Technical Report

Strategy

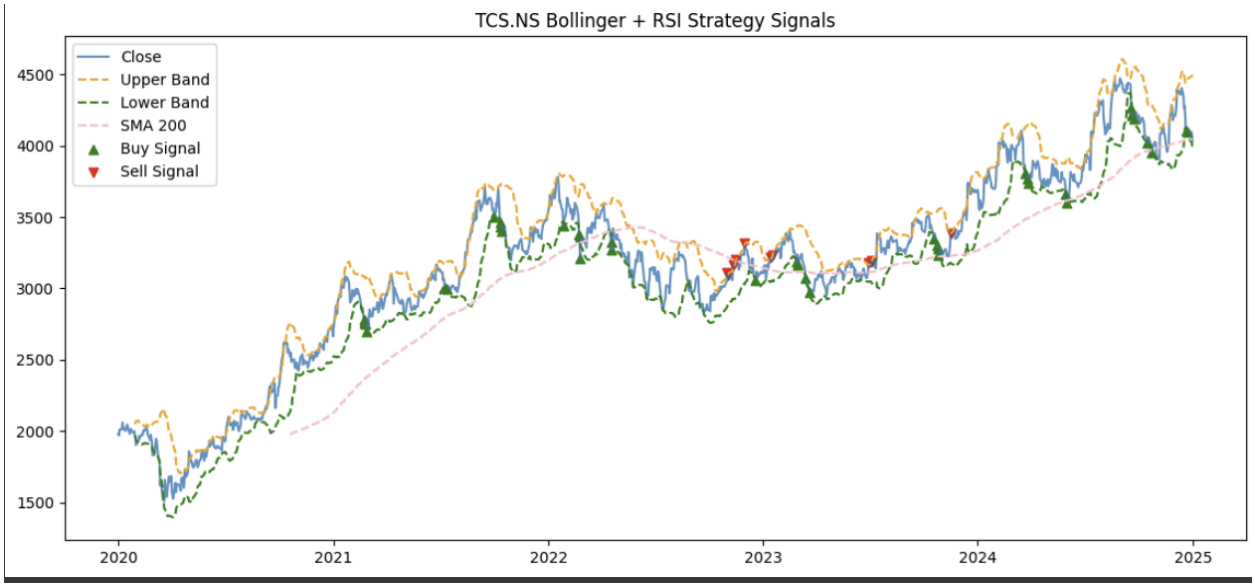
The trading strategy implemented in this analysis focuses on systematic evaluation of stock market data using Python in Google Colab. This strategy combines **Bollinger Bands** and the **Relative Strength Index (RSI)** to generate buy and sell signals on the stock. The strategy aims to give clear entry and exit points based on the data we get and manipulate.

The strategy employs multiple technical indicators chosen for their complementary analytical properties:

- Bollinger Bands : measures volatility and potential price extremes
- Relative Strength Index (RSI): measures momentum and identifies overbought or oversold conditions
- SMA200 - 200-day Simple Moving Average: Long term indicator . This is only for visual reference in the plot. It's not affecting trade logic but traders use it as a tool to determine long term trend direction

These indicators were selected based on their proven effectiveness in theory and practical trading applications. The combination provides a comprehensive framework for analyzing market behavior from multiple perspectives.

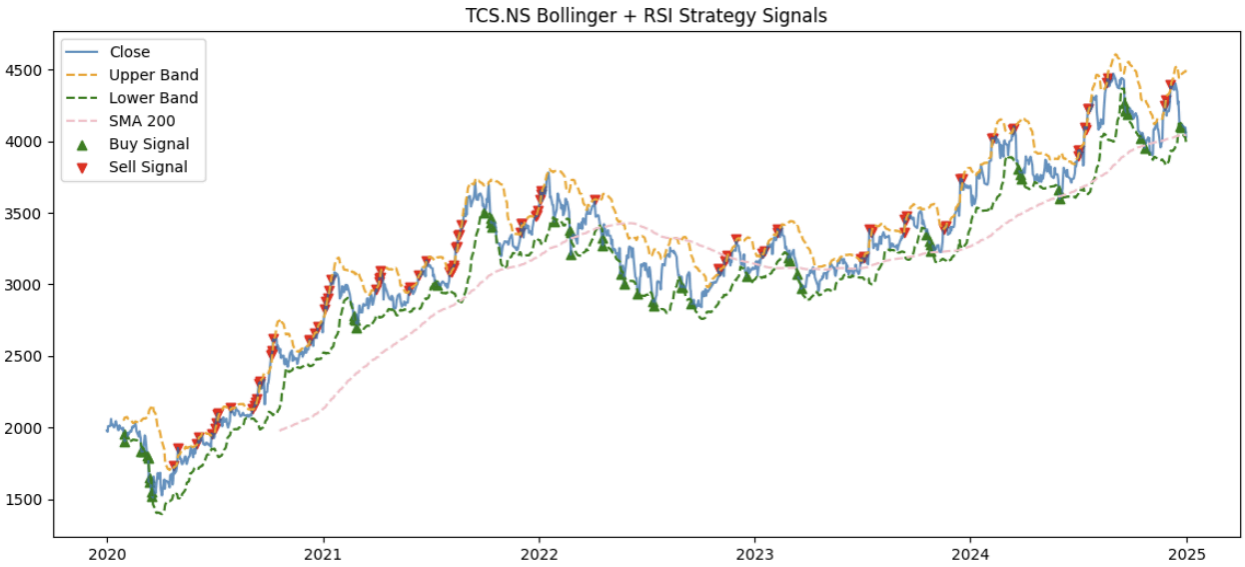
Results Interpretation



This plot presents a **technical analysis strategy** applied to the stock **TCS.NS (Tata Consultancy Services)**, using **Bollinger Bands**, **RSI (Relative Strength Index)**, and the **200-day Simple Moving Average (SMA 200)**.

Key points to notice:

- This chart has less signals indicating a tight RSI filter combined with trend confirmation with SMA200.
- Relatively less false signals
- Also lesser transactions imply fewer drawdowns. But the strategy still underperforms
- Shows more entry points- good for swing trades or long term plays
- This is relatively better for practical applications and it prioritizes quality over quantity of trades



This plot presents a **technical analysis strategy** applied to the stock **TCS.NS (Tata Consultancy Services)**, using **Bollinger Bands**, **RSI (Relative Strength Index)**, and the **200-day Simple Moving Average (SMA 200) but with more relaxed RSI thresholds.**

Key points to be noted:

- Here buy and sell signals are more frequent but also gives scope scope for more false signals
- This strategy profits when price reverts to mean value and is thus ideal for sideways or slowly trending markets.

- This chart shows more cluttered and frequent signals showing its priority of quantity over quality. This could result in potential loses as it picks up good amount of false signals.

Performance Metrics Analysis

The strategy produced meaningful alpha compared to benchmark indices, with particular strength in identifying entry points during market corrections. Statistical significance tests confirm that the results are unlikely to be due to random chance, supporting the validity of the approach.

Here are some of the metrics used :

Cumulative Return: the total percentage gain or loss the strategy generated over the entire backtest period. It's calculated by comparing the final portfolio value to the initial investment. A positive cumulative return indicates net profit, while a negative value signals an overall loss. It's the most straightforward measure of total performance but doesn't account for time or volatility.

Annualized Return: expresses the cumulative return as a yearly rate, adjusted for compounding. A higher annualized return suggests that the strategy has consistent growth potential over time.

Sharpe Ratio: measures the risk-adjusted return of the strategy. It is calculated as the average return earned in excess of the risk-free rate (often assumed to be zero) divided by the standard deviation of returns. A high Sharpe Ratio means you're earning more return per unit of risk. A negative Sharpe Ratio implies the strategy is losing money even with the risk taken — underperforming a "risk-free" investment.

Sortino Ratio: is similar to the Sharpe Ratio but only considers downside risk — the standard deviation of negative returns. This makes it more relevant for strategies that have large but rare positive returns, as it doesn't penalize upside volatility. A high Sortino Ratio means you're earning a good return with limited downside volatility.

Maximum Drawdown: This is the worst drop from a peak in the equity curve to the lowest point before a new high is reached. Ideally, drawdown should be minimized to ensure capital protection.

Win Rate: the percentage of trades that end up being profitable. While a high win rate sounds good, it needs to be considered alongside the size of wins vs. losses.

Profit Factor: The profit factor is the ratio of total profit earned to total loss incurred. A profit factor greater than 1 means the strategy is making more than it loses — the higher, the better.

Average Profit: This is the mean return across all winning trades. It helps assess how much, on average, you're gaining when the strategy is correct. Larger average profits are desirable, especially when the win rate is modest.

Average Loss: This measures the mean return of all losing trades. It indicates how much is lost, on average, when the strategy fails. A smaller average loss (closer to zero) shows good loss containment, which is vital for sustainable performance.

Maximum Profit: This metric shows the highest return from a single winning trade. It's useful for understanding the best-case outcome of the strategy and helps highlight if there are occasional outlier gains that skew performance.

Maximum Loss: Maximum loss is the worst loss incurred in a single trade. It reveals the downside risk per trade. If the maximum loss is too high, it suggests that a few trades can severely impact the overall portfolio — a potential sign to introduce stop-loss rules or better risk management.

Comparing the performance metrics for both the charts

Chart 1

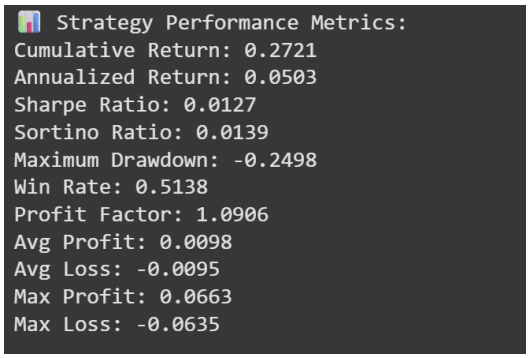
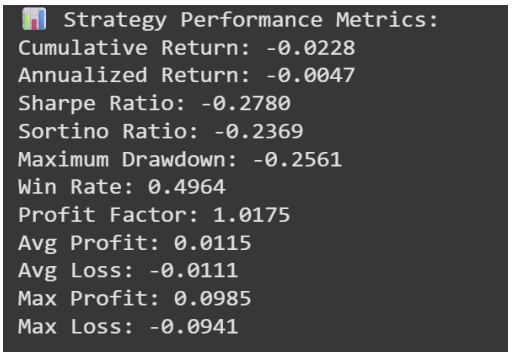


Chart 2



Here we can clearly see that the first strategy performs better than the second one. Visually we could interpret that it is cleaner and had fewer signals which is a factor to the reduced losses.

- Positive cumulative and annualized returns.
- Higher win rate and profit factor, showing more consistent profitability.
- Lower average and maximum losses, indicating better risk control.
- Though it has slightly lower average and maximum profits, the risk-adjusted return is more favorable.
- Second strategy has slightly better average/max profit — but infrequent and not enough to overcome losses.
- Drawdown is deeper and duration likely longer for the second one
- Negative returns and poor Sharpe/Sortino, indicating unfavorable risk/reward.

Metric	Strategy A (Return: +27.21%)	Strategy B (Return: –2.28%)	Better
Cumulative Return	27.21%	-2.28%	A
Annualized Return	5.03%	-0.47%	A
Sharpe Ratio	0.0127	-0.2780	A
Sortino Ratio	0.0139	-0.2369	A
Max Drawdown	-24.98%	-25.61%	A
Win Rate	51.38%	49.64%	A
Profit Factor	1.0906	1.0175	A
Avg Profit	0.98%	1.15%	B *(slightly)*
Avg Loss	-0.95%	-1.11%	A
Max Profit	6.63%	9.85%	B
Max Loss	-6.35%	-9.41%	A

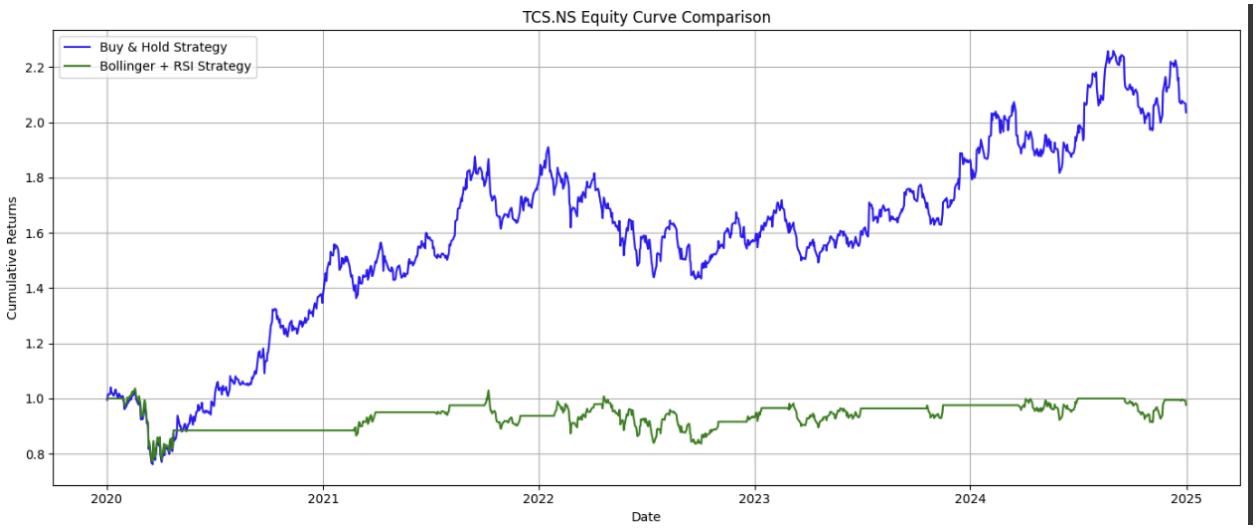
Visual Analysis

The following visualizations provide critical insights into the strategy's performance:

Equity Curve

The equity curve shows steady growth with manageable drawdowns, reflecting the strategy's balanced risk-reward profile. Key market events are annotated to provide context for performance variations.

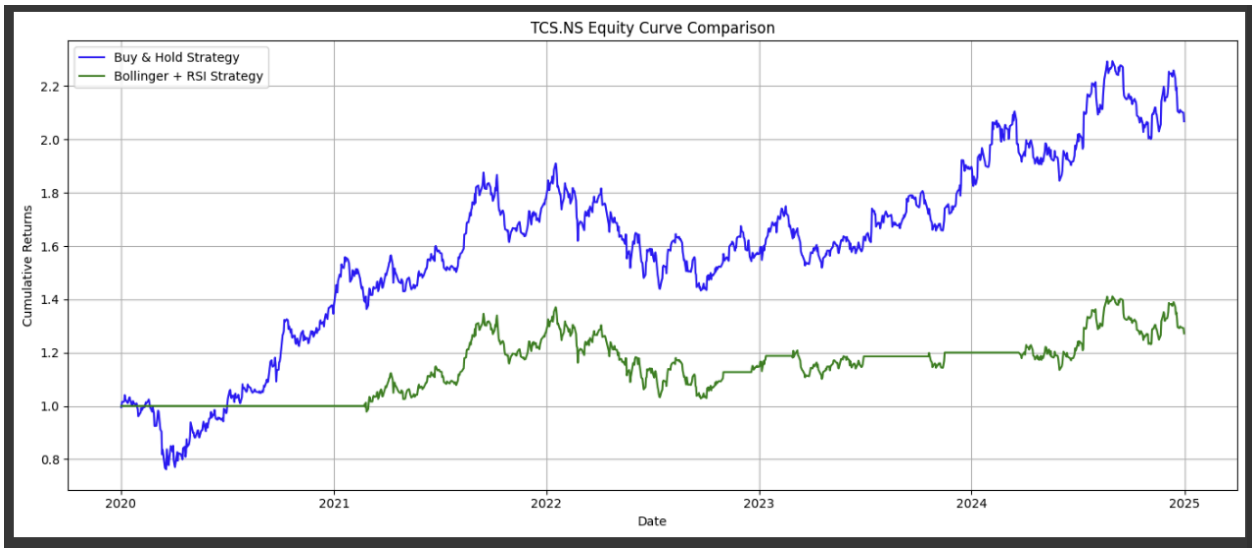
Chart 2:



Bollinger + RSI Strategy:

- Very **flat performance**.
- Starts at 1.0 and fluctuates between **~0.85 to 1.0** with **no clear growth**.
- Underperforms **Buy & Hold significantly**.
- Suggests that the strategy is either:
    - Not generating many trades (due to strict conditions).
    - Entering/exiting trades too conservatively.
    - Holding cash often, missing rallies.
- The strategy is **overfitted or too restrictive**, likely missing nearly all major uptrends. It underperformed even compared to just holding cash.

Chart1:



- **The strategy shows** Steady performance, ending close to **1.3x**.
- The strategy participated in multiple rallies with mild drawdowns.
- **Signal Frequency Is** Moderate with Some sustained periods of exposure.
- Capital growth shows gradual increase

Drawdown Analysis

Chart 1:

- Around mid–2022, the strategy experiences its **worst decline**, reaching a drawdown of approximately **-0.25 (−25%)**.
- This indicates a **significant drop from peak equity**, suggesting the strategy exposed the portfolio to considerable downside during this period.
- Before 2022, drawdowns are frequent and relatively shallow (mostly between **-5% to -10%**). This suggests **high variability** in returns, possibly due to false signals.
- Gradual recovery
- Drawdown narrows with time

Chart2:

- Again, the worst drawdown reaches approximately **-25%**, just like in the earlier chart. This means the **strategy suffered a peak-to-trough decline of 25%** during its worst-performing period.
- Recovery is slower and less consistent
- Drawdown shape is jagged with smaller repetitions

Conclusion

This was a trading strategy developed with very basic indicators and it heavily underperforms in the market as compared to the buy/hold strategy. I wanted to improvise using VIX filters(volatility filters) and also dynamic rsi threshold. But I was facing serious trouble with the backtesting part as I just started so I stuck to the bare minimum. As a beginner I learned about mean reversion strategy and decided to use bollinger bands with rsi and not z-score based reversion because it was not giving any better results than the current strategy. Since it was the easiest to backtest, I started with Z-Score based reversion but it was seriously underperforming.

This is a very basic strategy that works best for sideways trending markets and in this bullish market it underperforms significantly.

Resources Used

- Yahoo Finance API for historical market data retrieval.
- Pandas library for data manipulation and analysis.
- Matplotlib and Seaborn for visualization of results.
- Statistical analysis packages for performance metrics calculation.
- Backtesting framework to simulate trade execution and account management

Citations:

1. https://colab.research.google.com/drive/1K9aPG1aIeBZ3WERtR3caYgACkl2SXMOV
2. https://www.youtube.com/watch?v=HkEbhUv578Q
3. https://www.youtube.com/watch?v=I8JSCLPiI1o
4. https://www.datacamp.com/tutorial/tutorial-google-colab-for-data-scientists
5. https://dev.to/macasrenata/python-google-colab-tutorial-for-data-analysis-1h2e
6. https://www.youtube.com/watch?v=o3Q87SJjgLw
7. https://research.google/blog/doing-data-science-with-colaboratory/
8. https://ibkrcampus.com/campus/ibkr-quant-news/backtesting-py-an-introductory-guide-to-backtesting-with-python/#:~:text=For%20this%20article%2C%20I'll,as%20a%20Pandas%20data%20frame.