

“The effectiveness of technical trading strategies: Evidence from Indian equity markets”

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THE EFFECTIVENESS OF TECHNICAL TRADING STRATEGIES: EVIDENCE FROM INDIAN EQUITY MARKETS

Abstract

The purpose of the study was to analyze the effectiveness of technical trading strategies in trading stocks of selected Indian companies represented in the Nifty 50 Index. The research was done using secondary data from January 2022 to August 2022. Hourly share prices of 14 largest companies as per market capitalization from 14 different sectors from the Nifty 50 Index were considered as a part of the study. Simple Moving Average, Exponential Moving Average – Relative Strength Index and Bollinger Bands – Relative Strength Index – strategies considered in the study. It was found that strategy based on Bollinger Bands and Relative Strength Index performed the best. Performance was considered with respect to both the number of stocks having a net profit and the number of stocks that were able to outperform the buy-and-hold strategy for the time period considered. The study considered several combined strategies and performance indicators, whereas previous studies used limited indicators. Out of the 14 stocks considered, the Simple Moving Average strategy was able to generate net profit for 8 stocks and it outperformed the buy-and-hold strategy for 6 stocks, Exponential Moving Average – Relative Strength Index strategy generated net profit for 6 stocks and it outperformed the buy-and-hold strategy for 5 stocks, and the Bollinger Bands – Relative Strength Index generated net profit for 11 stocks and it outperformed the buy-and-hold strategy for 10 stocks. The Bollinger Bands – Relative Strength Index strategy was able to outperform as it was more dynamic and entered and exited positions actively.

Keywords

equity performance, investing, Nifty 50, prediction,
technical analysis, trade indicators, India

JEL Classification

G11, G17

INTRODUCTION

Investing in the stock markets and trading securities in the stock market has gained a lot of popularity in India and awareness of this is growing in the country. When an individual first enters the equity market for trading or investing purposes, one of the concepts which they learn, are the many different types of technical indicators used for analysis. Technical indicators are those measures that are based on the principle that the past and present performance of a stock or equity can be used to determine the future value of the same. Technical indicators are used to anticipate the future movement of a stock.

When considering taking a position in the market, many factors must be taken into consideration such as the fundamentals of a company, factors like industry outlook, macroeconomic factors, technical aspects of the traded security are some of the factors that are considered when identifying trading stocks of a company. The fundamental aspects of a company contain factors such as the revenue, profits, a company's assets, liabilities, financial leverage, potential of growth,

past performance and future performance, based on the headwinds and tailwinds it might face in its operations, how it performs with respect to its peers, the present scenario and the future prospects of the industry in which the company under analysis belongs to, and the macroeconomic conditions. The technical aspects of a stock can consist of the price action of the stock, whether the counter is in an overbought zone or an oversold zone, market trend, etc. Both traders and investors alike use technical indicators to make decisions regarding when to enter a trade, when to exit a trade, and in evaluating the current trend of the market. The study will evaluate the outcome when a trader or an investor makes decision regarding a trade based purely on technical strategies which has been created by using different kinds of technical indicators. The research will also map the gains against the various trading strategies.

1. LITERATURE REVIEW AND HYPOTHESES

The study and analysis of historical stock prices is an activity that has been performed since the advent of the market, and this activity will continue to grow in the future. There has been a significant increase in retail participation in the Indian stock markets. As India's economy grows, its stock market will develop, which is accompanied by an inflow of capital and an increase in the number of investors participating in the markets. It was also observed how the number of investors who opened an account with brokers increased and how trading activities of established investors increased during the COVID-19 pandemic (Ortmann et al., 2020). The fear of missing out on earning significant returns and the greed of earning more also influences retail investors and their decisions (Gupta & Shrivastava, 2022), which can again lead to an influx of retail investors in stock market. India has also seen a rise in smartphone application, which allows hundreds of thousands of Indians to trade daily, a process for which people earlier relied on stock brokers (Sumant et al., 2022). Consequently, there is an ease in performing transactions in the stock market. There has been a rapid increase in the number of traders and investors in the stock market, who might lack the basic knowledge of the fundamentals of investing and trading. Now, many financial analysts and traders are sure that the economic and fundamental aspects of the security under consideration are an important aspect in determining the price of a security, many are also of the belief and opinion that the historical prices of the securities and the patterns and trends they create can give them insights on the movement of the security. The empirical analysis of these historical security prices, which is then used to come up with different in-

sights on stocks, is what can be defined as technical analysis. Technical analysis and the many different indicators that are used for the same basically work by considering the historical prices of securities. Many investors and traders use these indicators to come up with strategies they use in deciding when to enter and exit trades. The interpretation of these indicators is subjective to the individual. Many investors and traders often consider these indicators to be fool proof in the results they generate. However, there has also been discussion and research on how the variations seen in the stock prices are similar to the values, which can be generated from a simple chance model and that changes generated in the stock prices behave identical to outcome of a roulette wheel (Roberts, 1959). Research done in the past has also suggested that macroeconomic news related to the fundamentals does not have a significant impact on the share price, and evidence has been found on how the stock market's reaction to macroeconomic news is dependent on the state of the economy, for example, the announcement of better-than-expected results in strong economic times and good conditions will have a relatively weaker response than when that same announcement might be made during the stage of weak economy and bad conditions. Another factor that can cause changes in stock prices is the anticipation of cash flows of companies across different states of economy (McQueen & Roley, 1993).

Studies have been done on the effectiveness of trading strategies, signals, and indicators in different stock markets. Studies have illustrated how models using technical rules provide excess returns in comparison to a simple buy-and-hold strategy (Gençay, 1998). There is a positive correlation between stock market development and economic growth of a country (Mohtadi & Agarwal,

2001). Considering emerging markets, specifically, the Asian stock markets of Malaysia, Thailand, and Taiwan, it has been found that technical trading strategies do have predictive ability, and they can help in making decisions regarding when to enter and exit trades. Also, the buy or sell signals generated in US markets can be used in the Asian markets (Bessembinder & Chan, 1995). Another South Asian market study that used moving averages in its technical strategy in making trading decisions suggests that equity returns in these markets are predictable, and this also rejected the hypothesis that return earned by employing trading strategy is equal to the buy-and-hold strategy, also called the naïve strategy (Gunasekarage & Power, 2001). Another such study was also performed on other south east Asian countries, where the profitability of technical strategies was examined against the buy-and-hold strategy, and it was found that the emerging markets of Philippines, Indonesia, etc., generated stronger and profitable performance in comparison to the mature markets of Singapore. However, it was also concluded in the research that these returns were significantly diminished by the various transaction cost, hence, giving minimal net returns. Apart from these findings, it was also found that these technical trading indicators could not be used to time the markets. The research also spoke about how following the trading strategy can be useful to individual investors in dealing with the biases that are usually present while trading or investing. Biases can be when the investor can hold on to losing stocks for too long or quickly let go of potentially winning stocks. Finally, the research also concluded that the technical strategies are also not reliable in predicting the direction of the markets (Tharavanij et al., 2015). Similar research was also conducted in the Chilean market, which also exhibited the similar trend (Parisi & Vasquez, 2000). The research on analyzing the profitability of technical trading rule was also conducted on the Brazilian stock market, and it was found that momentum indicators performed better and outperformed technical trading rules based on moving averages. Finally, it was also concluded that the best trading strategy outperformed the passive approach of buy and hold in the Brazilian stock markets (Miralles-Quiros et al., 2018). Now coming to the predictability of the Indian stock market, it was found that the Indian stock market returns

are predictable, however this predictability varied across different industries, where some sectors and industries are more predictable than others, which can then lead to more profitability (Narayan & Bannigidadmath, 2015). Further study showed that the magnitude of predictability varies across sectors, and some sectors of the Indian stock market are more profitable than others (Narayan et al., 2014). Research was also done to find whether the profitability of the Indian stock markets gave appropriate compensation for the risks present in the market. This research has revealed that over the time period considered, various industries have been profitable and most of the industries from the nine industries considered were profitable. The paper also talked on how the Indian stock market profits showed seasonality (Narayan et al., 2017). A study done on predictability of 93 technical indicators on the S&P 500 returns did not find any conclusive answers (Fang et al., 2014). Another study conducted concluded that there is lower liquidity in emerging markets in comparison to developed markets and the results of the study also indicated that trading rules presented the ability to forecast when they were applied to emerging markets. The research also mentioned that inefficiencies in the emerging markets can be taken advantage of and used in predicting price movements (Ratner & Leal, 1999). When considering data from the S&P 500 and assessing whether technical trading strategy can outperform the investment strategy of buy and hold, it was found that technical indicator strategies that are based on the over and under reaction effects in the market perform better than the buy-and-hold strategy in only certain scenarios. The research concluded that the buy and hold strategy is also superior in seasonality aspects. The commonness of trading strategies using moving averages is understandable due to its ability to generate returns, which are adjusted to the risk and the ability to generate a positive alpha in comparison to other risk factors, especially when the market is highly volatile (Dichtl, 2020). Current literature indicates that there is a direct relation between the volume of stock traded and the prices of stocks in the Arab markets. These results are also synchronous with other similar studies in other markets, which concluded that volume volatility has a correlation to increasing price volatility (Sabri, 2008). Technical indicators are not always suitable for an individual

investor and are appropriate for professional investors as technical indicator signals can lead an investor to make decisions, which are very optimistic and which can in some instances be wrong and lead to a loss (Hoffmann & Shefrin, 2014). Studies conducted on the New Zealand markets have found that the markets in the country have become more efficient in recent times due to the increase in informational efficiency. The increase in the amount of information available to the investor has been increasing over time, and this has led to more efficient markets. Due to this, the effectiveness of technical trading strategy has decreased, and it was concluded that these strategies do not add value to New Zealand investors (Marshall & Cahan, 2005). Analysis of trading strategies and rules was also done in the MENA markets. It was found that the efficiency level varied in the MENA markets, with some country's markets being more efficient than others. The study also explained how strategies used, which are using different kinds of technical indicators, can vary depending on the costs that will be incurred during the transaction (Bley & Saad, 2020). Another study concluded that profitability in the Asian markets can be achieved even after transaction costs are considered (Hatgioannides & Mesomeris, 2007). Technical trading strategies using indicators like moving averages and MACD in the Brazilian stock market have a higher probability of generating profits but it was unlikely that they will beat the buy and hold strategy, when considering the impact of costs associated with the trading transactions (da Costa et al., 2015). Research has also been done on the use of technical analysis by fund managers. It was concluded that majority of these professionals use technical indicators. Also, technical analysis findings are used in conjunction with fundamental analysis, and it is reasonable to use technical indicators when shorter time frames are considered (Menkhoff, 2010). A study was also performed to find the impact of frequency on the market returns when using technical indicators; this study found that the returns generated from these indicators when they are used at higher frequency are better, and this can be aided by a steady central bank exchange rate policy. The returns generated by these indicators get minimized because of transaction

costs (Frömmel & Lampaert, 2016). Research on industry specific technical indicators performance has also been done. One such study was conducted to find the effectiveness of these indicators on prominent US tech companies, and it was found that when these indicators are applied capably, the investor can generate profits from them (de Almeida, 2020). Another study was done from steel industry perspective, and it was concluded that the technical indicator used in the study can provide profits (Zuzik et al., 2014).

Analyzing the studies on specific technical indicators, research on the effectiveness of simple moving averages and displaced moving averages in the Indian equity markets found that both the indicators were successful in beating the market. The study also concludes that the markets are inefficient (Kakani & Sundhar, 2011). Multiple leading technical indicators gave predictability, which can improve financial forecasting (Hidayat & Sihabuddin, 2021). A study evaluated the effectiveness of moving averages of different intervals on the US and Canada markets, and these indicators were able to explain variations in the markets (Lento, 2011). An Australian market study using moving averages found the profits generated to be contrarian in nature (Pavlov & Hurn, 2012). A study was also conducted where BRICS markets were considered and the performance of the moving average strategies was divided here, where in some countries the technical strategy beat the buy-and-hold strategy and vice versa (Sobreiro et al., 2016). Research done on the relative strength index, another type of the technical indicator, in the US markets found it to perform better than the buy-and-hold strategy. Also, using this indicator in combination with trend following indicators helped in dealing with the market volatility (Faber, 2012). Another study done on relative strength index indicator in Indian equity markets concluded this indicator to be effective, and coupled with other technical indicators and fundamentals can provide better results (Bhargavi et al., 2017). Studies have also been conducted on the use of machine learning techniques in predicting trend, and it was found that these techniques bettered both the buy-and-hold strategy and the technical trading strategies (Stanković et al., 2015). Research has been done to find whether the technical strategies using technical indica-

tors can be used profitably in the forex markets, as well and it was found that in the highly volatile forex markets, these technical strategies can be used profitably when using them together with proper money management and by using fundamental information (Vajda, 2014). There have been studies on technical indicators in the past, the current study will evaluate trading strategies created by combining technical indicators in the Indian equity markets. The three strategies used in the study are based on hourly share prices of different companies as inputs for generating the triggers to enter and exit trades.

The following are the hypotheses for the study:

- H_1 : *The SMA Crossover Strategy outperformed its peer strategies and beat the buy-and-hold strategy.*
- H_2 : *The Exponential Moving Average - RSI Strategy outperformed its peer strategies and beat the buy-and-hold strategy.*
- H_3 : *The Bollinger Bands - RSI Strategy outperformed its peer strategies and beat the buy-and-hold strategy.*

2. METHODS

This study compares different trading strategies with the investment approach of buy and hold in order to help in the assessment. The research is based on secondary dataset. The data considered for the study is for the time period from January 1, 2022 till August 28, 2022. The study considers companies with the highest market capitalization, and each company belongs to one of the 14 different sectors, which are present in the Nifty 50 index of the Indian equity market. The 14 sectors from which the companies are considered are Automobile and Auto Components, Chemicals, Construction, Construction Material, Consumer Durables, Fast Moving Consumer Goods, Financial Services, Healthcare, Information Technology, Metals & Mining, Oil Gas & Consumable Fuels, Power, Services, Telecommunication. The companies considered for the study are depicted in the Appendix section, Table A1. To prevent the observations from having biases, companies from different sectors have been considered. The process of applying the trading strategies is done on the Trading View platform. All the strategies had an initial capital of INR. 10000. This capital is used in purchasing shares. The logic of the strategy

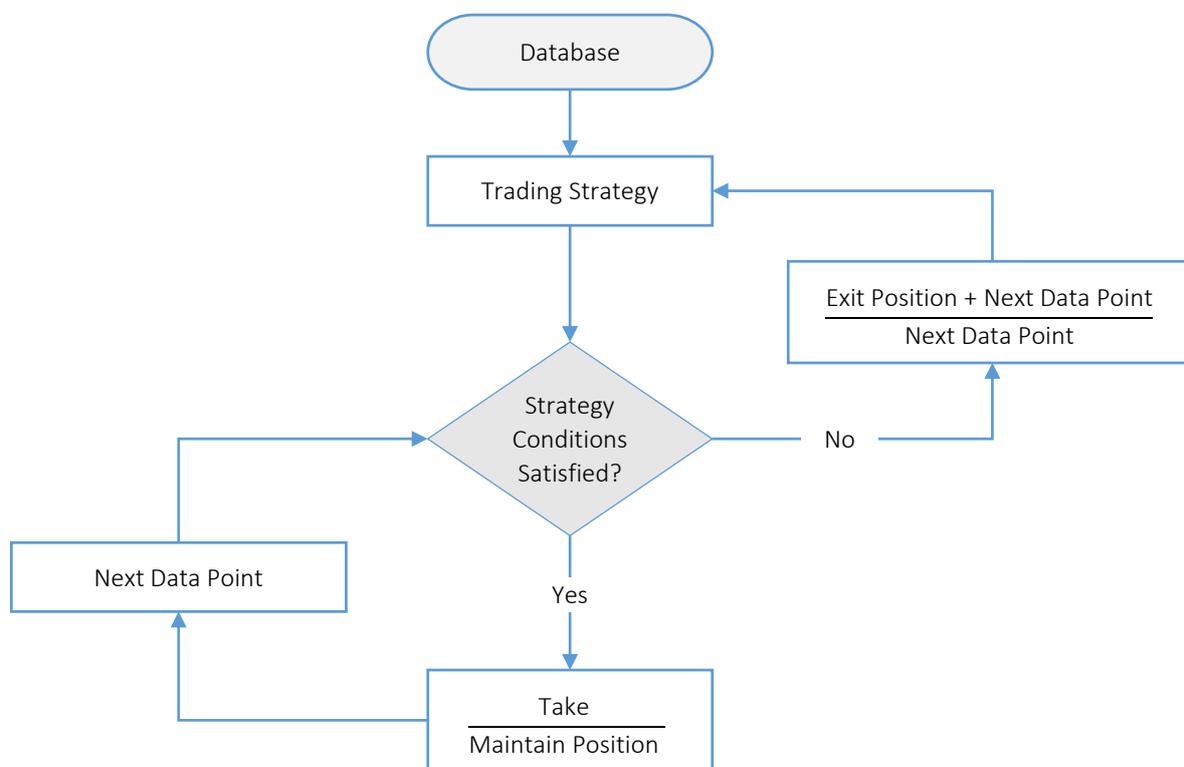


Figure 1. Flowchart depicting the framework for implementing a trading strategy

being tested has to be composed in the platform, which is also presented in Figure 1. These formulated strategies are in the form of code that has been fed and programmed in the platform.

The variables that are used in evaluating the strategies are net profit, gross profit, gross loss, max run-up, max drawdown, buy & hold return, Sharpe ratio, Sortino ratio, profit factor, number of winning trades, number of losing trades & percent profitable.

The technical indicators that are used in the strategies are simple moving averages, exponential moving averages, relative strength index and Bollinger bands. Simple moving averages are some of the most basic kinds of indicators which are used in trading. These are derived by adding the most recent share prices and dividing the total number of periods in consideration.

$$SMA = \sum_{i=1}^n \frac{A_i}{n}, \quad (1)$$

where A_n = price of asset at period n ; n = total number of periods.

Thus, the average changes every period and is therefore moving across the chart when plotted. They can be used in identifying an uptrend or a downtrend. A shorter-term moving average gives a closer depiction of the recent price action. Whereas, a longer-term moving average smooths out these price volatilities. In simple moving average, equal weightage is given to each of the prices considered within the time period during the calculation. This does not give an accurate depiction of the recent price trend. Older prices should have lower weightage in comparison to the most recent prices, as the most recent prices have higher impact on the upcoming price trends. To deal with this, exponential moving averages are used.

$$EMA_{current} = EMA_{previous} + \alpha [Price_{current} - EMA_{previous}] \quad (2)$$

However, this high weightage to recent values can also negatively impact the average, when there is high volatility in the prices. Relative Strength Index is a momentum indicator. It is a technical

indicator used in displaying the momentum of the stock price. RSI can be used to identify whether the security is in an overbought or oversold state.

$$RSI = 100 - \frac{100}{1 + RS}, \quad (3)$$

$$RS = \frac{n_{up}}{n_{down}}, \quad (4)$$

where n_{up} = average of n -day up closes; n_{down} = average of n -day down closes.

Bollinger bands are plotted at some standard deviations both above and below a simple moving average. Generally, the upper and lower bands are two standard deviations above and below a 20-time period simple moving average. The distance between the bands signifies the price volatility. The further apart the bands are from the SMA, the more volatile is the price action and vice versa. A strong trend can be anticipated if the stock price breaches the Bollinger bands.

Three trading strategies have been analyzed and tested in this research study. The first strategy is a simple moving average crossover strategy. In this strategy, 2 SMAs of different durations are being used. Trade entry and exit signals are generated when the two different duration SMAs cross each other. The short-term simple moving average is considering 50 time periods and the long term simple moving average is considering 200 time periods. When the short-term simple moving average crosses over the long-term simple moving average, a positive trend is indicated, thus a trade entry or a buy signal is generated. Whereas, when the short-term simple moving average crosses under the long-term simple moving average, a negative trend is being indicated, thus a trade exit or a sell signal is generated. In the second strategy, instead of using simple moving averages, the study will be employing exponential moving averages. The study will also be validating the buy signal which are generated by verifying the RSI indicator, which is a momentum indicator. In this strategy, when the short term or the faster EMA will cross over the long term or slower EMA and the relative strength index is greater than 50, a trade entry or a buy signal will be generated. If any of these

two conditions are not fulfilled, then that signifies a trade exit or a sell signal. The third strategy uses Bollinger bands and relative strength index indicators. In this case, when the closing price of the stock is higher than the simple moving average component of the Bollinger Band and it is supported by a relative strength index which is greater than 50, a trade entry signal is generated. When the share price touches the lower Bollinger band or if the relative strength index is below the appropriate level, a trade exit signal is generated.

3. RESULTS

All strategies were run on the hourly charts of companies as shown in Figures 2, 3 and 4. The Simple Moving Average (SMA) Crossover Strategy was able to generate net profit for 8 stocks and a net loss for 6 stocks. The SMA Crossover Strategy was able to outperform the buy and hold investing strategy for 6 stocks. Analyzing specific stocks, it was observed that the SMA Crossover Strategy had produced the highest net profit percentage which was equal to 25.71 %, when trading UPL Ltd. Over the time period considered, the strategy undertook only 2 trades in UPL Ltd., and both were winning or profitable trades.

The Exponential Moving Average (EMA) & Relative Strength Index (RSI) Strategy was able to generate net profit for 6 stocks and a net loss for 8

stocks. The EMA – RSI Strategy was able to outperform the buy-and-hold investing strategy for 5 stocks. Analyzing specific stocks, it was observed that the EMA – RSI Strategy had produced the highest net profit percentage, which was equal to 4.86 %, when trading Maruti Suzuki Ltd. Over the time period considered, the strategy undertook only 3 trades in Maruti Suzuki Ltd., of which 2 trades were winning and 1 trade was losing.

Finally, evaluating the performance of the Bollinger Bands – RSI Strategy, the study observed that the strategy was able to generate net profit for 11 stocks and a net loss for 3 stocks. The Bollinger Bands and RSI Strategy was able to outperform the buy and hold investing strategy for 10 stocks. Analyzing specific stocks, it was observed that the Bollinger Bands – RSI Strategy had produced the highest net profit percentage of 19.8 %, when trading Adani Ports Ltd. Over the time period considered, the strategy undertook 25 trades in Adani Ports Ltd. of which 10 trades were winning and 15 trades were losing. The Bollinger Bands – RSI strategy in general participated in a much higher number of trades in comparison to the other two strategies. The minimum number of trades undertaken by Bollinger Band – RSI Strategy were 23, and the maximum number of trades it took were 32. Whereas, minimum and maximum number of trades by SMA Crossover Strategy were 2 and 4, respectively, and the minimum and maximum number of trades by EMA – RSI Strategy were 1 and 4,



Figure 2. SMA Crossover Strategy applied on Maruti Suzuki Ltd.



Figure 3. EMA & RSI Strategy applied on Adani Ports & SEZ Ltd.

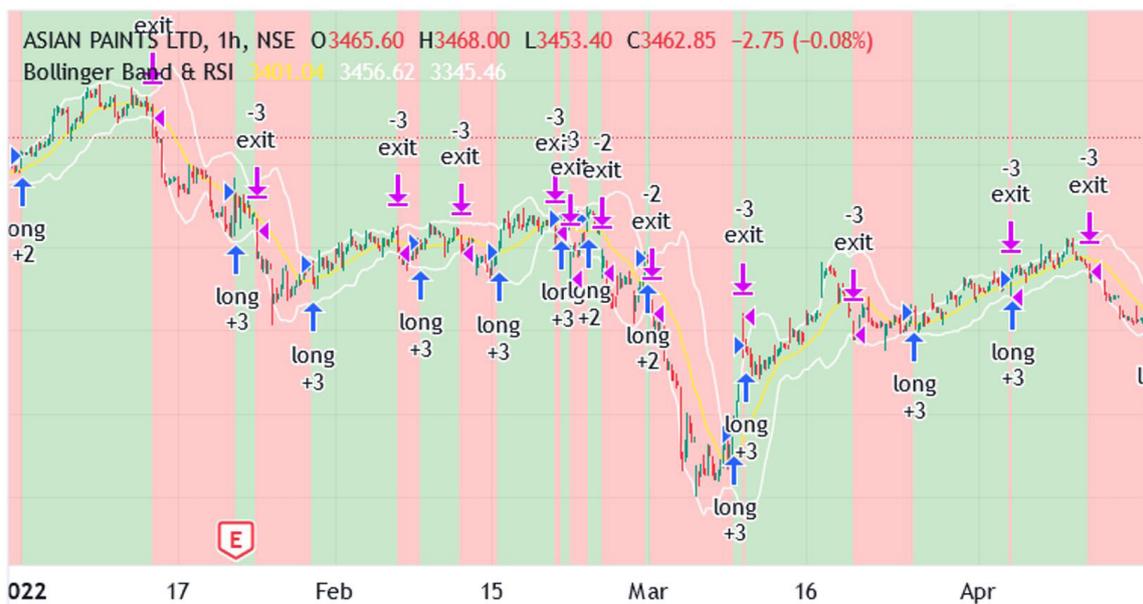


Figure 4. Bollinger Bands & RSI Strategy applied on Asian Paints Ltd.

respectively. The average profitability of trades undertaken by Bollinger Band – RSI Strategy across the 14 stocks considered was 39.54%. Thus, the Bollinger Band – RSI Strategy was much more dynamic and active, as demonstrated by the number of trades carried out according to the strategy. Participating in greater number of trades presented the strategy with more opportunities to either enter a position by buying shares – thereby capturing a stocks uptrend leading to the generation of profit and an increase in capital or exit a position by selling shares during a stock’s downtrend –

thereby preventing loss and a decrease in capital. Therefore, the study’s results support hypothesis H_3 . The results of the SMA Crossover Strategy, EMA – RSI strategy and Bollinger Bands – RSI Strategy are represented in Tables A2, A3, and A4 of the Appendix.

4. DISCUSSION

The results of the study show that trading strategy based on Bollinger Bands – Relative Strength Index (RSI) outperformed the remaining two

strategies considered, which used Simple Moving Average (SMA), Exponential Moving Average (EMA) and RSI indicators. Findings from this study are consistent with those discussed in the prior literature.

The results of the study are in line with Ni et al. (2020) who showed that investors in stocks of Taiwan 50 may be able to beat the markets by buying stocks when they hit the lower Bollinger band. This was shown by the abnormal positive returns generated. The study validated the results by considering both daily and weekly data of stock prices and a different Bollinger Band trading strategy, which was different from this study, which considered hourly prices. It further discussed how technical indicators might contain some information, which is embedded and not released.

The results of the study are not aligned with those in the study by Lento and Gradojevic (2007), which checked the efficiency of different strategies, including strategies based on moving average crossover and Bollinger bands on the S&P/TSX 300 Index, the Dow Jones Industrial Average Index, NASDAQ Composite Index, and the Canada/U.S.

spot exchange rate. In the study, the moving average crossover strategy consistently outperformed the buy-and-hold strategy and the Bollinger bands strategy did not, and this also concluded that the findings of the study could not be generalized into stating that all trading rules are profitable. The results of the study are coherent with the study by Windasari et al. (2018), which explored trading strategies based on Bollinger bands and Williams Percent Range in the Indonesian Stock Exchange over a one-year period. The strategy that had employed Exit Bollinger bands with confirmation by Williams Percent Range, where a position is entered when the close price of the stock is below the lower Bollinger band and when share is in oversold condition as per Williams % R and exits a position when close price of the stock is above the upper Bollinger band and the share is in overbought condition, was the strategy with the best performance. The research also had a strategy that utilized the middle band of the Bollinger, but it used Williams Percent Range instead of RSI, which is used in the current study, for confirmation, and it had the second-best performance among the three strategies. In this research study, the best performing strategy used Bollinger Bands and RSI for confirmation.

CONCLUSION

The aim of the study was to analyze the effectiveness of different technical trading strategies, namely, the Simple Moving Average Crossover Strategy, The Exponential Moving Average – Relative Strength Index Strategy and the Bollinger Bands – RSI Strategy, during the period under consideration from January 1, 2022 to August 28, 2022. After testing all the hypotheses, the study highlighted that the strategy based on Bollinger Bands and RSI performed the best out of the three strategies considered, with respect to both the number of stocks having a net profit and the number of stocks which were able to outperform the buy and hold strategy. Thus, the results support the hypothesis H_3 and reject hypotheses H_1 and H_2 . The reason why this strategy outperformed the other two is because it was much more dynamic in executing the trades. This can be inferred by the total number of trades the strategy initiated during the period under consideration. The Bollinger Bands and RSI strategy had an average of 26.5 executed trades across all the stocks, in comparison to the 3.2 and 3 average executed trades in the SMA Crossover and EMA & RSI strategy, respectively. Thus, executing a higher number of trades gave the strategy more opportunity to generate profit and take advantage of the uptrends in the market by creating and maintaining a market position and on the other hand, exiting from a market position during market downtrends. It would thus be ideal for a technical trading strategy to be active in entering and exiting position, as being agile in executing trades presents the strategy with more opportunities to capitalize on favorable stock price movements and market conditions. If both, the Sortino and the Sharpe Ratio is considered, higher the value of these ratios, better it is for the investor as they signify that the strategy earns more return per unit for the total risk and the downside risk, which have been taken by the strategies respectively. Negative Sortino and Sharpe ratio signifies that the strategy generates lower returns than

the risk-free rate. The Bollinger Bands and RSI strategy has had the highest number of positive Sharpe and Sortino ratios for the stocks under consideration. In conclusion, the strategy based on Bollinger Bands and RSI gave the best results.

This study is beneficial for investors and technical traders who would consider technical trading indicators to aid them in confirming their trading decisions and further providing them with an overview of the effectiveness of strategies based on indicators. The research is based on the assumption that the results displayed for the time period under consideration will also hold true for different time periods. However, the results will not be useful in the case of black swan events. Researchers can take this study further by considering different units of time instead of the hourly data which has been considered in this study. A longer time horizon can also be considered. Studying a longer time horizon will increase the data points and it can even contain data from black swan events, thus giving results which have been generalized even for the presence of black swan event. Researchers can also evaluate the effectiveness of strategies by performing sector specific analysis by collecting data for companies from a specific sector. There is also the possibility of evaluating efficiency of trading strategies using various types of technical indicators.

AUTHOR CONTRIBUTIONS

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Investigation: Jeevan Nagarkar, Dipen Paul, Dharmesh K. Mishra.

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APPENDIX A

Table A1. List of companies considered for the study

S. No.	Nifty 50 Sectors	Companies
1	Automobile and Auto Components	Maruti Suzuki India Ltd.
2	Chemicals	UPL Ltd.
3	Construction	Larsen & Toubro Ltd.
4	Construction Material	UltraTech Cement Ltd.
5	Consumer Durables	Asian Paints Ltd.
6	Fast Moving Consumer Goods	Hindustan Unilever Ltd.
7	Financial Services	HDFC Bank Ltd.
8	Healthcare	Sun Pharmaceutical Industries Ltd.
9	Information Technology	Tata Consultancy Services Ltd.
10	Metals & Mining	JSW Steel Ltd.
11	Oil Gas & Consumable Fuels	Reliance Industries Ltd.
12	Power	Power Grid Corporation of India Ltd.
13	Services	Adani Ports and Special Economic Zone Ltd.
14	Telecommunication	Bharti Airtel Ltd.

Table A2. SMA Crossover Strategy results

SMA Crossover Strategy														
Company Measure	Maruti Suzuki	UPL	LT	Ultratech	Asian Paints	HUL	HDFC Bank	Sun Pharma	TCS	JSW Steel	Reliance Industries	Power Grid Corp.	Adani Ports	Airtel
Net Profit	1633.95	2 571.30	456.5	219.75	398.55	277	-1209.90	-990.45	-745.00	-1212.05	113.9	-615.60	2117.05	-1366.20
	16.34%	25.71%	4.57%	2.20%	3.99%	2.77%	-12.1%	-9.9%	-7.45%	-12.12%	1.14%	-6.16%	21.17%	-13.66%
Gross Profit	1870.3	2571.3	987.5	695.8	1026.45	1114.6	0	0	0	0	940.8	0	2444	0
	18.70%	25.71%	9.88%	6.96%	10.26%	11.15%	0%	0%	0%	0%	9.41%	0%	24.44%	0%
Gross Loss	236.35	0	531	476.05	627.9	837.6	1209.9	990.45	745	1212.05	826.9	615.6	326.95	1366.2
	2.36%	0%	5.31%	4.76%	6.28%	8.38%	12.10%	9.90%	7.45%	12.12%	8.27%	6.16%	3.27%	13.66%
Max Run-up	1633.95	2571.3	987.5	695.8	1026.45	1114.6	0	0	0	0	940.8	0	2444	0
	14.04%	20.45%	9.44%	6.81%	9.87%	10.85%	0%	0%	0%	0%	8.92%	0%	20.17%	0%
Max Drawdown	405.4	91.2	532.5	552.6	762.9	1055.2	1209.9	990.45	745	1212.05	432.9	615.6	345.8	1366.2
	3.72%	0.81%	5.33%	5.53%	7.63%	10.55%	12.10%	9.90%	7.45%	12.12%	4.10%	6.16%	3.46%	13.66%
Buy & Hold Return	1185.3	269.1	608.5	-1078.85	230.85	859	-422.10	-47.85	-991.90	-5.60	603.6	1190.4	1334.45	371.7
	11.85%	2.69%	6.09%	-10.79%	2.31%	8.59%	-4.22%	-0.48%	-9.92%	-0.06%	6.04%	11.90%	13.34%	3.72%
Sharpe Ratio	0.485	0.678	0.203	0.062	0.125	0.069	-0.3	-0.41	-1.49	-1.259	0.178	-0.124	0.437	-0.294
Sortino Ratio	2.367	28.468	0.54	0.136	0.305	0.17	-0.395	-0.402	-0.83	-0.783	0.374	-0.181	1.968	-0.389
Profit Factor	7.913	N/A	1.86	1.462	1.635	1.331	0	0	0	0	1.138	0	7.475	0
Number Winning Trades	2	2	1	1	1	1	0	3	0	0	1	0	2	0
Number Losing Trades	1	0	2	2	2	3	4	1	3	4	2	2	1	4
Percent Profitable	66.67%	100%	33.33%	33.33%	33.33%	25%	0%	0	0%	0%	33.33%	0%	66.67%	0%

Table A3. EMA and RSI Strategy results

EMA & RSI Strategy														
Company Measure	Maruti Suzuki	UPL	LT	Ultratech	Asian Paints	HUL	HDFC Bank	Sun Pharma	TCS	JSW Steel	Reliance Industries	Power Grid Corp.	Adani Ports	Airtel
Net Profit	486.25	-1335.40	-208.00	-344.20	348.75	-793.60	308.15	-285.25	-1242.40	-27.95	188.45	371.25	417.45	-840.00
	4.86%	-13.35%	-2.08%	-3.44%	3.49%	-7.94%	3.08%	-2.85%	-12.42%	-0.28%	1.88%	3.71%	4.17%	-8.4%
Gross Profit	1276.9	721.4	1295.5	680	1275.15	941.1	1485.95	360.25	0	966.75	805.05	371.25	1129.2	545.4
	12.77%	7.21%	12.95%	6.80%	12.75%	9.41%	14.86%	3.60%	0%	9.67%	8.05%	3.71%	11.29%	5.45%
Gross Loss	790.65	2056.8	1503.5	1024.2	926.4	1734.7	1177.8	645.5	1242.4	994.7	616.6	0	711.75	1385.4
	7.91%	20.57%	15.04%	10.24%	9.26%	17.35%	11.78%	6.46%	12.42%	9.95%	6.17%	0%	7.12%	13.85%
Max Run-up	867.2	606.45	1295.5	680	1275.15	941.1	1485.95	223.3	0	966.75	805.05	371.25	1129.2	545.4
	8.27%	5.72%	13.23%	7.04%	12.32%	10.22%	14.42%	2.30%	0%	9.69%	7.90%	3.58%	10.84%	5.95%
Max Drawdown	1138.65	2260.3	1670	1196.95	1101.75	1998.7	1215	700.5	1242.4	1185.2	702.7	634.5	898.35	1850.4
	10.94%	21.31%	16.70%	11.97%	11.02%	19.99%	12.15%	6.91%	12.42%	11.85%	7.03%	6.35%	8.98%	18.50%
Buy & Hold Return	1726.25	-633.10	125	-1426.00	858.3	1120	-705.30	910.25	-1739.30	7	-49.20	-726.75	2056.6	811.3
	17.26%	-6.33%	1.25%	-14.26%	8.58%	11.20%	-7.05%	9.10%	-17.39%	0.07%	-0.49%	-7.27%	20.57%	8.11%
Sharpe Ratio	0.12	-0.268	-0.013	-0.143	0.093	-0.144	0.065	-0.26	-0.925	-0.025	0.037	N/A	0.096	-0.273
Sortino Ratio	0.19	-0.271	-0.018	-0.197	0.164	-0.177	0.117	-0.273	-0.679	-0.049	0.055	N/A	0.176	-0.303
Profit Factor	1.615	0.351	0.862	0.664	1.376	0.543	1.262	0.558	0	0.972	1.306	N/A	1.587	0.394
Number Winning Trades	2	2	1	1	1	1	2	2	0	1	2	1	2	1
Number Losing Trades	1	1	1	2	2	2	2	1	3	3	1	0	1	3
Percent Profitable	66.67%	66.67%	50%	33.33%	33.33%	33.33%	50%	66.67%	0%	25%	66.67%	100%	66.67%	25%

Table A4. Bollinger Bands and RSI Strategy results

Bollinger Bands & RSI Strategy														
Company	Maruti Suzuki	UPL	LT	Ultratech	Asian Paints	HUL	HDFC Bank	Sun Pharma	TCS	JSW Steel	Reliance Industries	Power Grid Corp.	Adani Ports	Airtel
Measure														
Net Profit	639.45	1778.85	383.9	-493.80	1787.15	1758	1084.3	-423.95	129.5	138.25	1597.25	-828.05	1980.45	247.4
	6.39%	17.79%	3.84%	-4.94%	17.87%	17.58%	10.84%	-4.24%	1.30%	1.38%	15.97%	-8.28%	19.80%	2.47%
Gross Profit	3275.4	4694.75	2740.8	1912.35	4020.6	3706	4086.25	3116.2	1712.45	3269.35	3882.8	2495.45	4355.75	3156.85
	32.75%	46.95%	27.41%	19.12%	40.21%	37.06%	40.86%	31.16%	17.12%	32.69%	38.83%	24.95%	43.56%	31.57%
Gross Loss	2635.95	2915.9	2356.9	2406.15	2233.45	1948	3001.95	3540.15	1582.95	3131.1	2285.55	3323.5	2375.3	2909.45
	26.36%	29.16%	23.57%	24.06%	22.33%	19.48%	30.02%	35.40%	15.83%	31.31%	22.86%	33.24%	23.75%	29.09%
Max Run-up	1412.9	2673.7	1275.05	967.2	2907.45	2589.2	1776.6	1013.55	888.15	1548	2043.65	1218.05	2283.1	1128.4
	13.05%	21.98%	12.10%	9.85%	24.29%	21.65%	15.37%	9.42%	8.60%	13.64%	17.39%	11.82%	18.95%	10.32%
Max Drawdown	1203.65	1301.35	1443.25	1199.3	1128.85	806.4	1643.5	1240.1	779.5	2408.2	1100.8	1582.15	1026	1365.9
	11.38%	12.16%	13.80%	11.99%	11.09%	7.95%	14.22%	11.52%	7.67%	21.21%	9.37%	15.35%	9.02%	12.50%
Buy & Hold Return	1434	-973.70	-366.75	-1405.00	82.7	1328	-437.70	645.7	-1570.90	-187.50	-42.20	-268.80	1703	915.6
	14.34%	-9.74%	-3.67%	-14.05%	0.83%	13.28%	-4.38%	6.46%	-15.71%	-1.87%	-0.42%	-2.69%	17.03%	9.16%
Sharpe Ratio	0.183	0.278	0.088	-0.147	0.397	0.427	0.323	-0.131	0.009	0.04	0.371	-0.225	0.353	0.053
Sortino Ratio	0.377	0.564	0.192	-0.212	0.905	1.108	0.635	-0.164	0.012	0.057	0.781	-0.273	0.665	0.078
Profit Factor	1.243	1.61	1.163	0.795	1.8	1.902	1.361	0.88	1.082	1.044	1.699	0.751	1.834	1.085
Number Winning Trades	12	9	10	9	13	10	9	11	10	11	10	8	10	13
Number Losing Trades	16	14	14	20	11	13	15	21	17	15	14	24	15	17
Percent Profitable	42.86%	39.13%	41.67%	31.03%	54.17%	43.48%	37.50%	34.38%	37.04%	42.31%	41.67%	25%	40%	43.33%