_{buy} is the average 10-day return from only buy signals.

μ_{sell} is the average 10-day return from only sell signals.

$\mu_{buy+sell}$ is the combined average 10-day return from both buy and sell signals.

$\mu_{buy\&hold}$ is the average 10-day return from the buy-and-hold strategy.

σ_{buy} is the standard deviation of the 10-day returns only from buy signals.

σ_{sell} is the standard deviation of the 10-day returns only from sell signals.

$\sigma_{buy+sell}$ is the standard deviation of the combined 10-day returns from both buy and sell signals

$\sigma_{buy\&hold}$ is the standard deviation of the 10-day returns from the buy-and-hold strategy.

N_{buy} is the number of 10-day return observations from buy signals.

N_{sell} is the number of 10-day return observations from buy signals.

$N_{buy+sell}$ is the number of combined 10-day return observations from both buy and sell signals.

$N_{buy\&hold}$ is the number of 10-day return observations from the buy-and-hold strategy.

RESULTS

The tables below present the test results for the calculated indices of the 10 Asian Stock Market Indices, using data from 2013 to 2023, and applying our trading rules. They show the average 10-day returns for the Buy and Hold strategy, the average return differences from buy and sell signals compared to the buy-and-hold strategy, and whether the combined buy and sell signals generate higher returns than the buy-and-hold approach. N(Buy) and N(Sell) represent the number of occurrences of buy and sell signals, respectively. Buy > 0 indicates the proportion of buy signals that resulted in positive returns, while Sell > 0 indicates the proportion of sell signals that produced positive returns. An asterisk (*) indicates significance at the 90% level, while double asterisks (**) indicate significance at the 95% level. The numbers in parentheses represent the calculated t-statistics used to compare the return difference with the buy-and-hold strategy as the benchmark.

Across all 10 Asian stock markets, the analysis for rule 1 shows that the average 10-day returns following the buy signals generated by the MACD Rule 1 (12,26,0) strategy did not significantly outperform the buy-and-hold strategy. Similarly, the average 10-day returns following the sell signals did not significantly outperform the buy-and-hold strategy in any of the 10 markets. Furthermore, the combined average 10-day returns from both buy and sell signals did not significantly outperform the buy-and-hold strategy in any of the markets. This indicates that the MACD Rule 1 (12,26,0) strategy, specifically when using the MACD crosses zero signal, did not provide a statistically significant advantage over a simple buy-and-hold approach across the analyzed markets.

The analysis above shows that, similarly to Rule 1 (MACD crosses zero), the MACD Rule 2 strategy generally did not offer a statistically significant advantage over the buy-and-hold strategy in most Asian markets. In most cases, the average 10-day returns following both buy and sell signals did not significantly outperform the buy-and-hold strategy. The combined returns from buy and sell signals also failed to consistently improve over buy-and-hold. The Singapore Exchange, was an exception to this, where the MACD Rule 2 strategy significantly outperformed, with both buy and sell signals showing statistical significance at the 95% level. This suggests the MACD Rule 2 strategy was particularly effective in this market. Overall, except for Singapore, the strategy of the MACD line crossing the signal line (Rule 2) mirrored the results of Rule 1, offering no statistically significant advantage over the buy-and-hold approach in the analyzed markets.

Table 5 presents the results for rule 3, which was based on the RSI line crossing above the midline (RSI = 50), using the RSI(14,50). The analysis shows that, similar to the MACD Rule 2 strategy, the RSI Rule 3 strategy generally did not outperform the buy-and-hold strategy in most Asian markets. In most cases, the average 10-day returns following both buy and sell signals from the RSI Rule 3 strategy did not significantly exceed those of the buy-and-hold strategy. The combined returns from buy and sell signals also failed to consistently outperform buy-and-hold. Again, the Singapore Exchange yielded an exception to this pattern, where the RSI Rule 3 strategy showed a significant positive difference between strategies. Sell signals produced statistically significant positive returns, with the combined buy and sell signals also showing significance at the 95% level. Like the MACD Rule 2 strategy, the RSI Rule 3 strategy was particularly effective in this market. Overall, except for Singapore, the RSI Rule 3 strategy yielded results similar to the MACD Rule 2 strategy, offering no statistically significant advantage over the buy-and-hold strategy across the analyzed market

Rule 4, yielded results similar to Rules 1, 2, and 3; the RSI Rule 4 strategy generally did not outperform the buy-and-hold strategy across most Asian markets. In most cases, the average 10-day returns from both buy and sell signals did not significantly exceed those of the buy-and-hold strategy. The combined returns from buy and sell signals also failed to consistently outperform buy-and-hold, mirroring the results seen for the previous rules. An exception to this was the Singapore Exchange, where the RSI Rule 4 strategy significantly outperformed buy-and-hold, with both buy and sell signals showing statistical significance at the 95% confidence level. This aligns with the Singapore-specific results seen in the MACD Rule 2 and RSI Rule 3 strategies. Overall, Rule 4's results are consistent with Rules 1, 2, and 3, showing no significant advantage over the buy-and-hold strategy in most markets, except in Singapore, where it proved effective.

The research as it stands might have limitations due to the reliance on specific settings for the MACD and RSI indicators (i.e., MACD (12,26,0), MACD (12,26,9), RSI (14,50), and RSI (14,30/70)). These settings, while standard and widely used, may not be optimal for all market conditions or across different stock exchanges. The effectiveness of these trading strategies could be significantly influenced by the parameters chosen, and thus, the conclusion might depend heavily on these specific settings.

To make the research more robust and comprehensive, it is essential to explore a broader range of settings for each trading rule. By using a computer algorithm to perform trial-and-error testing, or what is commonly referred to as parameter optimization, we can back-test data across all 10 Asian stock exchanges to identify the best settings for each trading rule that yield the highest 10-day returns. This approach allows for a more thorough analysis by uncovering the most effective combinations of parameters for different market environments, ensuring that the conclusions drawn are not biased or limited by the initial parameter choices. By doing so, we imposed a constraint requiring the settings to generate at least one buy or sell signal per year, ensuring the practical applicability and relevance of the trading strategies. This prevents the optimization process from selecting settings that might be overly conservative or specific, which could result in few or no trading signals over long periods.

The results presented in Table 7 show that even after optimizing the parameters for each trading rule across the 10 Asian stock markets to maximize 10-day returns, both MACD (Rules 1 and 2) and RSI (Rules 3 and 4) strategies still rarely outperform the buy-and-hold strategy. The optimization process identified settings that led to some trading strategies outperforming the buy-and-hold approach, but this success was limited to a few markets, specifically the Hong Kong Stock Exchange, Shenzhen Stock Exchange, Shanghai Stock Exchange, and the Stock Exchange of Thailand.

Despite these instances of outperformance, it’s important to note that the results stem from back-testing, meaning they are based on historical data and the optimization of parameters in hindsight. In real-time trading, these optimal parameters would not have been known in advance, and thus the returns presented do not reflect what a trader could realistically achieve.

This outcome reinforces the concept of weak form market efficiency, which suggests that all past trading information is already reflected in asset prices, making it difficult for traders to consistently achieve above-average returns using historical data alone. The fact that even optimized trading strategies often do not outperform a simple buy-and-hold strategy supports the idea that markets are, at least to some extent, weak form efficient, where historical prices and indicators provide limited predictive power for future returns.

Table 3: Performance of Trading Strategies using the MACD (12,26,0) Rule Compared to the Buy-and-Hold Strategy Across Various Stock Exchanges.

Stock Exchange	Trading Rule	N(Buy)	N(Sell)	Buy-and-Hold Average Return	Average Excess Return from Buy Signals vs. Buy-and-Hold.	Average Excess Return from Sell Signals vs. Buy-and-Hold	Buy>0	Sell>0	Average Excess Return from Buy/Sell Signals vs. Buy-and-Hold
Bombay Stock Exchange	MACD (12,26,0)	25	28	0.0049	-0.00138 (-0.202)	-0.00615 (-0.985)	0.64	0.393	-0.00390 (-0.847)
Tokyo Stock Exchange	MACD (12,26,0)	28	33	0.00342	0.00347 (0.605)	-0.00479 (-0.648)	0.679	0.515	-0.00097 (-0.207)
Hong Kong Stock Exchange	MACD (12,26,0)	32	33	-0.00107	-0.00471 (-0.834)	0.00483 (0.939)	0.406	0.515	0.00007 (0.258)
Shenzhen Stock Exchange	MACD (12,26,0)	31	26	0.00065	-0.00936 (-1.294)	0.00577 (0.540)	0.355	0.538	-0.00215 (-0.389)
Shanghai Stock Exchange	MACD (12,26,0)	32	29	0.00142	-0.00035 (-0.067)	0.00266 (0.341)	0.562	0.517	0.00106 (0.233)
National Stock Exchange	MACD (12,26,0)	22	27	0.00492	0.00202 (0.288)	-0.01093 (-1.59)	0.727	0.296	-0.00528 (-1.028)
Korea Exchange	MACD (12,26,0)	31	33	0.00095	0.00231 (0.504)	-0.00507 (-0.902)	0.548	0.424	-0.00153 (-0.404)
Taiwan Stock Exchange	MACD (12,26,0)	24	34	0.00283	-0.00430 (-0.579)	-0.01493 (-3.022)	0.583	0.353	-0.0077 (-2.469)
Singapore Exchange	MACD (12,26,0)	36	39	0.00008	0.00519 (1.184)	-0.00704 (-1.58)	0.583	0.333	-0.00099 (-0.363)
The Stock Exchange of Thailand	MACD (12,26,0)	28	27	0.00023	0.00293 (0.61)	-0.00290 (-0.588)	0.679	0.519	0.00002 (0.02)

Notes: "Buy-and-Hold Average Return" refers to the average 10-day market return. "Average Excess Return from Buy (Sell) Signals vs. Buy-and-Hold" is the difference between the average 10-day return following buy (sell) signals and the buy-and-hold return. The numbers in parentheses are the corresponding t-statistics (Student's t-test), testing whether the excess returns are significantly greater than zero. "Buy > 0" and "Sell > 0" represent the proportion of buy and sell signals that resulted in positive returns. * indicates significance at the 90% level; ** indicates significance at the 95% level.

Table 4: Performance of Trading Strategies using the MACD (12,26,9) Rule Compared to the Buy-and-Hold Strategy Across Various Stock Exchanges.

Stock Exchange	Trading Rule	N(Buy)	N(Sell)	Buy-and-Hold Average Return	Average Excess Return from Buy Signals vs. Buy-and-Hold.	Average Excess Return from Sell Signals vs. Buy-and-Hold	Buy>0	Sell>0	Average Excess Return from Buy/Sell Signals vs. Buy-and-Hold
Bombay Stock Exchange	MACD (12,26,9)	62	58	0.0049	0.00063 (0.171)	-0.01405 (-3.298)	0.613	0.379	-0.00644 (-2.224)
Tokyo Stock Exchange	MACD (12,26,9)	62	52	0.00342	-0.00107 (-0.232)	0.00013 (0.024)	0.516	0.442	-0.00054 (-0.149)
Hong Kong Stock Exchange	MACD (12,26,9)	58	61	-0.00107	0.00653 (1.127)	0.00250 (0.564)	0.638	0.541	0.00442 (1.22)
Shenzhen Stock Exchange	MACD (12,26,9)	60	52	0.00065	-0.00212 (-0.424)	0.00277 (0.359)	0.417	0.462	0.00015 (0.033)
Shanghai Stock Exchange	MACD (12,26,9)	61	55	0.00142	-0.00306 (-0.835)	0.00222 (0.322)	0.492	0.491	-0.00050 (-0.145)
National Stock Exchange	MACD (12,26,9)	65	52	0.00492	-0.00129 (-0.348)	-0.01368 (-3.263)	0.538	0.423	-0.00685 (-2.371)
Korea Exchange	MACD (12,26,9)	57	62	0.00095	-0.00038 (-0.098)	-0.00100 (-0.264)	0.561	0.468	-0.00071 (-0.256)
Taiwan Stock Exchange	MACD (12,26,9)	60	59	0.00283	0.00269 (0.724)	-0.00283 (-0.704)	0.633	0.441	-0.00007 (-0.016)
Singapore Exchange	MACD (12,26,9)	61	57	0.00008	0.00776 (2.446)**	0.00721 (2.130)**	0.656	0.614	0.00749 (3.197)**
The Stock Exchange of Thailand	MACD (12,26,9)	61	55	0.00023	0.00187 (0.426)	-0.00406 (-1.348)	0.508	0.509	-0.00104 (-0.342)

Notes: "Buy-and-Hold Average Return" refers to the average 10-day market return. "Average Excess Return from Buy (Sell) Signals vs. Buy-and-Hold" is the difference between the average 10-day return following buy (sell) signals and the buy-and-hold return. The numbers in parentheses are the corresponding t-statistics (Student's t-test), testing whether the excess returns are significantly greater than zero. "Buy > 0" and "Sell > 0" represent the proportion of buy and sell signals that resulted in positive returns. * indicates significance at the 90% level; ** indicates significance at the 95% level.

Table 5: Performance of Trading Strategies using the RSI (14,50) Rule Compared to the Buy-and-Hold Strategy Across Various Stock Exchanges.

Stock Exchange	Trading Rule	N(Buy)	N(Sell)	Buy-and-Hold Average Return	Average Excess Return from Buy Signals vs. Buy-and-Hold.	Average Excess Return from Sell Signals vs. Buy-and-Hold	Buy>0	Sell>0	Average Excess Return from Buy/Sell Signals vs. Buy-and-Hold
Bombay Stock Exchange	RSI (14,50)	52	56	0.00490	0.00041 (0.107)	-0.01602 (-4.163)	0.558	0.357	-0.00811 (-2.837)
Tokyo Stock Exchange	RSI (14,50)	48	68	0.00342	0.00342 (0.571)	-0.01011 (-1.872)	0.583	0.353	-0.00451 (-1.103)
Hong Kong Stock Exchange	RSI (14,50)	58	63	-0.00107	0.00462 (0.804)	0.00075 (0.174)	0.586	0.476	0.00261 (0.726)
Shenzhen Stock Exchange	RSI (14,50)	59	56	0.00065	-0.00125 (-0.217)	0.00126 (0.129)	0.559	0.429	-0.00003 (-0.005)
Shanghai Stock Exchange	RSI (14,50)	58	57	0.00142	-0.00537 (-1.016)	-0.00360 (-0.593)	0.569	0.368	-0.00449 (-1.109)
National Stock Exchange	RSI (14,50)	49	57	0.00492	-0.00063 (-0.140)	-0.01407 (-3.807)	0.571	0.404	-0.00786 (-2.636)
Korea Exchange	RSI (14,50)	61	53	0.00095	0.00098 (0.209)	-0.00143 (-0.433)	0.557	0.491	-0.00014 (-0.045)
Taiwan Stock Exchange	RSI (14,50)	50	60	0.00283	-0.00130 (-0.273)	-0.00729 (-2.169)	0.58	0.417	-0.00457 (-1.59)
Singapore Exchange	RSI (14,50)	59	58	0.00008	0.00352 (1.025)	0.00520 (1.685)**	0.61	0.69	0.00435 (1.860)
The Stock Exchange of Thailand	RSI (14,50)	54	56	0.00023	0.00206 (0.448)	-0.00215 (-0.635)	0.528	0.536	-0.00008 (-0.034)

Notes: "Buy-and-Hold Average Return" refers to the average 10-day market return. "Average Excess Return from Buy (Sell) Signals vs. Buy-and-Hold" is the difference between the average 10-day return following buy (sell) signals and the buy-and-hold return. The numbers in parentheses are the corresponding t-statistics (Student's t-test), testing whether the excess returns are significantly greater than zero. "Buy > 0" and "Sell > 0" represent the proportion of buy and sell signals that resulted in positive returns. * indicates significance at the 90% level; ** indicates significance at the 95% level.

Table 6: The Performance of Trading Strategies using the RSI (14,30/70) Rule Compared to the Buy-and-Hold Strategy Across Various Stock Exchanges.

Stock Exchange	Trading Rule	N(Buy)	N(Sell)	Buy-and-Hold Average Return	Average Excess Return from Buy Signals vs. Buy-and-Hold.	Average Excess Return from Sell Signals vs. Buy-and-Hold	Buy>0	Sell>0	Excess Return from Buy/Sell Signals vs. Buy-and-Hold
Bombay Stock Exchange	RSI	32	63	0.0049	0.00588	-0.00983	0.594	0.365	-0.00454
	(14,30/70)				(0.975)	(-3.031)			(-1.476)
Tokyo Stock Exchange	RSI	29	61	0.00342	0.00494	-0.00545	0.552	0.426	-0.00210
	(14,30/70)				(0.657)	(-1.388)			(-0.575)
Hong Kong Stock Exchange	RSI	51	55	-0.00107	0.00373	0.00492	0.569	0.509	0.00435
	(14,30/70)				(0.580)	(1.024)			(1.088)
Shenzhen Stock Exchange	RSI	40	55	0.00065	-0.01586	-0.00396	0.5	0.4	-0.00897
	(14,30/70)				(-2.487)	(-0.468)			(-1.591)
Shanghai Stock Exchange	RSI	43	61	0.00142	-0.00185	-0.01048	0.581	0.41	-0.00691
	(14,30/70)				(-0.434)	(-1.864)			(-1.821)
National Stock Exchange	RSI	32	65	0.00492	0.00315	-0.01088	0.625	0.385	-0.00625
	(14,30/70)				(0.557)	(-3.475)			(-2.151)
Korea Exchange	RSI	38	57	0.00095	-0.00281	-0.00806	0.658	0.386	-0.00596
	(14,30/70)				(-0.270)	(-2.639)			(-1.311)
Taiwan Stock Exchange	RSI	43	68	0.00283	-0.00600	-0.00650	0.581	0.426	-0.00631
	(14,30/70)				(-0.936)	(-1.952)			(-1.954)
Singapore Exchange	RSI	51	52	0.00008	0.00888	0.00846	0.647	0.635	0.00867
	(14,30/70)				(2.149)**	(2.682)**			(3.312)**
The Stock Exchange of Thailand	RSI	45	60	0.00023	0.00290	-0.00126	0.578	0.483	0.00052
	(14,30/70)				(0.626)	(-0.456)			(0.142)

Notes: "Buy-and-Hold Average Return" refers to the average 10-day market return. "Average Excess Return from Buy (Sell) Signals vs. Buy-and-Hold" is the difference between the average 10-day return following buy (sell) signals and the buy-and-hold return. The numbers in parentheses are the corresponding t-statistics (Student's t-test), testing whether the excess returns are significantly greater than zero. "Buy > 0" and "Sell > 0" represent the proportion of buy and sell signals that resulted in positive returns. * indicates significance at the 90% level; ** indicates significance at the 95% level.

Table 7: The Optimal Parameter Settings for Each Trading Rule Across 10 Asian Stock Markets, Identifying the Configurations that Maximize 10-Day Returns for the MACD (Rules 1 And 2) and RSI (Rules 3 And 4) Strategies.

Exchange	Optimal Setting of Trading Rule 1	Average Excess Return from Buy/Sell Signals vs. Buy-and-Hold	Optimal Setting of Trading Rule 2	Average Excess Return from Buy/Sell Signals vs. Buy-and-Hold	Optimal Setting of Trading Rule 3	Average Excess Return from Buy/Sell Signals vs. Buy-and-Hold	Optimal Setting of Trading Rule 4	Average Excess Return from Buy/Sell Signals vs. Buy-and-Hold
Bombay Stock Exchange	MACD (21,36,0)	0.01111 (1.024)	MACD (26,46,5)	-0.00217 (-0.944)	RSI (9,50)	-0.00102 (-1.463)	RSI (22,30/70)	-0.00508 (-2.387)
Tokyo Stock Exchange	MACD (19,29,0)	0.00676 (0.683)	MACD (21,42,10)	0.00609 (0.679)	RSI (20,50)	-0.00134 (-0.618)	RSI (14,20/80)	0.00644 (0.471)
Hong Kong Stock Exchange	MACD (11,34,0)	0.00375 (0.954)	MACD (29,44,5)	0.00721 (2.279)**	RSI (41,50)	0.00678 (1.545)*	RSI (17,30/70)	0.0066 (1.675)**
Shenzhen Stock Exchange	MACD (23,38,0)	0.01044 (1.334)*	MACD (30,41,10)	0.00521 (0.654)	RSI (43,50)	0.01251 (1.991)**	RSI (8,20/80)	0.00712 (1.086)
Shanghai Stock Exchange	MACD (20,31,0)	0.00818 (1.394)*	MACD (12,27,5)	0.00637 (1.393)*	RSI (44,50)	0.00935 (1.801)**	RSI (22,30/70)	0.00622 (0.743)
National Stock Exchange	MACD (29,39,0)	0.01274 (1.128)	MACD (10,20,5)	0.00287 (-0.787)	RSI (30,50)	-0.00224 (-0.632)	RSI (17,30/70)	-0.00112 (-1.92)
Korea Exchange	MACD (10,33,0)	0.00253 (0.423)	MACD (43,54,5)	0.00308 (0.693)	RSI (36,50)	0.00786 (2.023)**	RSI (7,20/80)	0.00318 (0.677)
Taiwan Stock Exchange	MACD (16,26,0)	-0.00029 (-0.849)	MACD (21,35,6)	0.00446 (0.567)	RSI (7,50)	-0.0017 (-0.437)	RSI (33,30/70)	-0.00022 (-0.487)
Singapore Exchange	MACD (29,40,0)	0.00531 (1.566)*	MACD (13,25,5)	0.00925 (3.702)**	RSI (10,50)	0.00526 (2.302)**	RSI (13,20/80)	0.01292 (3.57)**
The Stock Exchange of Thailand	MACD (10,21,0)	0.00137 (0.355)	MACD (18,42,9)	0.00408 (1.379)*	RSI (25,50)	0.00637 (2.264)**	RSI (15,30/70)	0.00313 (1.157)

CONCLUSION

The analysis of trading strategies across 10 Asian stock markets, including MACD Rule 1 (crossing zero), MACD Rule 2 (crossing the signal line), RSI Rule 3 (crossing the midline), and RSI Rule 4 (crossing into oversold/overbought regions), generally shows that these strategies do not outperform the buy-and-hold strategy. Across most markets, the average 10-day returns following buy and sell signals failed to significantly exceed the returns of the buy-and-hold approach. The combined returns from these signals also did not consistently outperform the buy-and-hold strategy. The exception to this pattern is the Singapore Exchange, where both MACD and RSI strategies demonstrated statistically significant outperformance, particularly under Rules 2, 3, and 4. Even after optimizing the parameters for each trading rule to maximize 10-day returns, both MACD (Rules 1 and 2) and RSI (Rules 3 and 4) strategies still rarely outperformed the buy-and-hold strategy. The optimization process identified settings that led to some trading strategies outperforming the buy-and-hold approach, but this success was limited to a few markets, specifically the Hong Kong Stock Exchange, Shenzhen Stock Exchange, Shanghai Stock Exchange, and the Stock Exchange of Thailand. However, it's important to note that these results stem from back-testing, meaning they are based on historical data and the optimization of parameters in hindsight. In real-time trading, these optimal parameters would not have been known in advance, and thus the returns presented do not reflect what a trader could realistically achieve.

This outcome reinforces the concept of weak form market efficiency, which suggests that all past trading information, such as prices and volumes, is already reflected in asset prices. This makes it difficult for traders to consistently achieve above-average returns using historical data alone. The fact that even optimized trading strategies often do not outperform the simple buy-and-hold strategy supports the idea that markets in this region are at least weak-form efficient, where historical prices and indicators provide limited predictive power for future returns.

RESEARCH RECOMMENDATIONS

Based on the findings of this study, several research recommendations can be made to further explore and understand the dynamics of technical trading strategies in Asian stock markets:

1. The Singapore Exchange consistently showed statistically significant outperformance using the MACD and RSI strategies under specific rules. Future research should delve deeper into understanding the unique characteristics of the Singapore market that may contribute to this anomaly. This could involve analyzing market structure, trading behavior, or economic factors that might differentiate Singapore from other markets in the region.
2. While this study focused on MACD and RSI, future research should consider exploring other technical indicators or combinations of indicators to determine if they offer better predictive power or performance across different markets. This could include indicators such as Bollinger Bands, Stochastic Oscillators, or moving average crossovers.
3. This study focused on 10-day returns, but different time frames (e.g., 5-day, 20-day, or even intraday) might yield different results. Researching the performance of these trading strategies over various time horizons could provide insights into their effectiveness under different market conditions.
4. Given the varying performance across different markets, a comparative study that includes other global markets beyond Asia could help identify whether these findings

are region-specific or indicative of broader trends. This could also involve analyzing the performance of these strategies during different economic cycles.

5. Beyond traditional technical trading rules, future research could explore how algorithmic trading and machine learning methods could enhance trading strategies. Machine learning techniques, such as reinforcement learning, neural networks, and decision trees, have the potential to improve predictive accuracy by adapting to changing market conditions. Additionally, automated trading systems could provide valuable insights into the reliability of technical indicators when applied in real-time, high-frequency trading environments. By leveraging these advanced approaches, researchers can gain a deeper understanding of how data-driven models can refine and optimize trading strategies in dynamic financial markets.

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