

A Performance Analysis of Technical Indicators on the Indian Stock Market

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1. Introduction

In the dynamic world of financial markets, investors and traders alike seek tools and methodologies that can provide insights into potential price movements and help them make informed decisions. Technical analysis stands at the forefront of such methodologies, offering a systematic approach to interpreting historical price data and identifying trends and patterns that may guide future market behavior.

Technical analysis is a method used to evaluate and predict future price movements of stocks and other financial instruments based on historical price data and trading volume. It operates on the premise that historical price movements and trading patterns can be indicative of future price movements. Technical analysis involves the use of various tools and indicators to analyze charts and identify trends, support and resistance levels, and potential entry and exit points for trades.

A robust technical analysis involves the construction of charts, trend lines, indicators, chart patterns, volume analysis, and candlestick patterns.

This paper delves into three powerful and widely-used technical indicators, Bollinger Bands, Moving Average Convergence

Divergence (MACD), and the Relative Strength Index (RSI), and makes a comparative study of the effectiveness of these indicators on the Indian stock market. For this study, stocks were chosen from 14 sectors listed on the National Stock Exchange (NSE) of India. The top stocks of each sector are identified based on their free-float market capitalization from the NSE's report published on July 1, 2022 (NSE Website). For each stock in 14 sectors, trading was done for one year from July 1, 2022, to June 30, 2023, with an initial capital of Indian Rupees (INR) 100,000 following the three technical indicators. For each stock, the technical indicator that yielded the highest return is identified. A comparative analysis is made based on the overall performance of the three indicators for all 14 sectors.

The current work has three unique contributions. First, it illustrates how the important technical indicators, Bollinger Bands, Moving Average Convergence and Divergence (MACD), and Relative Strength Index (RSI) can be effectively used in trading in the Indian stock market. Second, it presents a comparative framework for understanding the effectiveness of the three indicators in yielding returns on investments. Finally, the results of this study provide a deep insight into the current profitability of the sectors that will be useful for investors in the Indian stock market.

The organization of the paper unfolds as follows. Section 2 outlines various stock price prediction models including technical indicators-based analysis and portfolio design approaches in the current academic literature. Section 3 details the research approach adopted in the present study. Section 4 provides a comprehensive set of results accompanied by a thorough analysis of the same. Finally, Section 5 concludes the paper.

2. Related Work

In the literature, various approaches have been suggested to address the intricate challenge of robust stock price prediction and optimizing the combination of stocks to maximize return on investment. Researchers have extensively employed machine learning models for forecasting future stock prices (Carta et al., 2021; Chatterjee et al., 2021; Mehtab & Sen, 2021; Mehtab & Sen, 2020a;

Mehtab & Sen, 2019; Mehtab et al., 2021; Sarmiento & Horta, 2020; Sen, J., 2018a; Sen & Datta Chaudhuri, 2017a).

The utilization of deep learning architectures and algorithms has resulted in enhancements in the prediction accuracies of the models (Chatterjee et al., 2021; Chen et al., 2018; Chong et al., 2017; Sen & Mehtab, 2021b; Mehtab & Sen, 2021; Mehtab & Sen, 2020a; Mehtab & Sen, 2020b; Mehtab & Sen, 2019; Mehtab et al., 2021; Mehtab, et al., 2020; Sen, 2018a; Sen & Mehtab, 2021a; Sen & Mehtab, 2021b; Sen et al., 2021a; Sen et al., 2021b; Sen et al., 2021i; Sen et al., 2020; Sen & Mehtab, 2022b; Thormann et al., 2021; Tran et al., 2019). Various text mining approaches have been successfully implemented on social media and the web, further enhancing prediction accuracies of stock prices (Li & Pan, 2022; Mehtab & Sen, 2019; Thormann et al., 2021; Zhang et al., 2021).

Among other approaches to predicting stock prices, there is notable popularity in the use of time series decomposition-based statistical and econometric approaches (Chatterjee et al., 2021; Cheng et al., 2018; Sen, 2022a; Sen, 2018b; Sen, 2017a; Sen, 2017b; Sen & Datta Chaudhuri, 2018; Sen & Datta Chaudhuri, 2017b; Sen & Datta Chaudhuri, 2016a; Sen & Datta Chaudhuri, 2016b; Sen & Datta Chaudhuri, 2016c; Sen & Datta Chaudhuri, 2016d; Sen & Datta Chaudhuri, 2015).

In some studies, various types of the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model have been used for predicting future volatility and assessing the risk of stock portfolios (Sen et al., 2021d).

In recent years, reinforcement learning has been widely employed for the reliable and precise prediction of stock prices and the design of portfolios (Brim, 2020; Fengqian & Chao, 2020; Kim et al., 2022; Kim & Kim, 2019; Lei et al., 2020; Li et al., 2019; Lu et al., 2021; Park & Lee, 2021; Sen, 2023; Sen, 2022d).

The classical mean-variance optimization approach stands out as the most widely recognized method for optimizing portfolios (Sen & Mehtab, 2022a; Sen et al., 2021e; Sen et al., 2021g; Sen et al., 2021h; Sen & Sen, 2023).

Some researchers have put forth various alternatives to the mean-variance approach for portfolio optimization. Noteworthy among these methods are (i) multiobjective optimization (Wang et al, 2022; Zheng & Zheng, 2022), (ii) eigen portfolios using principal

component analysis (Sen & Dutta, 2022b; Sen & Mehtab, 2022a), (iii) risk parity-based methods (Sen & Dutta, 2022a; Sen & Dutta, 2022c; Sen & Dutta, 2021; Sen et al., 2021c; Sen et al., 2021f), and (iv) swarm intelligence-based approaches (Corazza et al., 2021; Thakkar & Chaudhuri, 2021). The use of genetic algorithms (Kaucic et al., 2019), fuzzy sets (Karimi et al., 2022), prospect theory (Li et al., 2021), and quantum evolutionary algorithms (Chou et al., 2021) are also proposed in the literature.

Some researchers have suggested pair-trading portfolios, involving two stocks, as an alternative to portfolios comprising multiple stocks (Flori & Regoli, 2021; Gupta & Chatterjee, 2020; Ramos-Requena et al., 2021; Sen, 2022b; Sen, 2022c).

Seshu et al. (2022) presented an approach that is capable of assessing the performance of diverse automated trading strategies using various metrics. The scheme proposed by the authors utilizes predictions generated by two strategies, Bollinger Bands and Long Short-Term Memory (LSTM) networks. The LSTM strategy incorporates predictions from 250 LSTM neural networks (5 models per company), while the Bollinger Bands strategy employs close price, simple moving averages, and standard deviations for buy or sell decisions. The performance of these strategies has been evaluated through backtesting with historical data and real-time data from stocks in the NIFTY50 index. The results indicate that the proposed custom strategies have outperformed market baselines in 35.93% of all tested periods, demonstrating higher returns compared to investing in the stock market index during the same periods.

Zheng et al. (2022) proposed a hybrid predictive model that adheres to the conservative principle of risk hedging and split-position trading and reconfigures the position distribution by integrating the Bollinger Bands strategy and the regression polynomial combination model. The model was found to capture the temporal fluctuations of gold and bitcoin and exhibited characteristics of high total return, low total transaction cost, and a small maximum drawdown.

Lauguico et al. (2020) introduce an algorithm that employs three fuzzy logic controllers to execute a specific trading strategy. Technical indicators, including candlestick parameters and Bollinger Bands (BB), are utilized to determine the strength of buy, hold, and sell signals. Stock price data from a specific company are collected,

featuring opening and closing prices used in BB calculations. Both raw and computed values serve as crisp input parameters for the Fuzzy Inference System (FIS). Membership functions are categorized into very low, low, high, and very high levels based on default input parameters commonly used by traders. Fuzzy logical rules are then established to generate signals indicating the strength of an execution recommendation. The system is implemented using NI LabVIEW and MATLAB, demonstrating that the tests yield satisfactory results, achieving an accuracy of about 94.44%.

Au & Keung (2023) argue that while MACD is straightforward to interpret, it suffers from two notable drawbacks, the time lagging problem and the issue of generating false signals, leading to delays in decision-making for buying or selling. The authors introduce a novel approach, called the *volume square-weighted moving average convergence & divergence* (VSWMACD) for improving the performance of MACD. The proposed methodology is subjected to various evaluation tools to validate the improvements. Testing is conducted on five datasets, each containing 200 stocks from the Hong Kong Stock Market. The results indicate that, in comparison to MACD, VSWMACD demonstrates an approximately 15% increase in the average return and a reduction of around 5% in the average maximum drawdown.

Deac & Iancu (2023) propose the utilization of a genetic algorithm (GA) to optimize two trading strategies, a MACD crossover strategy and an ensemble strategy combining moving average convergence divergence with relative strength index (MACD-RSI), specifically applied to Nvidia stock using daily data. The GA is employed to identify the optimal parameter sets for both MACD and MACD-RSI, prominent technical indicators in the trading domain. The work presents a comprehensive explanation of the GA's design, indicators, metrics, architecture, and details on Experiments and results.

Chen et al. (2022) propose an innovative approach to maximizing the utility of the commonly used technical indicator, the RSI. The authors employ a modified metaheuristic algorithm known as the global best-guide quantum-inspired tabu search algorithm with *quantum NOT gate* (GNQTS) to efficiently search for optimized parameters for RSI. Additionally, the methodology incorporates a sliding window to dynamically adjust training periods, mitigating the

risk of overfitting. The experimental scope encompassed popular indices and companies in the United States stock market, including DJIA, AAPL, and others. The results demonstrate that GNQTS successfully identifies optimized RSI parameters, yielding higher profits compared to both traditional RSI and buy-and-hold strategies.

Zatwarnicki et al. (2023) present an algorithmic methodology for assessing the efficacy of signals produced by the RSI. Backtesting of the strategies was conducted using a model mirroring an authentic cryptocurrency exchange. The findings indicate that relying on RSI as a momentum indicator in the cryptocurrency market entails substantial risk, and exploring alternative applications of RSI can provide traders with an edge in the cryptocurrency market.

The current work explores three influential and commonly employed technical indicators, namely Bollinger Bands, MACD, and RSI. It presents a comparative analysis to evaluate the effectiveness of these indicators across 14 sectors within the Indian stock market. To the authors' knowledge, no prior studies have pursued this specific direction. Consequently, the findings from this research are anticipated to provide valuable insights for investors in the Indian stock market.

3. Methodology

This section presents the methodology employed in this study, with a specific emphasis on the steps undertaken to identify the signal points for buy and sell decisions in trading based on the three technical indicators, Bollinger bands, MACD, and RSI. The methodology encompasses a sequence of eight steps which is discussed in the following.

(i) Choice of the sectors for analysis: Fourteen important sectors are first selected from those listed in the NSE so that they exhibit diversity in the Indian stock market. The chosen 14 sectors are (i) *auto*, (ii) *banking*, (iii) *financial services except banks*, (iv) *consumer durables*, (v) *fast-moving consumer goods (FMCG)*, (vi) *information technology (IT)*, (vii) *media*, (viii) *metal*, (ix) *mid-small IT and telecom*, (x) *oil and gas*, (xi) *pharma*, (xii) *private banks*, (xiii) *PSU banks*, and (xiv) *realty*. The monthly reports of the NSE identify

the ten stocks with the maximum free-float capitalization from each sector. In this work, the report published on June 30, 2022, is used for identifying the ten stocks from each of the fourteen sectors, and the 50 stocks from NIFTY 50 (NSE Website).

(ii) Extraction of historical stock prices from the web: From the Yahoo Finance website, the historical daily prices of the stocks are extracted from July 1, 2022, to June 30, 2023, using the *DataReader* function of the *pandas_datareader* module of Python. The *close* values of the stocks are used in computing three technical indicators, Bollinger band (BB), moving average convergence divergence (MACD), and relative strength indicator (RSI).

(iii) Computation of the simple moving averages of prices: The 20-day rolling simple moving average values for the *close* prices are computed for every stock in each sector. For the computation of the 20-day rolling average, the *rolling* function in Python is used with a parameter value of 20, and then the *mean* function is applied over the 20 observations.

(iv) Computation of the Bollinger bands: The concept of Bollinger bands was introduced by John Bollinger in 1980. Bollinger Bands consist of three lines: the middle band, the upper band, and the lower band. These bands are based on a *simple moving average* (SMA) and standard deviation. In the following, the computation of the bands is discussed.

(a) *The computation of the middle band:* To compute the middle band, first the period N for the computation of the SMA is chosen. The most common value of N is 20. Next, the SMA for each period is computed by summing up the closing prices of the stock over N periods and dividing the sum by the number of periods. The computation of the middle band is shown in (1).

$$\text{Middle Band (SMA)} = \frac{\text{Sum of closing prices over } N \text{ periods}}{N} \quad (1)$$

(b) *The computation of the standard deviation:* In this step, the standard deviation of the closing prices for N observations is computed using (2).

$$\text{Standard Deviation} = \sqrt{\frac{\sum_{i=1}^N (X_i - \bar{X})^2}{N}} \quad (2)$$

In (2), X_i is the closing price for each day, and \bar{X} is the mean closing price over N periods.

(c) *The computation of the upper and lower bands:* To compute the upper and the lower bands, first a factor K is chosen. The usual value of K is 2. The upper band is computed by adding K times the standard deviation to the middle band as in (3). Similarly, the lower band is computed by subtracting K times the standard deviation from the middle band as shown in (4).

$$\text{Upper Band} = \text{Middle Band} + (K * \text{Standard Deviation}) \quad (3)$$

$$\text{Lower Band} = \text{Middle Band} - (K * \text{Standard Deviation}) \quad (4)$$

The three Bollinger Bands are used extensively to analyze market conditions and identify trends and potential reversal points. In a strong uptrend, prices often touch or exceed the upper band, while in a strong downtrend, prices may touch or fall below the lower band. Traders use this information to identify the direction of the trend. Bollinger Bands expand and contract based on market volatility. Wide bands indicate volatility, while narrow bands suggest low volatility. Traders can use this information to gauge the market environment and adjust their strategies accordingly. Sudden price movements that cause the bands to expand can be interpreted as a volatility breakout. Traders might look for opportunities to enter trades in the direction of breakout. When prices touch or exceed the upper band, it may indicate an overbought condition, suggesting a potential reversal to the downside. Conversely, when prices touch or fall below the lower band, it may signal an oversold condition and a potential reversal to the upside. Traders often look for divergence or convergence between price and the Bollinger Bands. For example, if prices are making new highs, but the upper band is expanding, it could signal a weakening trend.

(v) **Computation of the Moving Average Convergence Divergence (MACD):** MACD is a popular momentum indicator used in technical analysis to identify potential trend reversals, generate trading signals, and assess the strength of a trend. The concept was first introduced by Gerald Appel in 1970. The MACD indicator is calculated using two *exponential moving averages* (EMAs) of an asset's price. The two main components of the MACD are: (a) MACD line (the fast line): which is the difference between a short-term EMA (usually based on 12 periods) and a longer-term EMA (usually 26 periods), and (b) Signal line (the slow line): this is the 9-day EMA of the MACD line that is used to generate trading signals. The computation of the MACD lines involves the following steps.

(a) *The computation of the Short-Term EMA (Exponential Moving Average):* To compute the short-term EMA, the number of days of the short-term EMA is first chosen. The usual length of this period is 12 days. The EMA for each day is computed using the closing prices of stocks using (5).

$$EMA_{short-term} = (CP * \frac{2}{STP+1}) + (PEMA * (1 - \frac{2}{STP+1})) \quad (5)$$

In (5), CP, STP, and PEMA denote the *closing price*, *short-term period*, and *previous EMA*, respectively. The initial EMA is usually the SMA of the first day's closing prices.

(b) *The computation of the MACD line (fast line):* The MACD line is computed by subtracting the *long-term EMA* (EMA_{LT}) from the *short-term EMA* (EMA_{ST}) as in (6).

$$MACD \text{ Line} = EMA_{ST} - EMA_{LT} \quad (6)$$

© *The computation of the Signal line (slow line):* To compute the *signal line*, first the number of periods for the signal line is chosen. The most used value for the number of periods for the signal line is 9. The signal line is the EMA of the MACD line computed based on the signal line period as in (7).

$$Signal \text{ Line} = EMA(MACD \text{ Line}, Signal \text{ Line Period}) \quad (7)$$

(d) *The computation of the MACD histograms:* In the final step, the MACD histograms are computed by subtracting the signal line from the MACD line as in (8).

$$\text{MACD Histogram} = \text{MACD Line} - \text{Signal Line} \quad (8)$$

The resulting MACD histograms are a visual representation of the difference between the MACD line and the signal line. When the MACD line crosses above the signal line, it generates a bullish signal, indicating a potential upward momentum. Conversely, when the MACD line crosses below the signal line, it generates a bearish signal, indicating potential downward momentum. Divergence occurs when the price of the asset and the MACD indicator move in opposite directions, while convergence occurs when they move in the same direction. Divergence can be a sign of a potential reversal. When the MACD histograms are above the zero line and rising, it indicates a bullish momentum. When it is below the zero line and falling, it suggests a bearish momentum.

(vi) Computation of the Relative Strength Index: The *relative strength index* (RSI) is a momentum oscillator that measures the speed and change of price movements. The RSI is often used to help traders identify potential trend reversals and generate buy or sell signals. The computation of RSI involves the following steps.

(a) *Choosing the period:* The most used period length is 14 which represents 14 trading days or periods. However, traders can adjust this period based on their preferences and the timeframe they are analyzing.

(b) *The computation of the average gain and average loss:* The average gain and average loss are computed over the selected period using (9) and (10). The gain or loss for each period is determined by comparing the current closing price with the previous closing price.

$$\text{Average Gain} = \frac{\text{Sum of Gains over } N \text{ periods}}{N} \quad (9)$$

$$\text{Average Loss} = \frac{\text{Sum of Losses over } N \text{ periods}}{N} \quad (10)$$

(c) *The computation of the relative strength (RS):* The *relative strength* (RS) is computed by dividing the average gain by the average loss as in (11).

$$RS = \frac{\text{Average Gain}}{\text{Average Loss}} \quad (11)$$

(d) *The computation of the RSI:* Finally, the RSI value is computed as in (12). The value of RSI lies between 0 and 100.

$$RSI = 100 - \left(\frac{100}{1 + RS} \right) \quad (12)$$

If the RSI is above 70, it is often considered overbought, indicating that the stock may be overvalued, and a trend reversal or corrective pullback may be imminent. On the other hand, if the RSI is below 30, it is considered oversold, indicating that the asset may be undervalued, and a trend reversal or corrective upward movement may be on the horizon. The divergence between the RSI and the price movement can also provide signals. For example, if the price is making new highs, but the RSI is not confirming those highs, it may indicate a weakening momentum. Some traders use the level of 50 as a threshold. An RSI above 50 is considered bullish, while an RSI below 50 is considered bearish.

(vii) Graphical representation of the technical indicators: For each stock, the Bolinger Bands, MACD histograms, and RSI plots are constructed and the buy and sell signal points are identified.

(viii) Computation of the returns: In the final step, for each stock, the returns yielded by trading using three technical indicators are computed over 12 months (July 1, 2022, to June 30, 2023), and a comparative analysis of the three indicators is made based.

4. Experimental Results

This section presents the detailed results and analysis of the portfolios. The fourteen sectors which are studied in this work are the following (i) *auto*, (ii) *banking*, (iii) *financial services except banks*, (iv) *consumer durables*, (v) *FMCG*, (vi) *IT*, (vii) *media*, (viii) *metal*,

(ix) *mid-small IT and telecom*, (x) *oil and gas*, (xi) *pharma*, (xii) *private banks*, (xiii) *PSU banks*, and (xiv) *realty*. The Bollinger Bands, MACD, and RSI values are computed and plotted for the top ten stocks of the 14 sectors using Python 3.9.8 and its associated libraries *numpy*, *pandas*, *matplotlib*, and *yf*. The programs are executed on the Google Colab platform (Google Colab).

In the following, the results of the three technical indicators-based investment strategies for the top ten stocks of the 14 sectors are presented in detail.

Auto sector: As per the report published by the NSE on June 30, 2022, the ten stocks of the *auto* sector with the largest free-float market capitalization and their contributions (in percent) to the overall sectoral index are the following: Mahindra & Mahindra (M&M): 17.92, Maruti Suzuki India (MARUTI): 17.71, Tata Motors (TATAMOTORS): 15.39, Bajaj Auto (BAJAJ-AUTO): 7.57, Eicher Motors (EICHERMOT): 6.25%, Hero MotoCorp (HEROMOTOCO): 5.65, Tube Investment of India (TIINDIA): 4.36, TVS Motor Company (TVSMOTOR): 4.35, Ashok Leyland (ASHOKLEY): 3.59, and Bharat Forge (BHARATFORG): 3.24 (NSE Website). The ticker names of the stocks are mentioned in parentheses. The ticker name of a stock is its unique identifier for a given stock exchange.

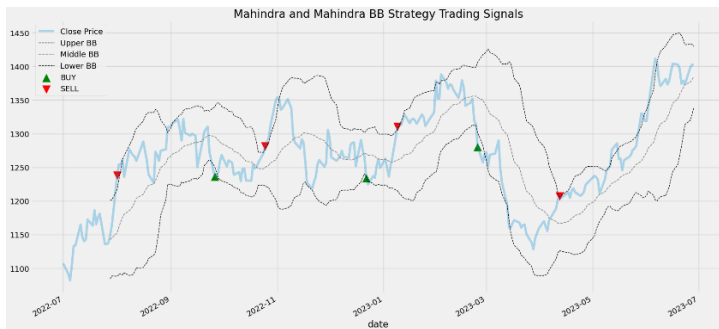


Figure 1. The Bollinger Bands plot of Mahindra and Mahindra stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

Figures 1, 2, and 3 present the Bollinger Bands, MACD, and RSI plots respectively, of Mahindra and Mahindra, one of the ten stocks of the *auto* sector. The plots of the other stocks of the *auto* sector are not shown to avoid repetition. Table 1 exhibits the annual returns yielded by the three strategies for the 10 stocks of the *auto* sector. The highest return for a given stock is shown in a bold font.

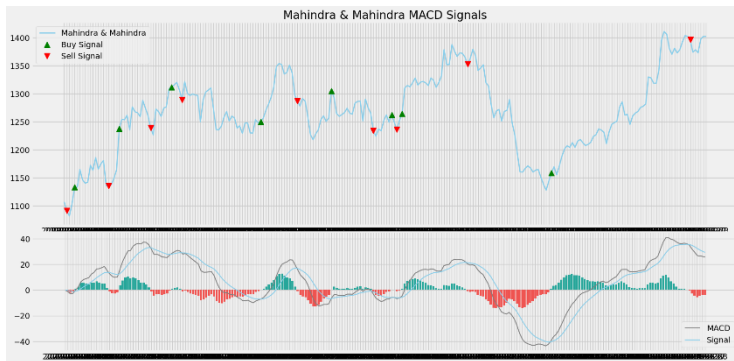


Figure 2. The MACD plot of Mahindra and Mahindra stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

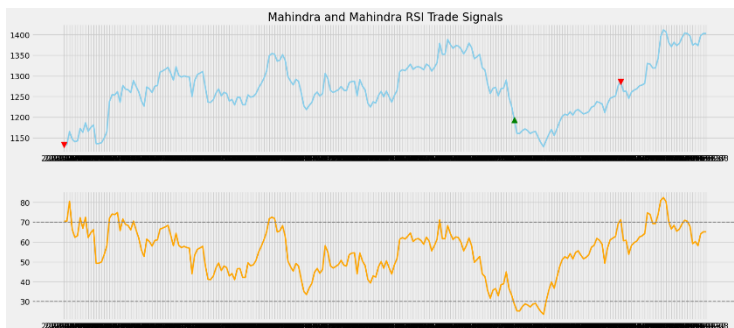


Figure 3. The RSI plot of Mahindra and Mahindra stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

TABLE 1. THE ANNUAL RETURNS (IN PERCENT) YIELDED BY THE BB, MACD, AND RSI METHODS FOR AUTO SECTOR STOCKS (PERIOD: JULY 1, 2022 – JUNE 30, 2023)

Stock	BB	MACD	RSI
M&M	12.71	20.74	6.55
MARUTI	10.40	9.58	7.42
TATAMOTORS	21.09	29.60	9.50
BAJAJ-AUTO	13.43	30.30	5.19
EICHERMOT	10.54	19.04	13.53
HEEROMOTOCO	1.88	5.12	17.03
TIINIDA	35.13	41.47	0.00
TVSMOTOR	13.83	28.70	8.54
ASHOKLEY	12.25	-4.20	13.41
BHARATFORG	29.75	-5.04	6.65

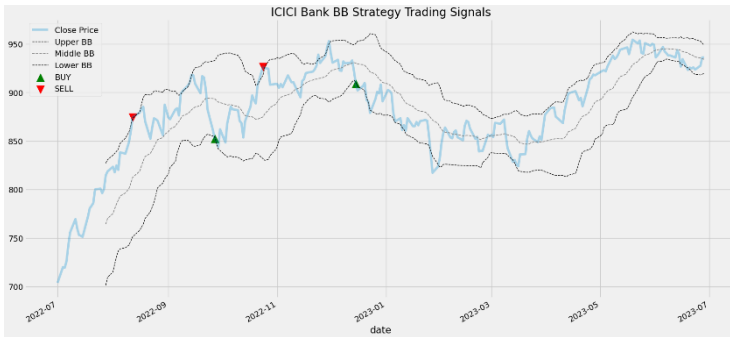


Figure 4. The Bollinger Bands plot of ICICI Bank stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

Banking sector: As per the report published by the NSE on June 30, 2022, the ten stocks with the largest free-float market capitalization in the *banking* sector and their contributions (in percent) to the overall index of the sector are as follows: (i) HDFC Bank (HDFCBANK): 28.42%, (ii) ICICI Bank (ICICIBANK): 24.04%, (iii) State Bank of India (SBIN): 9.89%, (iv) Kotak Mahindra Bank (KOTAKBANK):

9.40%, (v) Axis Bank (AXISBANK): 9.35%, (vi) IndusInd Bank (INDUSINDBK): 6.74%, (vii) Bank of Baroda (BANKBARODA): 2.75%, (viii) AU Small Finance Bank (AUBANK): 2.56%, (ix) Federal Bank (FEDERALBNK): 2.33%, and (x) IDFC First Bank (IDFCFIRSTB): 1.98% (NSE Website). The ticker names of the stocks are mentioned in parentheses.

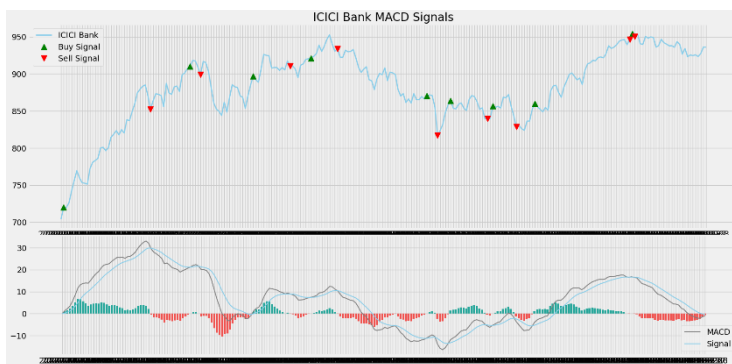


Figure 5. The MACD plot of ICICI Bank stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

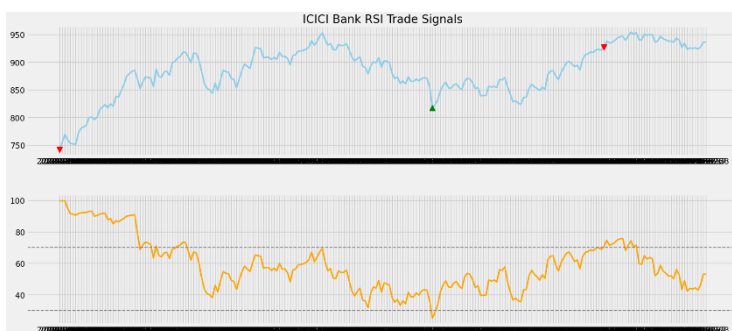


Figure 6. The RSI plot of ICICI Bank stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

Figures 4, 5, and 6 present the Bollinger Bands, MACD, and RSI plots respectively, of ICICI Bank, one of the ten stocks of the *banking* sector. The plots of the other stocks of the *banking* sector are not shown to avoid repetition. Table 2 exhibits the annual returns yielded by the three strategies for the 10 stocks of the *banking* sector. The highest return for a given stock is shown in a bold font.

TABLE 2. THE ANNUAL RETURNS (IN PERCENT) YIELDED BY THE BB, MACD, AND RSI METHODS FOR BANKING SECTOR STOCKS (PERIOD: JULY 1, 2022 – JUNE 30, 2023)

Stock	BB	MACD	RSI
HDFCBANK	23.11	12.82	0.00
ICICIBANK	28.78	19.95	11.63
SBIN	6.46	22.04	6.75
AXISBANK	30.81	32.29	6.81
KOTAKBANK	11.22	3.16	3.22
INDUSINDBK	24.29	11.73	11.24
AUBANK	13.39	25.08	20.18
BANKBARODA	18.96	29.12	14.04
FEDERALBNK	42.35	2.29	0.00
IDFCFIRSTB	22.48	38.13	0.00

Financial Services Ex-Banks sector: Based on the NSE's report published on June 30, 2022, the ten stocks that have the maximum free-float market capitalization and their respective contributions to the overall index to the *financial services except banks* sector are as follows: (i) HDFC (HDFC): 25.11%, (ii) Bajaj Finance (BAJFINANCE): 16.35%, (iii) Bajaj Finserv (BAJAJFINSV): 7.09%, (iv) HDFC Life Insurance Company (HDFCLIFE): 5.99%, (v) SBI Life Insurance Company (SBILIFE): 5.04%, (vi) Shriram Finance (SHRIRAMFIN): 3.967%, (vii) Cholamandalam Investment and Finance (CHOLAFIN): 3.86%, (viii) ICICI Lombard General Insurance Company (ICICIGI): 2.94%, (ix) Bajaj Holdings & Investment (BAJAJHLDNG): 2.60%, and (x) Power Finance Corporation (PFC): 2.15% (NSE Website). The ticker names, the unique identifier for the stocks, are mentioned in parentheses.

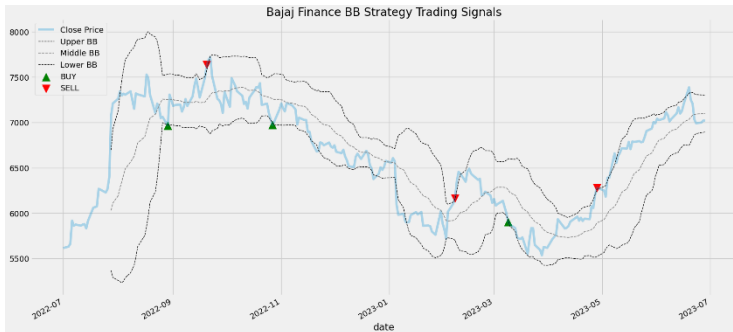


Figure 7. The Bollinger Bands plot of Titan Company stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

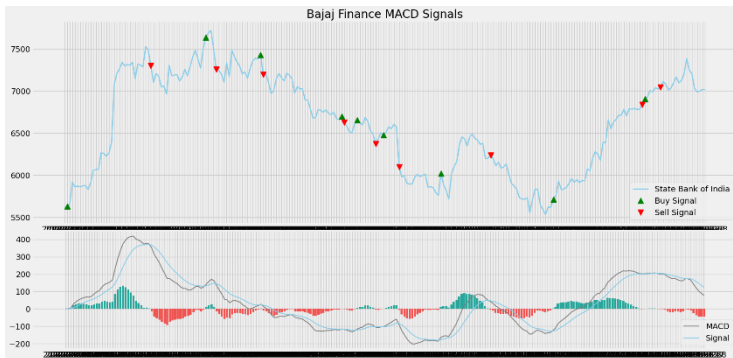


Figure 8. The MACD plot of Bajaj Finance stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

Figures 7, 8, and 9 present the Bollinger Bands, MACD, and RSI plots respectively, of Bajaj Finance, one of the ten stocks of the *financial services except banks* sector. The plots of the other stocks of this sector are not shown to avoid repetition. Table 3 exhibits the annual returns yielded by the three strategies for the 10 stocks of the *financial services except banks* sector. The highest return for a given stock is shown in a bold font.

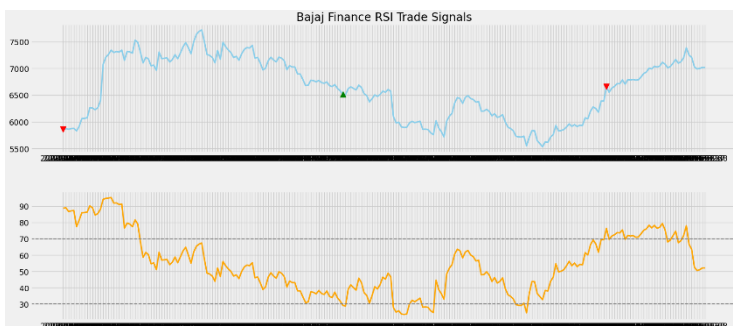


Figure 9. The RSI plot of Bajaj Finance stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

TABLE 3. THE ANNUAL RETURNS (IN PERCENT) YIELDED BY THE BB, MACD, AND RSI METHODS FOR FINANCIAL SERVICES EX-BANKS SECTOR STOCKS
(PERIOD: JULY 1, 2022 – JUNE 30, 2023)

Stock	BB	MACD	RSI
HDFC	23.11	20.54	0.00
BAJFINANCE	22.25	30.96	1.97
BAJAJFINSV	27.70	28.40	-4.47
HDFCLIFE	4.44	19.18	5.02
SBILIFE	14.55	11.59	8.37
SHRIRAMFIN	3.08	20.49	18.47
CHOLAFIN	21.44	57.03	0.00
ICICIGI	8.59	4.39	5.37
BAJAJHLDNG	12.24	44.19	8.77
PFC	19.72	56.69	4.21

Consumer Durables sector: As NSE’s report published on June 30, 2022, the ten stocks from the *consumer durables* sector that have the largest free-float market capitalization and their contributions (in percent) to the overall index of the sector are as follows: (i) Titan Company (TITAN): 32.75%, (ii) Havells India (HAVELLS): 14.95%, (iii) Crompton Greaves Consumer Electricals (CROMPTON): 8.40%,

(iv) Voltas (VOLTAS): 7.96%, (v) Dixon Technologies (DIXON): 6.80%, (vi) Kajaria Ceramics (KAJARIACER): 5.32%, (vii) Bata India (BATAINDIA): 4.99%, (viii) Blue Star (BLUESTARCO): 3.98%, (ix) Rajesh Exports (RAJESHEXPO): 3.08%, and (x) Relaxo Footwears (RELAXO): 3.05% (NSE Website). The ticker names of the stocks are mentioned in parentheses.

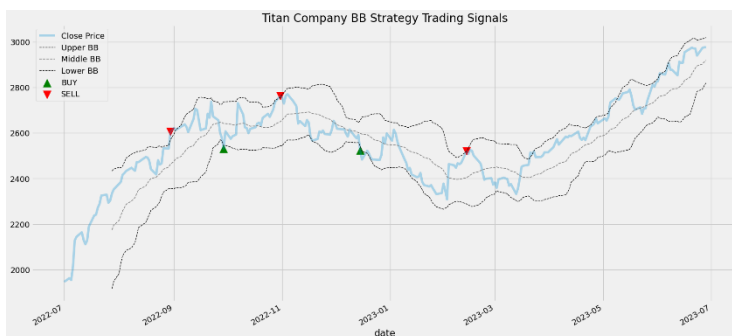


Figure 10. The Bollinger Bands plot of Titan Company stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

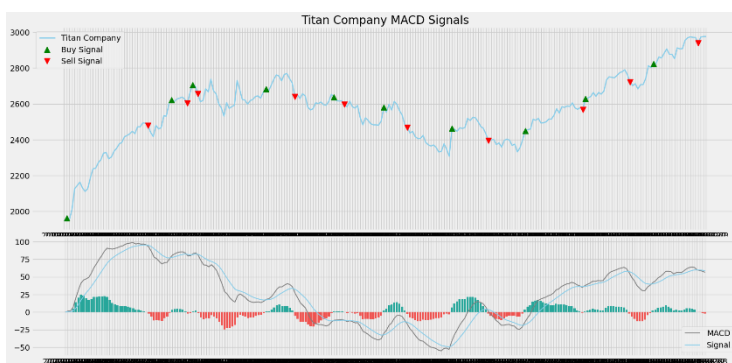


Figure 11. The MACD plot of Titan Company stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

Figures 10, 11, and 12 present the Bollinger Bands, MACD, and RSI plots respectively, of Titan Company, one of the ten stocks of the *consumer durables* sector. The plots of the other stocks of this sector are not shown to avoid repetition. Table 4 exhibits the annual returns yielded by the three strategies for the 10 stocks of the *consumer durables* sector. The highest return for a stock is shown in bold font.

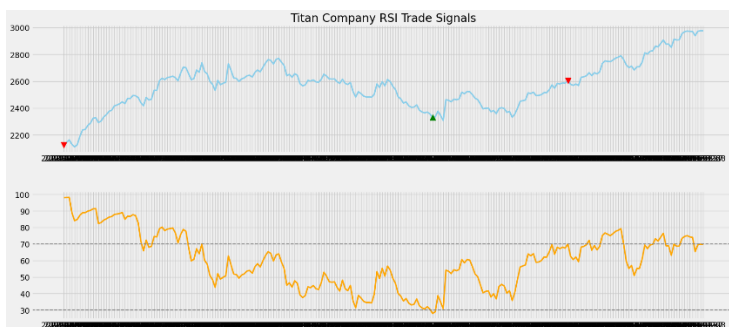


Figure 12. The RSI plot of Titan Company stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

TABLE 4. THE ANNUAL RETURNS (IN PERCENT) YIELDED BY THE BB, MACD, AND RSI METHODS FOR CONSUMER DURABLES SECTOR STOCKS
(PERIOD: JULY 1, 2022 – JUNE 30, 2023)

Stock	BB	MACD	RSI
TITAN	29.20	26.80	9.05
HAVELLS	16.09	4.05	9.23
CROMPTON	18.71	-29.38%	-21.86
VOLTAS	9.72	-10.56	3.14
DIXON	-16.30	54.34	-16.66
KAJARIACER	26.62	20.11	0.00
BATAINDIA	-5.57	5.99	0.59
BLUESTARCO	20.06	50.69	5.36
RAJESHEXPO	27.70	-10.98	-9.73
RELAXO	-7.95	-8.56	-9.51

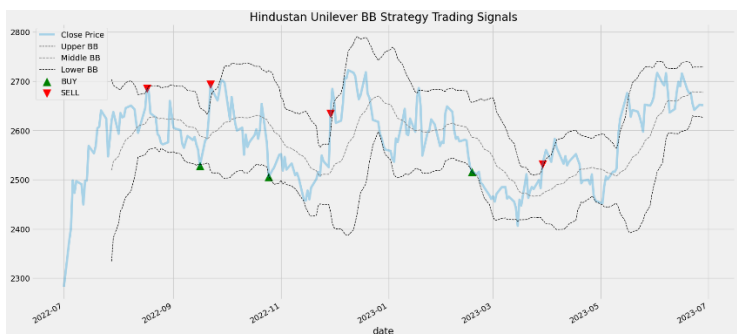


Figure 13. The Bollinger Bands plot of Hindustan Unilever stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

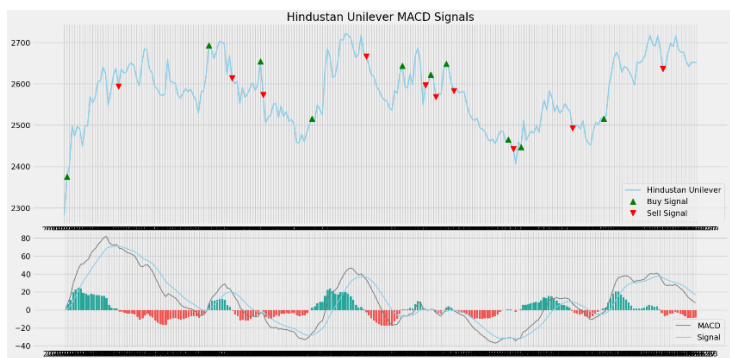


Figure 14. The MACD plot of Hindustan Unilever stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

FMCG sector: Based on the NSE's report published on June 30, 2022, the ten stocks that have the maximum free-float market capitalization in the FMCG sector, and their contributions to the overall index of the sector are as follows: (i) ITC (ITC): 32.04%, (ii) Hindustan Unilever (HINDUNILVR): 21.71%, (iii) Nestle India (NESTLEIND): 7.64%, (iv) Britannia Industries (BRITANNIA): 6.24%, (v) Tata Consumer Products (TATACONSUM): 5.63%, (vi)

Godrej Consumer Products (GODREJCP): 4.32%, (vii) Varun Beverages (VBL): 4.15%, (viii) Dabur India (DABUR): 3.71%, (ix) United Spirits (MCDOWELL-N): 3.26%, and (x) Marico (MARICO): 3.20% (NSE Website).

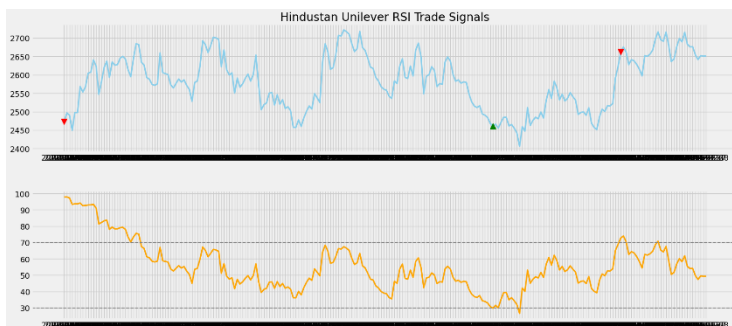


Figure 15. The RSI plot of Hindustan Unilever stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

TABLE 5. THE ANNUAL RETURNS (IN PERCENT) YIELDED BY THE BB, MACD, AND RSI METHODS FOR FMCG SECTOR STOCKS (PERIOD: JULY 1, 2022 – JUNE 30, 2023)

Stock	BB	MACD	RSI
ITC	8.77	34.06	0.00
HINDUNILVR	26.31	11.89	7.42
NESTLEIND	12.79	20.42	7.31
BRITANNIA	18.61	17.40	0.00
TATACONSUM	12.95	7.62	2.97
GODREJCP	23.50	17.71	0.00
VBL	17.36	38.82	19.89
DABUR	11.76	7.44	0.00
MCDOWELL-N	2.12	13.44	-3.61
MARICO	12.04	-4.68	0.00

Figures 13, 14, and 15 present the Bollinger Bands, MACD, and RSI plots respectively, of Hindustan Unilever, one of the ten stocks of the FMCG sector. The plots of the other stocks of the FMCG sector are not shown to avoid repetition. Table 5 exhibits the annual returns

yielded by the three strategies for the 10 stocks of the FMCG sector. The highest return for a given stock is shown in a bold font.

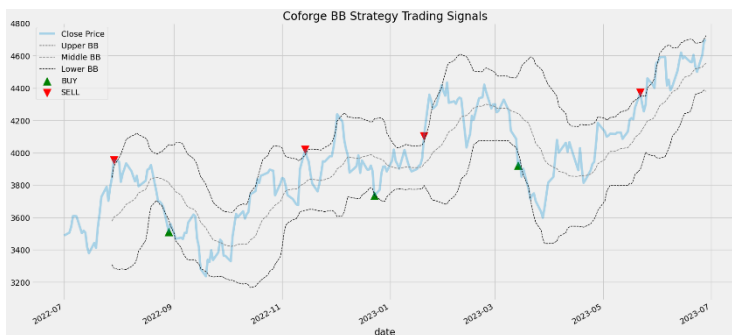


Figure 16. The Bollinger Bands plot of Coforge stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

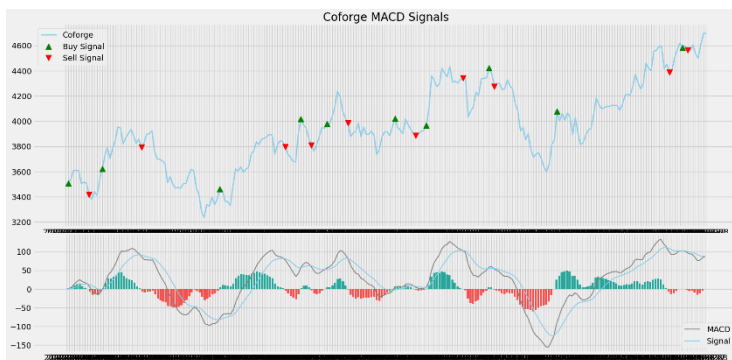


Figure 17. The MACD plot of Coforge stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

Information Technology (IT) sector: As per the report published by the NSE on June 30, 2022, the ten stocks with the largest free-float market capitalization and their respective contributions (in percent) to the overall index of the IT sector are as follows: (i) Infosys (INFY): 27.32%, (ii) Tata Consultancy Services (TCS): 26.32%, (iii) Wipro (WIPRO): 9.44%, (iv) Tech Mahindra (TECHM): 9.31, (v) HCL

Technologies (HCLTECH): 8.87%, (vi) LTIMindtree (LTIM): 7.05%, (vii) Persistent Systems (PERSISTENT): 3.84%, (viii) Coforge (COFORGE): 3.12%, (ix) Mphasis (MPHASIS): 2.99%, and (x) L&T Technology Services (LTTS): 1.74% (NSE Website).

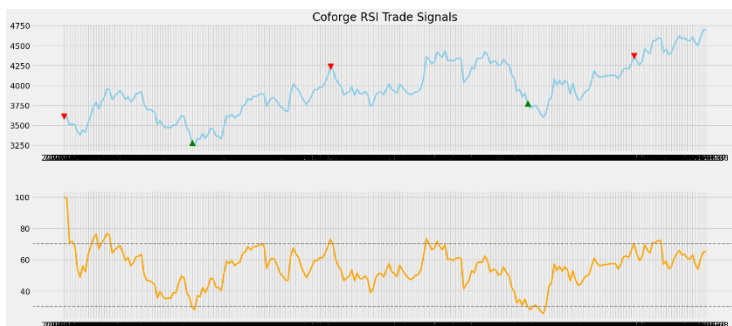


Figure 18. The RSI plot of Coforge stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

TABLE 6. THE ANNUAL RETURNS (IN PERCENT) YIELDED BY THE BB, MACD, AND RSI METHODS FOR IT SECTOR STOCKS (PERIOD: JULY 1, 2022 – JUNE 30, 2023)

Stock	BB	MACD	RSI
INFY	0.16	-5.40	-10.99
TCS	-0.54	4.28	3.77
WIPRO	1.03	-1.07	6.30
TECHM	14.98	13.91	11.97
HCLTECH	4.22	14.48	0.00
LTIM	34.93	13.83	26.79
PERSISTENT	7.08	39.30	0.00
COFORGE	37.57	17.03	32.60
MPHASIS	-11.16	1.35	3.70
LTTS	41.61	19.57	10.01

Figures 16, 17, and 18 present the Bollinger Bands, MACD, and RSI plots respectively, of Coforge, one of the ten stocks of the IT sector. The plots of the other stocks of the IT sector are not shown to avoid repetition. Table 6 exhibits the annual returns yielded by the

three strategies for the 10 stocks of the IT sector. The highest return for a given stock is shown in a bold font.

Media sector: As per the report published by the NSE on June 30, 2022, the ten stocks that have the largest free-float market capitalization and their respective contributions to the overall index of the *media* sector are as follows: (i) Zee Entertainment Enterprises (ZEEL): 33.67%, (ii) PVR (PVRINOX): 22.86%, (iii) Sun TV Network (SUNTV): 9.46%, (iv) TV18 Broadcast (TV18BRDCST): 8.00%, (v) Nazara Technologies (NAZARA): 7.30, (vi) Dish TV India (DISHTV): 7.17%, (vii) Network18 Media & Investments (NETWORK18): 4.47%, (viii) Navneet Education (NAVNETEDUL): 3.56%, (ix) Hathway Cable & Datacom (HATHWAY): 2.15%, and (x) NDTV (NDTV): 1.35% (NSE Website). The stocks of PVRINOX and NAZARA could not be considered in the media sector portfolio as these two stocks were listed on NSE later than the starting date of the portfolio formation i.e., July 1, 2019. The listing dates for PVRINOX and NAZARA on NSE were November 11, 2022, and March 30, 2021, respectively. In place of these two stocks, the stocks of TV Today (TVTODAY) and Saregama India (SAREGAMA) are considered as the market capitalizations of these stocks are higher among the remaining stocks in the *media* sector.

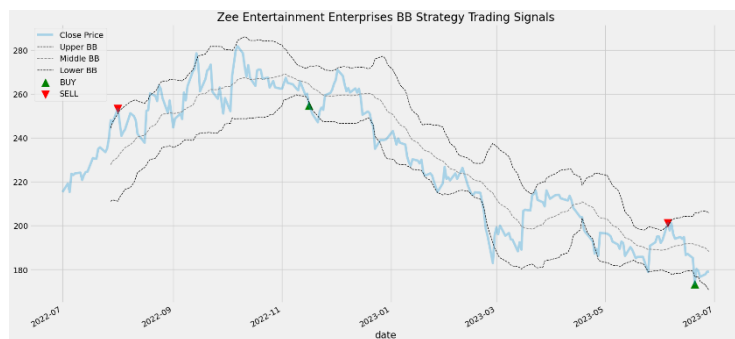


Figure 19. The Bollinger Bands plot of Zee Entertainment Enterprises stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

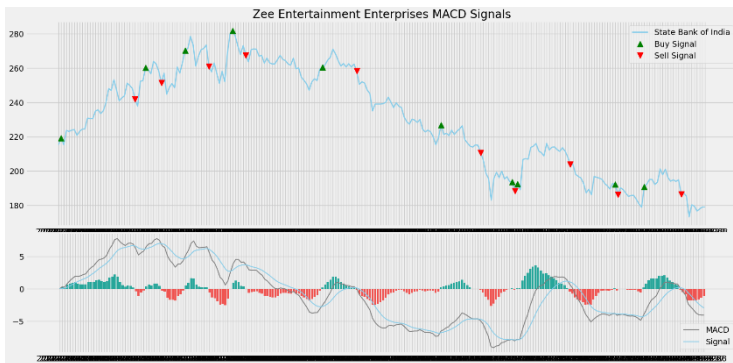


Figure 20. The MACD plot of Zee Entertainment Enterprises stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

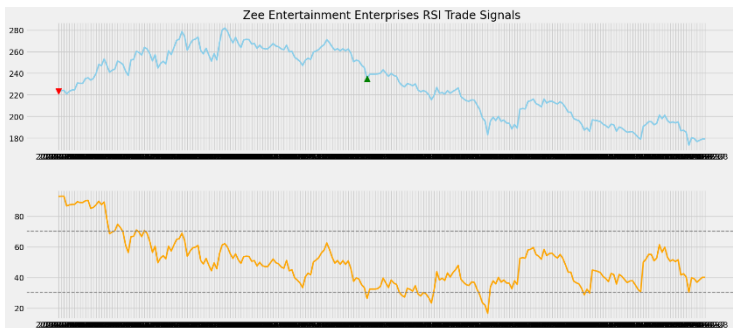


Figure 21. The RSI plot of Zee Entertainment Enterprises stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

Figures 19, 20, and 21 present the Bollinger Bands, MACD, and RSI plots respectively, of Zee Entertainment Enterprises, one of the ten stocks of the *media* sector. The plots of the other stocks of the *media* sector are not shown to avoid repetition. Table 7 exhibits the annual returns yielded by the three strategies for the 10 stocks of the *media* sector. The highest return for a given stock is shown in a bold font.

TABLE 7. THE ANNUAL RETURNS (IN PERCENT) YIELDED BY THE BB, MACD, AND RSI METHODS FOR MEDIA SECTOR STOCKS (PERIOD: JULY 1, 2019 – JUNE 30, 2022)

Stock	BB	MACD	RSI
ZEEL	-5.55	-13.25	-31.28
PVRINOX	-21.68	-28.74	10.76
SUNTV	28.06	-20.60	-1.56
TV18BRDCST	-2.81	-8.29	12.12
NAZARA	-1.18	-7.65	21.00
DISHTV	-18.15	70.31	-4.29
NETWORK18	3.08	-16.55	31.11
NAVNETEDUL	-0.68	27.72	-6.48
HATHWAY	4.04	-0.31	11.11
NDTV	73.74	185.85	-23.09

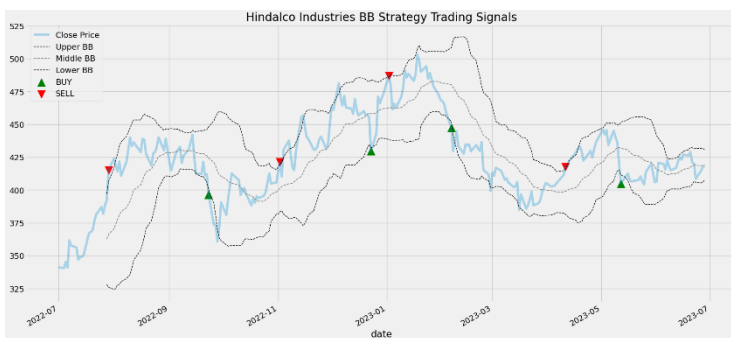


Figure 22. The Bollinger Bands plot of Hindalco Industries stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

Metal sector: As per the report published by the NSE on June 30, 2022, the ten stocks of the *metal* sector that have the largest free-float market capitalization and their respective contributions (in percent) to the overall index of the *metal* sector are as follows: (i) Tata Steel (TATASTEEL): 20.84%, (ii) Adani Enterprises (ADANIENT): 16.09%, (iii) JSW Steel (JSWSTEEL): 15.74%, (iv) Hindalco Industries (HINDALCO): 14.17%, (v) Vedanta (VEDL): 6.89%, (vi)

APL Apollo Tubes (APLAPOLLO): 5.75%, (vii) Jindal Steel & Power (JINDALSTEL): 5.15%, (viii) Jindal Stainless (JSL): 2.91%, (ix) Steel Authority of India (SAIL): 2.87%, and (x) NMDC (NMDC): 2.81% (NSE Website).

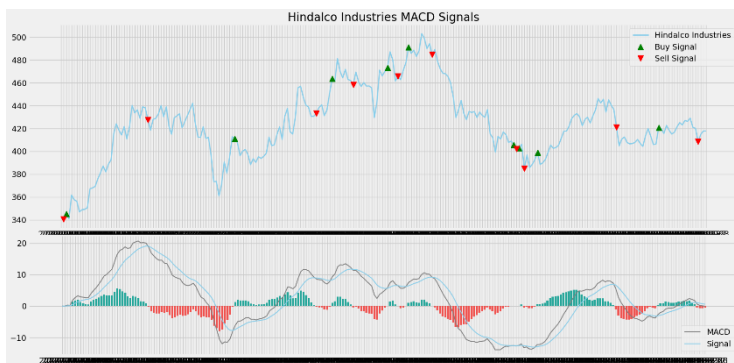


Figure 23. The MACD plot of Hindalco Industries stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

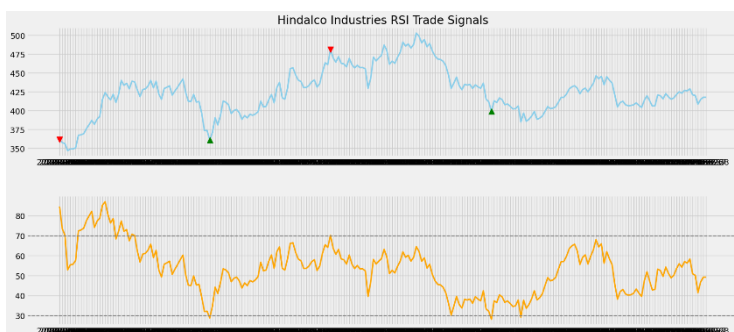


Figure 24. The RSI plot of Hindalco Industries stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

Figures 22, 23, and 24 present the Bollinger Bands, MACD, and RSI plots respectively, of Hindalco Industries, one of the ten stocks of the *metal* sector. The plots of the other stocks of the *metal* sector are

not shown to avoid repetition. Table 8 exhibits the annual returns yielded by the three strategies for the 10 stocks of the *metal* sector. The highest return for a given stock is shown in a bold font.

TABLE 8. THE ANNUAL RETURNS (IN PERCENT) YIELDED BY THE BB, MACD, AND RSI METHODS FOR METAL SECTOR STOCKS
(PERIOD: JULY 1, 2022 – JUNE 30, 2023)

Stock	BB	MACD	RSI
TATASTEEL	30.05	15.65	6.13
ADANI	-19.12	117.35	-47.74
JSWSTEEL	15.64	8.24	34.56
HINDALCO	33.35	21.42	33.22
VEDL	22.96	2.66	-2.78
APOLLO	28.59	34.63	11.18
JINDAL	19.40	8.24	12.02
SAIL	40.75	-10.37	12.11
NMDC	1.40	-13.76	6.21
JSL	28.09	72.75	0.00

MidSmall IT & Telecom sector: This sector consists of mid-cap and small-cap stocks within the information technology and telecommunication sector. As per the report published by the NSE on June 30, 2022, the ten stocks with the largest free-float market capitalization in this sector and their respective contributions to the overall index of the sector are as follows: (i) Tata Elxsi (TATAELXSI): 10.97%, (ii) Persistent Systems (PERSISTENT): 10.74%, (iii) Tata Communications (TATACOMM): 9.22%, (iv) Coforge (COFORGE): 8.71%, (v) Mphasis (MPHASIS): 8.36%, (vi) KPIT Technologies (KPITTECH): 7.69%, (vii) Cyient (CYIENT): 5.34%, (viii) L&T Technology Services (LTTS): 4.87%, (ix) Sonata Software (SONATSOFTW): 4.49%, and (x) Oracle Financial Services Software (OFSS): 3.99% (NSE Website). The ticker names of the stocks are mentioned in parentheses. The stocks are identified by their ticker names in a stock exchange.

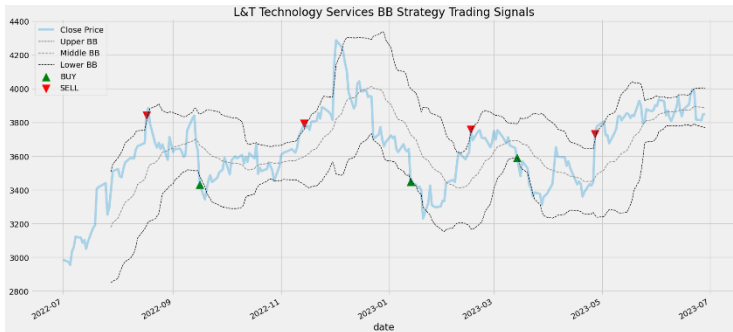


Figure 25. The Bollinger Bands plot of L&T Technology Services stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

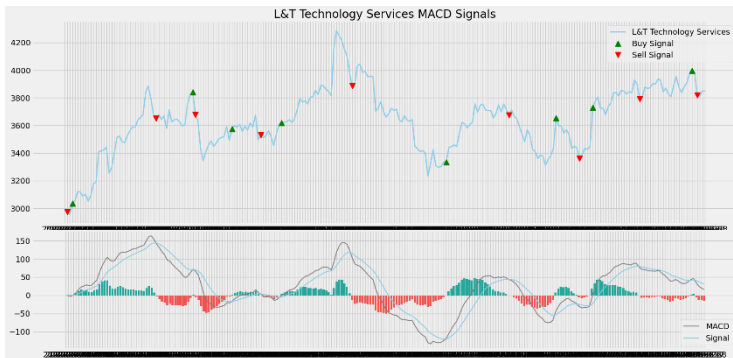


Figure 26. The MACD plot of L&T Technology Services stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

Figures 25, 26, and 27 present the Bollinger Bands, MACD, and RSI plots respectively, of L&T Technology Services, one of the ten stocks of the *mid-small IT and telecom* sector. The plots of the other stocks of this sector are not shown to avoid repetition. Table 9 exhibits the annual returns yielded by the three strategies for the 10 stocks of

the *mid-small IT and telecom* sector. The highest return for a given stock is shown in a bold font.

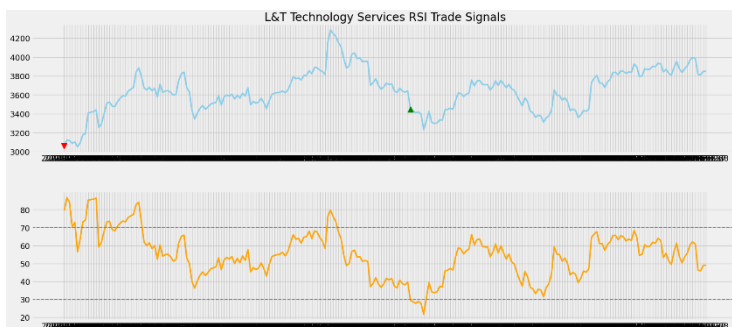


Figure 27. The RSI plot of L&T Technology Services stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

TABLE 9. THE ANNUAL RETURNS (IN PERCENT) YIELDED BY THE BB, MACD, AND RSI METHODS FOR MIDSMALL IT & TELECOM SECTOR STOCKS
(PERIOD: JULY 1, 2022 – JUNE 30, 2023)

Stock	BB	MACD	RSI
TATAELXSI	-19.21	22.14	-1.49
PERSISTENT	7.08	39.30	0.00
TATACOMM	39.34	34.96	0.00
COFORGE	37.57	17.03	32.60
MPHASIS	-11.16	1.36	3.70
KPITTECH	23.87	9.44	0.00
CYIENT	10.71	26.38	7.12
LTTS	41.61	19.57	10.01
SONATASOFTW	21.17	61.19	0.00
OFSS	4.41	6.97	0.00

Oil & Gas sector: The NSE’s report published on June 20, 2022, the ten stocks with the largest market capitalization and their contributions to the overall index of the *oil and gas* sector are as follows: (i) Reliance Industries (RELIANCE): 30.85%, (ii) Oil &

Natural Gas Corporation (ONGC): 15.92%, (iii) Bharat Petroleum Corporation (BPCL): 8.31%, (iv) Indian Oil Corporation (IOC): 7.94%, (v) GAIL India (GAIL): 7.40, (vi) Adani Total Gas (ATGL): 4.21%, (vii) Hindustan Petroleum Corporation (HINDPETRO): 4.16%, (viii) Petronet LNG (PETRONET): 4.04%, (ix) Indraprastha Gas (IGL): 3.74%, and (x) Oil India (OIL): 3.17% (NSE Website).

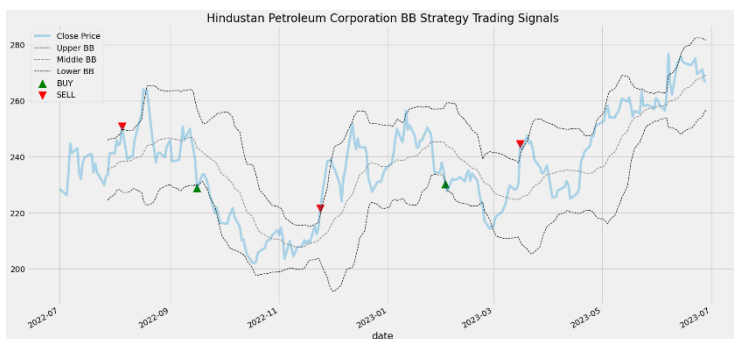


Figure 28. The Bollinger Bands plot of Hindustan Petroleum Corporation stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

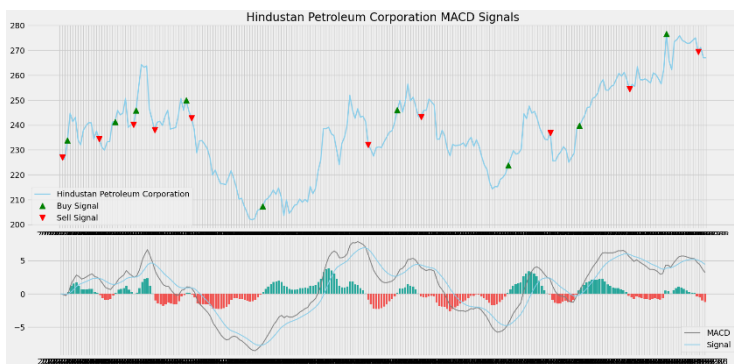


Figure 29. The MACD plot of Hindustan Petroleum Corporation stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

Figures 28, 29, and 30 present the Bollinger Bands, MACD, and RSI plots respectively, of Hindustan Petroleum Corporation, one of the ten stocks of the *oil & gas* sector. The plots of the other stocks of this sector are not shown to avoid repetition. Table 10 exhibits the annual returns yielded by the three strategies for the 10 stocks of the *oil & gas* sector. The highest return for a given stock is shown in a bold font.

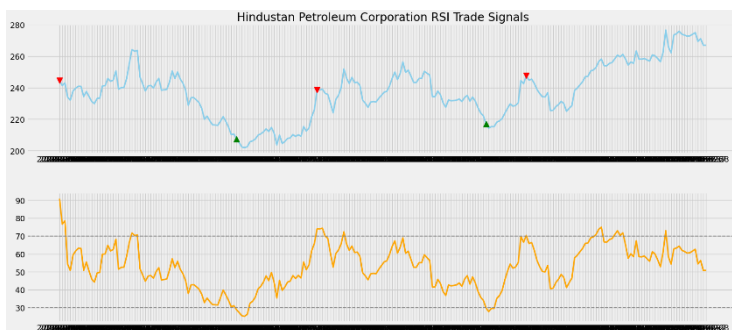


Figure 30. The RSI plot of Hindustan Petroleum Corporation stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

TABLE 10. THE ANNUAL RETURNS (IN PERCENT) YIELDED BY THE BB, MACD, AND RSI METHODS FOR OIL & GAS SECTOR STOCKS (PERIOD: JULY 1, 2022 – JUNE 30, 2023)

Stock	BB	MACD	RSI
RELIANCE	6.22	-1.07	21.20
ONGC	23.42	-2.98	10.73
BPCL	16.12	6.45	13.46
IOC	8.95	21.39	-0.73
GAIL	7.97	-13.09	0.00
ATGL	-297	18.44	-401.63
HINDPETRO	10.92	10.97	23.09
PETRONET	10.85	-21.92	2.70
IGL	27.31	16.43	0.00
OIL	4.00	-20.83	12.73

Pharma sector: As per the NSE's report of June 30, 2022, the ten stocks with the largest free-float market capitalization and their contributions to the index of the *pharma* sector are as follows: (i) Sun Pharmaceuticals Industries (SUNPHARMA): 24.59%, (ii) Dr. Reddy's Labs (DRREDDY): 13.66%, (iii) Cipla (CIPLA): 12.28%, (iv) Divi's Laboratories (DIVISLAB): 9.35%, (v) Lupin (LUPIN): 4.73%, (vi) Aurobindo Pharma (AUROPHARMA): 4.61%, (vii) Alkem Laboratories (ALKEM): 3.88%, (viii) Torrent Pharmaceuticals (TORNTPHARM): 3.65%, (ix) Zydus Lifesciences (ZYDUSLIFE): 3.19%, and (x) Laurus Labs (LAURUSLABS): 2.76%.

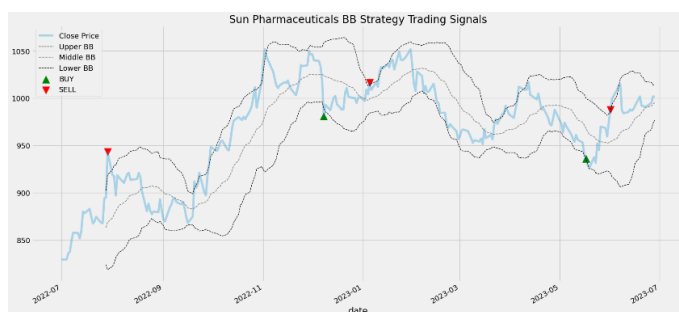


Figure 31. The Bollinger Bands plot of Sun Pharmaceutical Industries stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

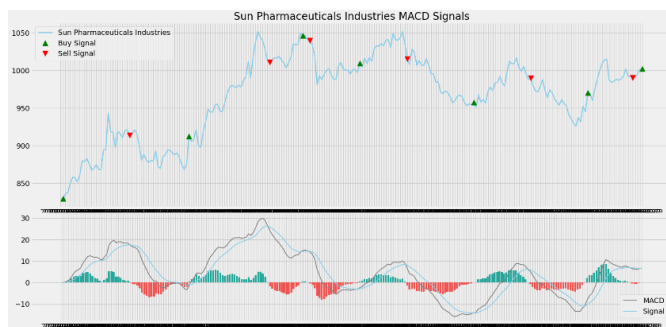


Figure 32. The MACD plot of Sun Pharmaceutical Industries stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

Figures 31, 32, and 33 present the Bollinger Bands, MACD, and RSI plots respectively, of Sun Pharmaceutical Industries, one of the ten stocks of the *pharma* sector. The plots of the other stocks of this sector are not shown to avoid repetition. Table 11 exhibits the annual returns yielded by the three strategies for the 10 stocks of the *pharma* sector. The highest return for a given stock is shown in a bold font.

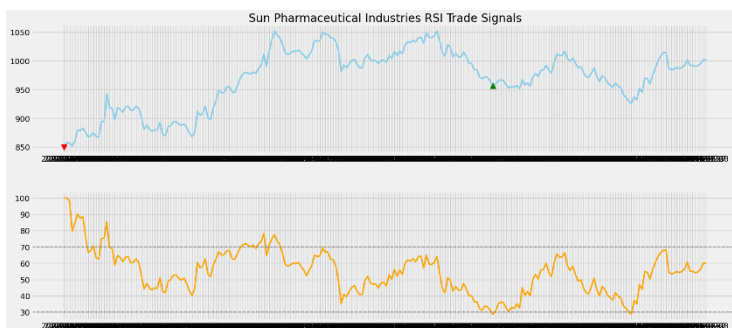


Figure 33. The RSI plot of Sun Pharmaceutical Industries stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

TABLE 11. THE ANNUAL RETURNS (IN PERCENT) YIELDED BY THE BB, MACD, AND RSI METHODS FOR PHARMA SECTOR STOCKS (PERIOD: JULY 1, 2022 – JUNE 30, 2023)

Stock	BB	MACD	RSI
SUNPHARMA	19.91	28.16	4.47
DRREDDY	5.86	1.64	20.10
CIPLA	-9.09	-2.21	11.88
DIVISLAB	38.08	-11.48	-7.68
LUPIN	14.24	2.15	9.31
AUOPHARMA	16.55	2.36	6.64
ALKEM	15.68	12.26	0.00
TORNTPHARM	8.99	22.71	10.19
ZYDUSLIFE	12.30	36.46	5.43
LAURUSLABS	-39.40	-26.80	-38.27



Figure 34. The Bollinger Bands plot of Axis Bank stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.



Figure 35. The MACD plot of Axis Bank stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

Private Banks sector: The report published by the NSE on June 30, 2022, identified the top ten stocks in the *private banks* sector having the largest free-float market capitalization. These stocks and their respective contributions (in percent) to the overall index of the sector are as follows: (i) ICICI Bank (ICICIBANK): 25.96%, (ii) HDFC Bank (HDFCBANK): 25.17%, (iii) IndusInd Bank (INDUSINDBK): 10.58%, (iv) Kotak Mahindra Bank

(KOTAKBANK): 10.15%, (v) Axis Bank (AXISBANK): 10.09%, (vi) Federal Bank (FEDERALBNK): 5.92%, (vii) IDFC First Bank (IDFCFIRSTB): 4.96%, (viii) Bandhan Bank (BANDHANBNK): 3.02%, (ix) RBL Bank (RBLBANK): 2.47%, and (x) City Union Bank (CUB): 1.75% (NSE Website). The ticker names of the stocks are mentioned in parentheses. The ticker names are the unique identifiers for the stocks listed on a stock exchange.



Figure 36. The RSI plot of Axis Bank stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

TABLE 12. THE ANNUAL RETURNS (IN PERCENT) YIELDED BY THE BB, MACD, AND RSI METHODS FOR PRIVATE BANKS SECTOR STOCKS
(PERIOD: JULY 1, 2022 – JUNE 30, 2023)

Stock	BB	MACD	RSI
ICICIBANK	28.78	19.95	11.63
HDFCBANK	23.11	12.82	0.00
INDUSINDBK	24.29	11.73	11.24
KOTAKBANK	11.22	3.16	3.22
AXISBANK	30.81	32.29	6.81
FEDERALBNK	42.35	2.29	0.00
IDFCFIRSTB	22.48	38.13	0.00
BANDHANBNK	8.21	0.32	0.25
RBLBANK	39.58	56.09	18.43
CUB	-3.00	-9.45	-28.64

Figures 34, 35, and 36 present the Bollinger Bands, MACD, and RSI plots respectively, of Axis Bank, one of the ten stocks of the *private banks* sector. The plots of the other stocks of this sector are not shown to avoid repetition. Table 12 exhibits the annual returns yielded by the three strategies for the 10 stocks of the *private banks* sector. The highest return for a given stock is shown in a bold font.

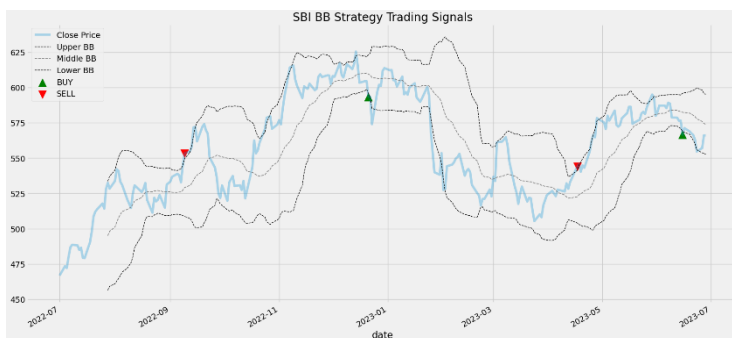


Figure 37. The Bollinger Bands plot of State Bank of India stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

PSU Banks sector: As per the report published by the NSE on June 30, 2022, the ten stocks that have the largest free-float market capitalization in this sector, and their respective contributions (in percent) to the overall index of the sector are as follows: (i) State Bank of India (SBIN): 28.13%, (ii) Bank of Baroda (BANKBARODA): 19.53%, (iii) Punjab National Bank (PNB): 12.58%, (iv) Canara Bank (CANKB): 11.99%, (v) Union Bank of India (UNIONBANK): 8.22%, (vi) Indian Bank (INDIANB): 6.87%, (vii) Bank of India (BANKINDIA): 5.29%, (viii) Bank of Maharashtra (MAHABANK): 2.65%, (ix) Indian Overseas Bank (IOB): 1.58%, and (x) Central Bank of India (CENTRALBK): 1.46% (NSE Website). The ticker names of the stocks, which are their unique identifiers, are mentioned in parentheses.

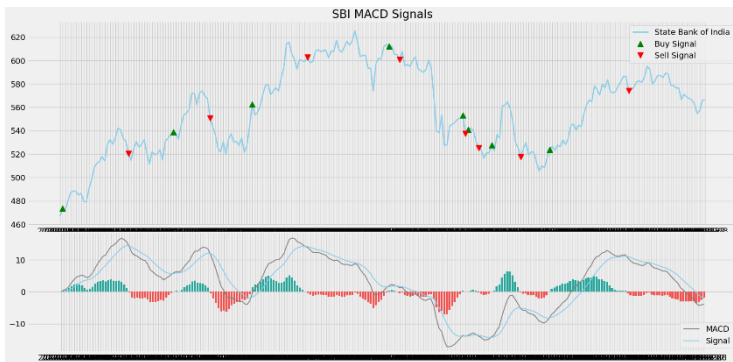


Figure 38. The MACD plot of State Bank of India stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

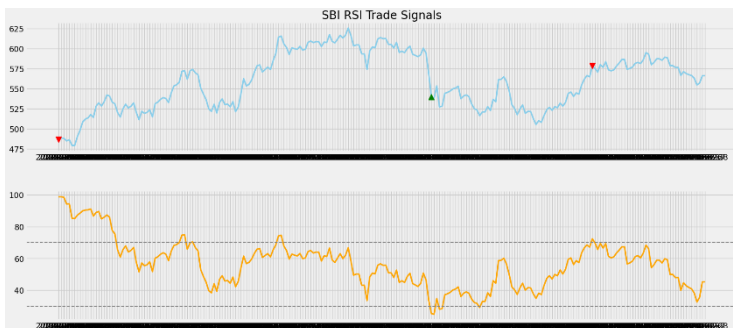


Figure 39. The RSI plot of State Bank of India stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

Figures 37, 38, and 39 present the Bollinger Bands, MACD, and RSI plots respectively, of the State Bank of India, one of the ten stocks of the *PSU banks* sector. The plots of the other stocks of this sector are not shown to avoid repetition. Table 13 exhibits the annual returns yielded by the three strategies for the 10 stocks of the *PSU banks* sector. The highest return for a given stock is shown in a bold font.

TABLE 13. THE ANNUAL RETURNS (IN PERCENT) YIELDED BY THE BB, MACD, AND RSI METHODS FOR PSU BANKS SECTOR STOCKS
(PERIOD: JULY 1, 2022 – JUNE 30, 2023)

Stock	BB	MACD	RSI
SBIN	6.46	22.04	6.75
BANKBARODA	18.96	29.13	14.04
PNB	13.86	71.13	0.00
CANBK	30.23	23.60	0.00
UNIONBANK	17.17	101.29	4.04
INDIANB	24.74	101.29	23.14
BANKINDIA	11.68	41.33	2.00
MAHABANK	10.20	95.83	18.03
IOB	-7.48	27.79	-0.83
CENTRALBK	1.05	72.91	12.74

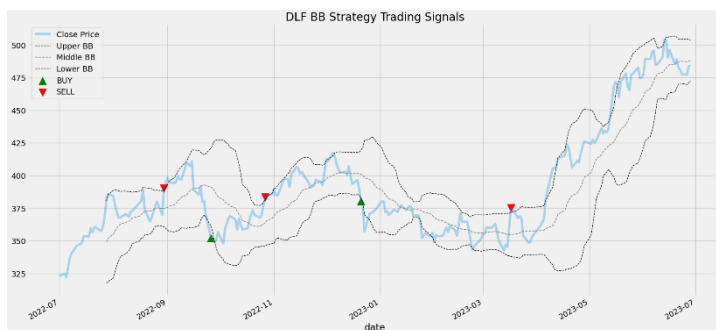


Figure 40. The Bollinger Bands plot of DLF stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

Realty sector: As per the report published by the NSE on June 30, 2022, the ten stocks that have the largest free-float market capitalization in the *realty* sector and their contributions (in percent) to the overall index of the sector are as follows: (i) DLF (DLF): 25.82%, (ii) Godrej Properties (GODREJPROP): 15.95%, (iii) Macrotech Developers (LODHA): 14.71%, (iv) Phoenix Mills (PHOENIXLTD): 12.93%, (v) Oberoi Realty (OBEROIRLTY): 10.48%, (vi) Prestige Estate Projects (PRESTIGE): 6.64%, (vii) Brigade Enterprises (BRIGADE): 5.93%, (viii) Mahindra Lifespace

Developers (MAHLIFE): 3.09%, (ix) Indiabulls Real Estate (IBREALEST): 2.65%, and (x) Sobha (SOBHA): 1.80% (NSE Website). The stock of LODHA was first listed on NSE on April 19, 2021. Hence, in place of it, the stock of Sunteck Realty (SUNTECK) is considered as it has the highest free float market capitalization among the remaining stocks in the *realty* sector.

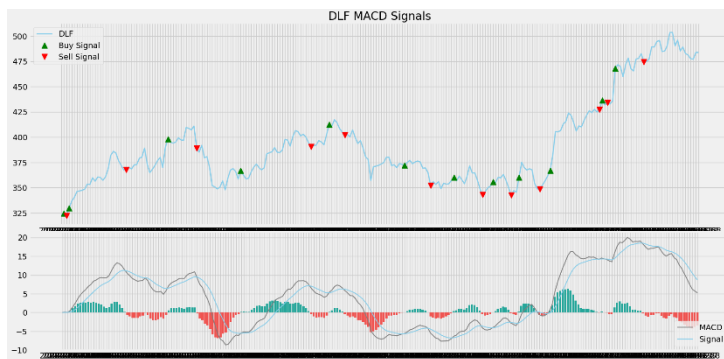


Figure 41. The MACD plot of DLF stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

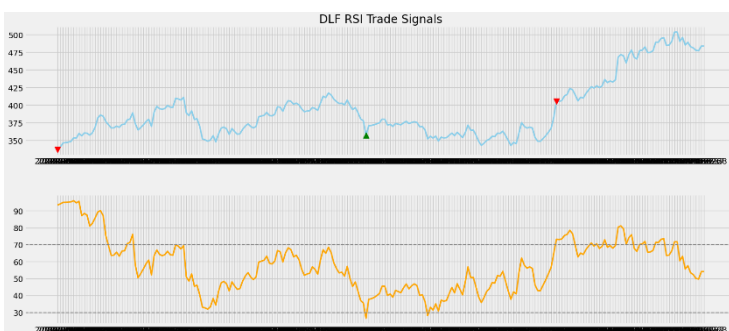


Figure 42. The RSI plot of DLF stock with the trading signal points identified over the period July 1, 2022, to June 30, 2023.

Figures 40, 41, and 42 present the Bollinger Bands, MACD, and RSI plots respectively, of DLF, one of the ten stocks of the *realty* sector. Table 14 exhibits the annual returns yielded by the three strategies for the 10 stocks of the *realty* sector. The highest return for a given stock is shown in a bold font.

TABLE 14. THE ANNUAL RETURNS (IN PERCENT) YIELDED BY THE BB, MACD, AND RSI METHODS FOR REALTY SECTOR STOCKS (PERIOD: JULY 1, 2022 – JUNE 30, 2023)

Stock	BB	MACD	RSI
DLF	19.18	13.61	9.99
GODREJPROP	2.27	15.84	-4.68
LODHA	7.16	-19.49	11.65
PHOENIXLTD	18.27	2.00	11.45
OBEROIRLTY	41.72	7.84	17.17
PRESTIGE	22.95	26.81	15.56
BRIGADE	18.28	5.87	0.00
MAHLIFE	2.24	10.33	6.45
IBREALEST	2.57	14.38	13.04
SOBHA	22.42	1.78	-11.53

TABLE 15. THE SUMMARY OF THE PERFORMANCES OF THE THREE TECHNICAL INDICATORS ON THE STOCKS FROM FOURTEEN SECTORS

Sector	BB	MACD	RSI
Auto	2	6	2
Banking	5	5	0
Financial Services Ex Banks	3	7	0
Consumer Durables	7	3	0
FMCG	6	4	0
Information Technology	5	3	2
Media	2	3	5
Metal	5	3	2
Mid-Small IT & Telecom	4	6	0
Oil & Gas	5	2	3
Pharma	4	4	2
Private Banks	7	3	0
PSU Banks	1	9	0
Realty	5	4	1
Total	61	62	17

Table 15 exhibits the summary of the results, in which for each sector the number of stocks that yielded the highest returns corresponding to each of the three strategies are listed. For example, for the *auto* sector, for the period from July 1, 2022, to June 30, 2023, two stocks yielded the highest returns using Bollinger bands, the MACD strategy yielded the highest return for six stocks, while for two stocks the RSI strategy yielded the highest return. The column-wise totals represent the total number of stocks that yielded the highest returns corresponding to the three strategies for the said period. It is observed that Bollinger Bands, MACD, and RSI strategies yielded the highest returns for 61, 62, and 17 stocks, respectively. It is evident that while the Bollinger Bands and MACD strategies performed equally well, RSI's performance was poor. The Bollinger Bands strategy exhibited the best performance for the *consumer durables* and *private banks* sectors. For the *PSU banks* sector, the performance of the MACD strategy has been excellent. While the performance of the RSI strategy is found to be quite poor in general for the period of this study, for the *media* sector, this strategy worked reasonably well.

5. Conclusion

This paper explored three prominent and extensively utilized technical indicators - Bollinger Bands, MACD, and RSI - and conducted a comparative investigation into their efficacy within the context of the Indian stock market. The study focused on stocks selected from 14 sectors listed on the NSE of India. The top 10 stocks in each sector are determined based on their free-float market capitalization, as reported by the NSE on July 1, 2022 (NSE Website). Trading activities were conducted for a duration of one year, spanning from July 1, 2022, to June 30, 2023, with an initial capital of Indian Rupees (INR) 100,000, employing the three technical indicators. The technical indicator that produces the highest return for each stock is identified, and a comparative analysis is performed based on the overall performance of these indicators across all 14 sectors.

The analysis reveals that Bollinger Bands, MACD, and RSI approaches resulted in the highest returns for 61, 62, and 17 stocks, respectively. Notably, Bollinger Bands and MACD strategies demonstrated comparable effectiveness, whereas RSI exhibited a distinctly subpar performance. Specifically, the Bollinger Bands

strategy excelled in the *consumer durables* and *private banks* sectors, while the MACD strategy stood out in the *PSU banks* sector. Despite its generally lackluster performance, the RSI strategy demonstrated reasonable effectiveness in the *media* sector.

Future research will encompass an investigation into constructing resilient portfolios by incorporating the three technical indicators. The objective is to assess the performance of these portfolios, aiming to gain insights into the efficacy of the indicators in a portfolio context.

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