Inter IIT Tech Meet 2023

Team ID - 45

A gap-up opening and the possibility of a trend reversal, indicating a favorable outlook among investors, are strong indicators of successful trading outcomes for stocks with high volatility.

Abstract

Price action trading is a method for speculating in financial markets that involves analysing basic price movements over time. This study tested the hypothesis using a sample of 20 high-volatility stocks. A long-only strategy was developed based on the hypothesis. Its effectiveness was evaluated using various metrics such as drawdown, skew, kurtosis, beta, alpha, returns to maximum drawdown ratio, Sharpe ratio, Sortino ratio, and annualized returns. The study was conducted over three years, from July 1, 2018, to July 1, 2021.

Additionally, the study broadened its focus by examining the hypothesis on the Bank NIFTY index through a long-short strategy that utilized futures contracts composed of 12 companies. Also, verifying that a gap-up opening, which reflects a favourable investor sentiment, and the possibility of a trend reversal were found to be crucial predictors of successful trading outcomes, particularly for highly volatile stocks.

Key Words - Price Action, Candlesticks, Gap-Ups, Volatility, Trend Reversal, Risk Factor, P-Value

Terms Introduction and Basics [1]

Price Action

Price action is the study of price movements in a market without using indicators. It is a trading strategy that allows a trader to study the market for indications on where the market could move next. Price action traders disregard fundamental analysis[1] aspects to focus on current and prior price movements. It entails locating support[2] and resistance[3], creating trend lines[4], and determining the price concerning these points.

Price action works well because everyone is looking at the same chart in the same time frame. When a large percentage of traders have similar levels on their charts, then the price action respects those levels. Different disciplines of price action trading exist, including Japanese candlestick patterns, support and resistance, trend lines, price bands[5], breakouts[6], high and low swings, and chart patterns.

1 - Fundamental analysis is a method employed by stock analysts to evaluate the market value of a stock and determine if it is overvalued or undervalued.
2 - Support is the level at which demand is strong enough to stop the stock from falling further.
3 - Resistance is the level at which supply is strong enough to stop the stock from moving higher.
4 -Trendlines is a graphical depiction of support and resistance in any time frame that highlights the direction and pace of price movements and highlights patterns during periods of price consolidation.
5 - A price band is a value-setting method in which a seller indicates an upper and lower cost limit between which buyers can place bids.
6 - A breakout is a stock price moving outside a defined support or resistance level with increased volume.

This paper will confine the discussion to - Candlestick Patterns: Bullish and Bearish Behavior, and Chart Patterns: Gap-up Opening and Trend Reversal.

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Candlestick

Candlesticks are a type of financial chart used in technical analysis to represent the price action of a financial instrument over a specified period. Each candlestick displays four essential price values: the opening price, closing price, highest price, and lowest price, with the body representing the difference between the opening and closing prices and the wick indicating the high and low prices. The green or white candlestick suggests a price increase, while the red or black candlestick indicates a decline in price during the period.

Bullish Behaviour - Refers to a market trend where the price of an asset is expected to rise. Most traders and investors buy in a bullish market, increasing prices.

Bearish Behaviour - Refers to a market trend where the price of an asset is expected to fall. Most traders and investors sell in a bearish market, pushing the price down.

Gap Up Opening

A gap-up opening refers to a situation in which the opening price of a stock or other financial asset is higher than the previous day's closing price. This is considered a bullish signal and indicates positive investor sentiment.

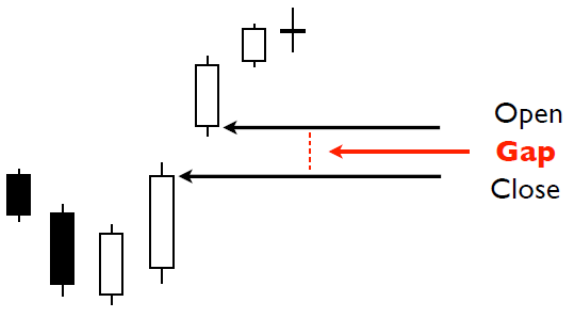


Fig 1. - Gap Up Opening

Volatility

Volatility is a measure of the amount of uncertainty or risk involved with the price change of a financial instrument over a given period. It is often used to describe fluctuations in stock prices, currency exchange rates, or other assets. A higher volatility means that an asset's price can change dramatically in either direction over a short period, while a lower volatility means that an asset's price changes more slowly and smoothly.

Trend Reversal

A potential trend reversal in price action refers to a situation in which the current trend of an asset's price movement appears to change. It suggests that the asset's price may move opposite from its previous direction and continue to follow this new trend.

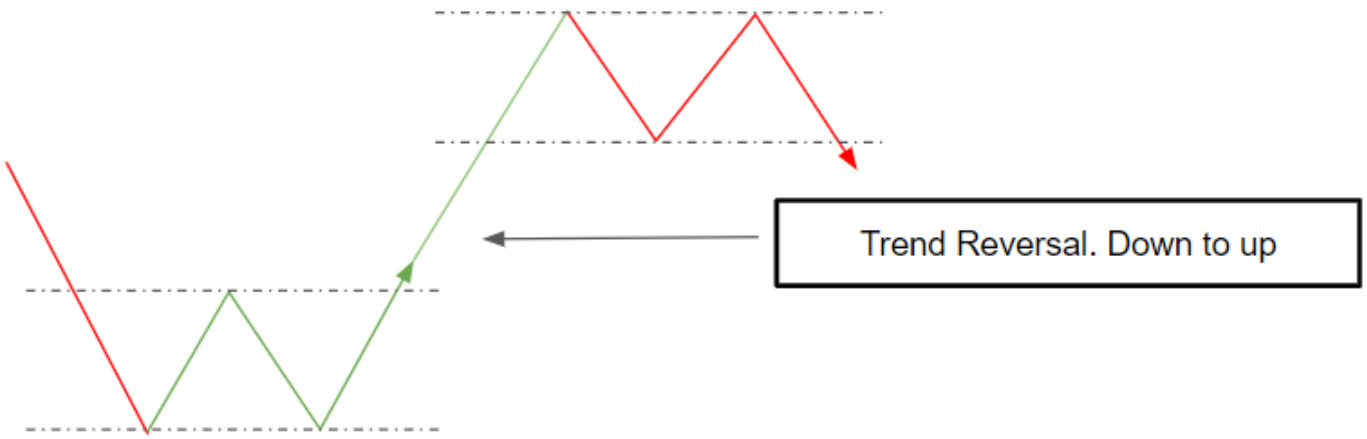


Fig 2. – Initially, the asset was in an upward trend, then changed to a downward trend. The two dotted lines in the picture are support and resistance, respectively.

Annual Volatility

Annualized volatility is the calculation of the standard deviation of a financial asset's returns over time, expressed as an annual rate. The annual volatility was determined by finding the daily standard deviation of the log returns[7], known as the daily volatility, and then multiplying it by the square root of 252.

7 - The Log Return method of calculating return assumes that returns are continuously compounded and calculates it by dividing the natural logarithm of the ending value by the beginning value. It is one of three methods used to calculate returns

Universe Selection and Methodology

This study uses a vast data set of NIFTY 500[8] index constituents ranging from 1st January 2017 to 1st July 2021. The stock price data used is of the type "Daily" or "End of the Day" (EOD).

The daily share data comprises OPEN, HIGH, LOW, CLOSE, and VOLUME data points for each stock taken from the databases of Blueshift and Yahoo! Finance. Data was separated and bonus-adjusted. The sample period underwent economic events like the **2019 Elections, the 2020 Farmer Protest, IL&FS Crisis, Crude Oil Price Reduction, Corporate Tax Cut, and Covid-19.** [2] The sample period has also gone through country-specific and global geopolitical events.

We have made a decision regarding the data, which will be divided into 2 segments.

- 1st January 2017 to 1st January 2018 is the lookback period to calculate the most volatile stock list.
- 1st July 2018 to 1st July 2021 as the back testing period for the strategy/hypothesis.

The hypothesis is based on the initial assumption that trend reversal strategies work best on high-volatility stocks. Accordingly, the universe selected to back test this strategy is the 20 most volatile stocks on the NIFTY 500 Index in 2017-2018. The volatility of the stocks was determined by calculating the annual volatility of the present constituents of the NIFTY 500 Index at the end of 2018.

The universe consists of the following stocks:

Stock Name -	Ticker Symbol -	Calculated Annual Volatility -
Olectra Greentech	OLECTRA	0.686
ITI Limited	ITI	0.680
TATA Teleserv (Maharashtra)	TTML	0.669
HEG Limited	HEG	0.668
Indiabulls Real Estate	IBREALEST	0.603
Capri Global Capital	CGCL	0.601
Graphite India	GRAPHITE	0.599
HFCL	HFCL	0.579
Fertilisers and Chemicals Travancore	FACT	0.579
Saregama India	SAREGAMA	0.577
Dhani Services	DHANI	0.564
Rattanindia Enterprises Limited	RTNINDIA	0.560
RAIN Industries	RAIN	0.552
Brightcom Group	BCG	0.544
Adani Enterprises	ADANIENT	0.524
Punjab National Bank	PNB	0.521
Adani Transmission Limited	ADANITRANS	0.518
Mastek	MASTEK	0.512
Infibeam Avenues Limited	INFIBEAM	0.503
Radico Khaitan Limited	RADICO	0.499

8 - The NIFTY 500 is India's first widely established stock market index. It includes the top 500 NSE-listed companies. About 96.1% of free float market capitalization and 96.5% of total turnover on the National Stock Exchange comprise the NIFTY 500 index (NSE).

The generated universe encompasses a diverse array of sectors, with its performance displaying a decline in the event of a reduction in the volatility of the stock universe. To affirm the validity of the hypothesis, higher volatility stocks are deliberately selected, as these equities have the potential to yield greater returns despite the elevated level of risk involved.

The Python code used to calculate the annual volatility for the NIFTY 500 is attached below.

```
#importing the necessary libraries
import pandas as pd
import numpy as np
import math
import yfinance as yf

#Fetching data of top 500 stocks from the internet
stockList=list(pd.read_html("https://www.traderscockpit.com/?pageView=nse-indices-stock-watch&index=NIFTY+500")[3]['Index'])

for i in range(len(stockList)):
    stockList[i]+=".NS"

data=yf.download(" ".join(stockList),start="2017-01-01", end="2018-01-01")
#Downloading the data from yfinance

returns=pd.DataFrame()
newStockList=[]

#Checking if the initial values are nan
for i in stockList:
    if math.isnan(data['Adj Close'][i][0])==False:
        returns[i]=np.log(data['Adj Close'][i]/data['Adj Close'][i].shift())
        newStockList.append(i)

#calculating annual volatility
volatility=[]
for i in newStockList:
    if math.isnan(returns[i].std())==False:
        volatility.append([returns[i].std()*252**0.5,i[:-3]])
volatility.sort(reverse=True)

df=pd.DataFrame(volatility,columns=['volatility','ticker'])
df.to_csv('2017_2018.csv',index=False)
#converting to CSV file
```

There were a few stocks initially listed on BSE and later listed on NSE as well (after the start of our lookback period) for example – Alok Industries (ALOKINDS). This stock was in our top – 20 most volatile stocks but was not listed on NSE during our lookback period.

Trading Strategy Explanation

The strategy aims to trade rapid price changes by detecting and capitalizing on the onset of an upward or downward trend. It recognizes bullish sentiment through gap-up openings and by evaluating the length of the first candle relative to the opening price. Suppose the body length is more than 1% of the opening price, and the current bar is green with a body length exceeding 1% of the opening price (like tweezer bottom[9] and 3 inside up[10]). In that case, the strategy will open long positions on volatile stocks. On the other hand, strategy squares off the trade based on momentum breakout, if a red bar occurs or a Bearish Doji Star is formed.

9 - If the first candle has a body length greater than 1% of the opening price, is red, and the current bar is green with a candle length greater than 1% of the opening price, it is referred to as a tweezer bottom.

10 - The three inside-up pattern is a bullish reversal signal consisting of a large red candle followed by a green candle contained within the last candle's range and then another green candle that closes above the close of the second candle. This pattern indicates a reversal from a bearish trend to a bullish sentiment.

11 - A momentum breakout refers to a substantial shift in the price of an asset.

12 – Bearish Doji Star - The first candle is green, followed by a doji. The body of the first candle should be greater than 1% of the open, and the body of the doji should be less than 0.1% of the open. A doji represents a trading session in which the open and close of security are virtually equal.

Risk Management

The strategy enters a long position if the current bar opens above the previous bar's close or if the first candle has a body length greater than 1% of the open and the contemporary bar is green with a body length greater than 1% of the open. The strategy squares off the trade if a red bar occurs or a Bearish Doji Star is formed.

The strategy uses a stop-loss of 3% (the position is squared off if the market price goes below 3% of the buying price or if the loss incurred exceeds 3%). Additionally, a trailing stop loss of 5% (the trade is closed when the market price decreases by more than 5% from the current high in par with the industry standard price) and a profit booking[13] value of 50%.

The strategy also implements a 0.3% charge for transaction and brokerage. (A cost of 0.3% is within the industry standard range for traders. Traders dealing in high volumes may prefer brokers with fixed charges over brokers charging a specified percentage.)

Since we are trading in highly liquid, volatile stocks using limit-based algorithmic trading[14], slippage is minimal even though we have considered a slippage of 0.002%. This means that the trading price may differ from the market price by a maximum of 0.002%.

13 - Profit booking is crucial for maximizing the benefits of your stock investments. Without it, the investments become vulnerable to market shocks and turbulence, with the possibility of significant losses in a volatile market.

14 - Algorithmic trading systems are based on pre-defined rules and instructions, which can limit the ability of traders to customize their trades to meet their specific needs or preferences.

3 Percent Stop-Loss Reasoning -

Stop-loss is an order to sell an asset when it reaches a specified price point, used to limit loss. This strategy uses a stop-loss of 3%, which aligns with the industry standard of 2-5%. However, in a volatile market with frequent trend reversals, the stop-loss is likely to be triggered unnecessarily. If the stock price falls more than 5%, the likelihood of trend reversals is low, leading to excessive losses. [3]

Strategy Buying Methodology

The strategy, as discussed earlier, enters a long position - If the current bar opens above the previous bar's close or if the first candle has a body length greater than 1% of the open and the current bar is green with a body length greater than 1% of the opening price.

The following study explains both of the buying methodologies –

Gap Up Opening - During the pre-market opening session, a call auction processes all orders to determine an equilibrium price. This price is the one that receives the most orders for buying or selling a share and serves as the opening price of a stock. A gap-up open indicates a highly bullish sentiment and is considered a potential entry point for a long trade.

Second Method - if the first line is a candle with a body length greater than 1% open and the current bar is green with a candle length greater than 1% open

Case I:- if the first line is a candle with a body length greater than 1% open, it is green, and the current bar is also green with a candle length greater than 1% open.

The three-inside-up pattern is a bullish reversal pattern that consists of a large red candle, followed by a green candle contained within the first candle, and then another green candle that closes above the close of the second candle. In the statement mentioned above, the two green candles indicate a reversal from a bearish trend to an upcoming bullish sentiment.

Here the 1st candle signifies a possible bullish trend, and the second candle serves as a confirmation of the bullish trend, thereby indicating a strong bullish trend.

Case II:- if the first line is a candle with a body length greater than 1% open, it is red, and the current bar is also green with a candle length greater than 1% open. (Tweezer Bottom)

The first candle represents bearish sentiment, while the second candle indicates the return of the bulls. The fact that the two candles formed shadows at the same level confirms the strength of the support and suggests that the downtrend has likely paused or reversed into an uptrend, making it a potential time to enter a long position.

Strategy Selling Methodology

The strategy squares off the trade if a red bar occurs or a Bearish Doji Star is formed.

The below study explains both of the selling methodologies –

Red Candle - As this strategy trades in a highly volatile environment, it signals potential weakness in the bullish trend or even a bearish breakout, making it a possible point to exit positions.

Bearish Doji Star Selling - The first green candle indicates a bullish trend, followed by a red or green doji, which suggests a slowdown in the movement (green doji) or a probable reversal of the trend (red doji). This, in turn, signals a safe time to square off positions.

It is important to remember that the strategy only involves taking long positions in the equity market and never short-sells any stock, which can be confirmed through the transaction records generated.

Statistical Strategy Testing

Multiple Testing

Multiple tests involve executing multiple back tests with the same strategy while adjusting the numerical parameters. The goal is to identify the "optimal" parameters within the back testing period.

To enhance the strategy, the risk factor and profit booking were adjusted from 10% to 100% to optimize it further.

Risk factor = {20%, 40%, 60%, 80%, 100%}
Profit booking = {25%, 50%, 75%, 100%}

Weight = 1 / (number of securities)

Risk Factor - The risk factor is the percentage of total capital invested per trade. To elaborate, when investing in multiple stocks, each with equal weighting, a risk factor of 40% would mean that 40% of the weight per stock was invested per trade. The adjusted weight can be calculated as follows: Risk factor adjusted weight = (40/100) * (1/number of securities).

Profit booking - The maximum profit percentage achieved before closing a position.

The only variables being adjusted are the risk factor and profit booking, as the trading strategy lacks multiple parameters that can be optimized. The parameters of the buy/sell conditions, which have limited potential for optimization, are infrequent—making modifications to these parameters would result in a significant increase in the number of tests and labour with minimal benefit.

The risk factor and profit booking could have been randomly altered using Python code, producing numerous tests. Nonetheless, due to time limitations, only 20 tests were executed.

Dealing with the Multiple Testing Problem

One significant issue with multiple testing is the potential for incorrect inferences. The Bonferroni test was applied to mitigate the False Positive Rate and minimize the impact of this problem.

Bonferroni Test: The Bonferroni test is a method for addressing the problem of multiple testing.

Multiple Testing Problem: When working with tests with many parameters, it is possible to identify a "successful" strategy that only works in the back testing period by chance. Such strategies are referred to as false positives.

To address false positives, the Bonferroni correction is employed. The P-Value is adjusted by dividing it by the number of multiple tests, making the test more stringent and reducing the likelihood of false positive results.

Threshold P-value (Significance Level): Probability of the study rejecting the null hypothesis, given that the null hypothesis is true.

The Bonferroni corrected P-Value, P' = P/N

P' = 0.05 / 20 = 0.0025

P = 0.05 (General value used by Statisticians)

Although the test is quite stringent, it increases the risk of overlooking some effective strategies. However, as all the tests met the t-statistic threshold, there was no requirement to consider less strict tests.

Hypothesis testing [4]

Hypothesis testing is a statistical technique used to determine the validity of a hypothesis by examining sample data. The sample data is assumed to follow a normal distribution, and two hypotheses are established: the null hypothesis and the alternative hypothesis. The threshold p-value is selected based on the level of rigor required for the test, with a typical choice being 0.05. However, if the Bonferroni test is applied, the corrected p-value is 0.0025. Finally, the t-statistic is calculated and converted to a p-value.

T-Statistics: In statistical analysis, the T-Statistics represents the ratio of the deviation of an estimated parameter from its hypothesized value and standard error.

If the calculated p-value is less than the predetermined threshold p-value, the null hypothesis is rejected, and the alternative hypothesis is accepted. Although this method does not definitively prove the truth or falsity of a hypothesis, it is a valuable tool in statistical analysis. The limitations of this approach are discussed in more depth in the corresponding sub-topic.

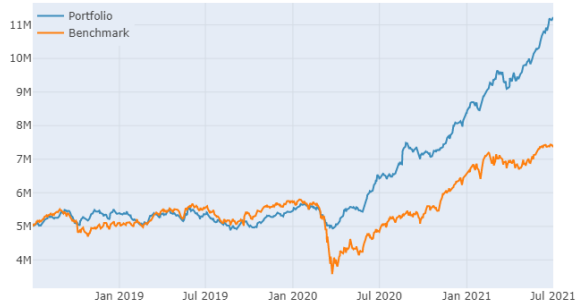


Fig 3. – Sharpe 2.38 | Take Profit 50%

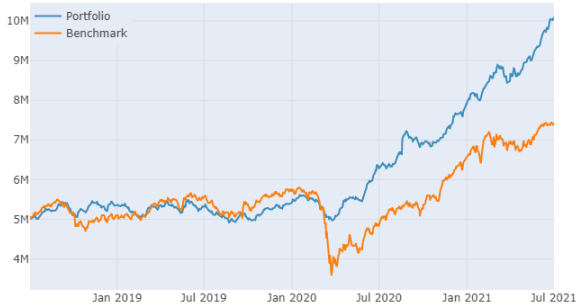


Fig 4. – Sharpe 2.39 | Take Profit 100%

Fig 5. Sharpe 2.43 | Take Profit 50%

Graphs Depicting the Top 3 Results of Multiple Testing with the Highest Sharpe Ratios.

These cases can be found on next page's table in blue.

Results of Multiple Testing

Risk Factor %	Take Profit %	Returns %	Alpha	Beta	Sharpe	Drawdown %	Capital
20	25	23.48	0.06	0.08	2.04	-4.53	5000000
20	50	22.88	0.06	0.08	2.09	-4.38	5000000
20	75	24.59	0.07	0.08	2.1	-4.43	5000000
20	100	25.11	0.07	0.08	2.13	-4.46	5000000
40	25	44.24	0.11	0.14	2.14	-7.24	5000000
40	50	46.86	0.12	0.14	2.21	-7.02	5000000
40	75	50.89	0.13	0.14	2.2	-7.29	5000000
40	100	51.82	0.13	0.14	2.23	-7.37	5000000
60	25	67.28	0.16	0.19	2.23	-9.84	5000000
60	50	75.27	0.18	0.2	2.26	-9.44	5000000
60	75	76.39	0.18	0.2	2.27	-9.78	5000000
60	100	77.19	0.18	0.2	2.28	-9.80	5000000
80	25	89.21	0.21	0.23	2.29	-11.52	5000000
80	50	101.80	0.23	0.24	2.38	-11.33	5000000
80	75	100.13	0.23	0.24	2.33	-11.60	5000000
80	100	101.16	0.23	0.24	2.34	-11.67	5000000
100	25	110.83	0.24	0.27	2.32	-12.84	5000000
100	50	126.29	0.27	0.28	2.43	-12.51	5000000
100	75	122.99	0.27	0.28	2.38	-12.63	5000000
100	100	124.61%	0.27	0.28	2.39	-12.88%	5000000

This Section is Based on the Research Paper Entitled "Evaluating Trading Strategies" by Campbell R. Harvey and Yan Liu.

The Sharpe ratio will serve as the metric to evaluate our trading strategy for two reasons:

- The Sharpe ratio is already expressed in the t-statistic form (t-statistic = Sharpe ratio * square root of the number of years)
- The Sharpe ratio integrates risk and reward, comprehensively assessing the strategy's performance.

Alpha - Alpha is the excess return on an investment after adjusting for market-related volatility and random fluctuations.

Beta - Beta is a concept that measures the expected move in a stock relative to movements in the overall market.

Drawdown - A drawdown refers to how much an investment or trading account is down from the peak before it recovers back to the peak.

H_0 - The strategy lacks a discernible advantage. It is derived from a normal distribution of strategies with a Sharpe ratio of 0.

H_1 - The strategy possesses a strategic advantage. It is derived from a distribution with a Sharpe ratio greater than 0.

The testing results produced the highest Sharpe ratio of 2.43. The associated t-statistic can be calculated using the following formula: t-statistic = Sharpe ratio * square root of the number of years.

- **T-Statistic = 2.43 * square root of 3 = 4.209**

The t-statistic calculated above results in a p-value of 0.000238, significantly lower than the threshold p-value of 0.0025. Thus, rejecting the null hypothesis and conclude that the strategy has a strategic advantage.

The testing produced the lowest Sharpe ratio of 2.04. The associated t-statistic can be calculated as follows:

- **T-Statistic = 2.04 * square root of 3 = 3.533. The corresponding p-value is 0.001111**

Thus, the strategy remains effective even under conditions with the lowest Sharpe ratio. As a result, less stringent tests, such as the Holm and BHY tests, were unnecessary.

Limitations [5]

Let us say there are x strategies that are to be tested. The likelihood of discovering an effective trading strategy is assumed to be 1%, with the possibility that the actual probability could be lower. This indicates that 99% of the strategies are ineffective, while only 1% are effective. The test has a significance level of 0.25%, which means that of all the strategies, (24.75x)/(10000) will be considered false positives, while the remaining (9875.25x)/(10000) will be considered true negatives.

Power: The probability of rejecting a null hypothesis given the null hypothesis is false.

The power of the hypothesis test is estimated at 80%. However, this is only an estimate. The power can be lower because we have used a stringent test. Thus, the number of true positives is expected to be (8/1000)x, while the number of false negatives is estimated at (2/1000)x.

The probability of a false positive is calculated as the ratio of [(24.75/10000)x] to the sum of [(24.75/10000)x + (80/10000)x], which results in a value of 23.62%.

It is important to note that this value indicates a non-negligible chance (approximately 25%) of the strategy being a false positive, despite its good performance in back testing.

Statistical hypothesis testing should not be interpreted as a guarantee that the hypothesis is true or false with absolute certainty. Instead, it should be viewed as a tool for making informed decisions based on probability. [6]

The following part of the report will thoroughly examine the additional evaluation metrics relevant to our trading approach. The metrics will be critically analyzed to gain a deeper understanding of their significance and impact on our trading strategy. With this trading strategy, Sharpe ratio may be relatively less accurate. This reduces the accuracy of our tests to some extent. This will be discussed further in the next section.

Abstract Strategy Testing

This section evaluates various metrics commonly used to assess the performance of a trading strategy. The ratios mentioned below are widely used in the industry to compare the returns to the risk associated with the strategy. This also encompasses certain indicators relevant to the performance of the specific trading strategy and provides more precise insights.

Sharpe Ratio

The Sharpe Ratio measures the risk-adjusted returns of an investment. It represents the ratio of the excess returns of a portfolio to the standard deviation of its returns, serving as a gauge of volatility or risk.

Sharpe Ratio = (Rp - rf) / (sigma(p))

where Rp = portfolio return
rf = risk-free rate
sigma(p) = standard deviation of the portfolio's excess returns

The Sharpe ratio for the given strategy is **2.43 -** This is also an indicator that the strategy provides high risk-adjusted returns. A high Sharpe ratio also conveys that this strategy produces high returns with a higher risk level.

Sortino Ratio

The Sortino Ratio is a variation of the Sharpe Ratio. It distinguishes between detrimental volatility and total volatility by considering only the standard deviation of the negative returns of a portfolio, known as the downside deviation. Since variation in positive returns is advantageous for an investor, it is not considered a risk. As a result, the Sortino Ratio provides a more accurate evaluation of the risk-adjusted returns of a particular investment.

Sortino Ratio = (Rp - rf) / (sigma(d))

where Rp = Portfolio return
rf = risk-free rate
sigma(d) = downside deviation

For the strategy, the Sortino ratio comes out to be **4.09** - This indicates that the strategy provides high returns for the given level of downside risk.

It is crucial to remember that the Sharpe and Sortino ratios rely on the assumption that investment returns follow a normal distribution. However, the nature of dynamic trading strategies can result in a skewed and non-normal distribution of returns, characterized by high skewness and Kurtosis. This deviation from a normal distribution can impact these ratios' accuracy as risk-adjusted returns measures. [7]

Thus, it is essential to consider the distribution of returns when interpreting these ratios carefully and to use alternative measures, such as the Returns to Drawdown ratio, which can provide a more comprehensive assessment of the risk-adjusted performance of a trading strategy.

Kurtosis

The metric of Kurtosis is used to quantify the outliers in a distribution. It measures the extent to which the data is concentrated in the distribution's tails, allowing for an assessment of how frequently extreme values or outliers occur.

Kurtosis = (4th Central Moment) / (Standard Deviation^4)

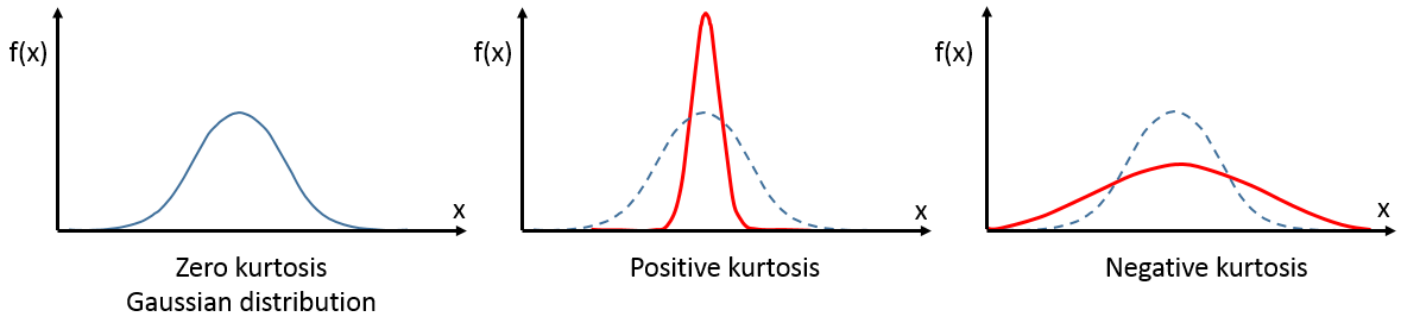


Fig 6. Kurtosis Curves

In a normal distribution, the Kurtosis is equal to 3. However, in the case of the returns from the trading strategy under consideration, the Kurtosis equals **4.71** - resulting in a low positive excess Kurtosis (leptokurtosis). This suggests that outliers, or deviations from the mean, are not frequent but still exist.

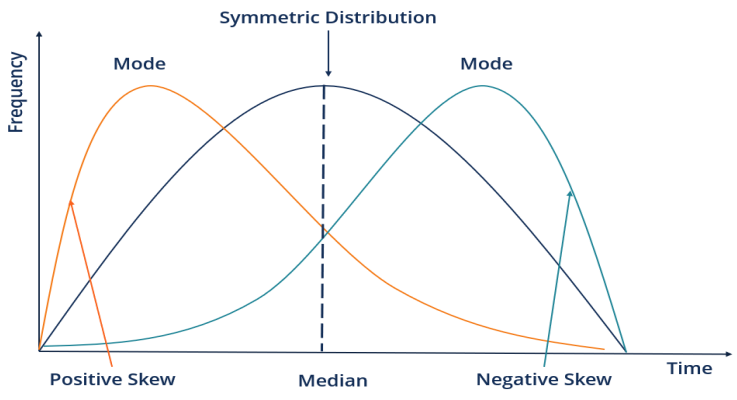
Skewness

Skewness is a statistical measure of the asymmetry of a distribution relative to its mean. It reflects a bias in the distribution, which can be either positive, negative, or neutral (i.e., zero). In a normal distribution, the observations are symmetrically distributed around the mean, resulting in zero skew.

Skewness = (3*(Mean - Median)) / (Standard Deviation)

For the dynamic strategy under examination, skewness is calculated as **0.67** - This positive skew shows that the returns are more heavily weighted towards the left side of the mean, meaning the distribution's right tail is longer, and there are more outliers on the right side of the mean.

Fig 7. Kurtosis Curves



In summary, the high Kurtosis and skewness of the returns for the given strategy indicate that the returns do not follow a normal distribution. Therefore, the Sharpe and Sortino ratios may not accurately reflect the risk involved with the strategy and must be considered accordingly.

RoMaD can be used instead of the Sharpe and Sortino ratios to solve the issue of high Kurtosis and skewness. RoMaD measures the risk involved in a strategy, making it a suitable alternative.

RoMaD (Returns over Maximum Drawdown)

The maximum drawdown measures the most significant drop in a portfolio's value from its peak to its low point. It is a common way of expressing the risk involved with a portfolio. The returns over maximum drawdown (RoMaD) is a risk metric used to evaluate a portfolio's performance.

RoMaD = (Portfolio Return / Maximum Drawdown)

The given strategy has a RoMaD of **10.08** - significantly better than the typical industry benchmark of 2-3. This outstanding performance can be attributed to the strategy's focus on investing in highly volatile stocks, which can generate high returns in a short period but also come with a higher level of risk.

Fig 8. Overall Performance Curve

For the three years of July 2018 to July 2021, this strategy achieved annual returns of **32.11%** and cumulative returns of **126.28%**, outperforming the benchmark significantly. The strategy's annual volatility was **11.73%** compared to 22.02% for the benchmark (NIFTY 50) during the same period. This suggests that the strategy delivers more consistent returns compared to the benchmark, which is advantageous for traders.

Performance on Decreasing Volatility

Fig 9. 20 – 40 Most Volatile Stock Performance

Fig 10. 40 – 60 Most Volatile Stock Performance

In this study, the hypothesis was tested on a universe of the 20 most volatile stocks and the results showed remarkable success. The findings indicated that the strategy performed exceptionally well when stock prices experienced significant price fluctuations.

To further bolster this claim, the strategy was applied to two separate universes, one consisting of stocks ranked 21-40 in terms of volatility and the other of stocks ranked 41-60. As the order of volatility decreased, the performance metrics such as Returns, Sharpe Ratio, Sortino Ratio, Maximum Drawdown, and Omega Ratio showed a corresponding decline in the strategy's performance.

This supports the hypothesis and confirms the validity of the universe selected.

Early Exit from Trading Reasoning

As the market nears its final hour of trading, an intra-day squaring off panic often ensues, resulting in undesirable impacts on our strategy. Our approach is not well-suited for intra-day volatility due to the limitations posed by the 1% candle parameters, 50% profit booking, and 3% stop loss criteria. These criteria are beyond the scope of intra-day trading, making our strategy ineffective for such trades.

Conclusion

Price action analysis is a method of analyzing the movement of financial asset prices based on past market data, trends, charts, and candlestick patterns, without relying on technical or fundamental indicators.

In the study, the practicality and efficiency of the price action hypothesis was examined using a selected universe of stocks based on volatility. To ensure optimal conditions, stop-loss and brokerage strategies were applied. The results indicated that the price action hypothesis generated positive returns in the chosen universe. The strategy was back-tested using data from July 1st, 2018, to July 1st, 2021, and the most volatile stock list was calculated using data from January 1st, 2017, to January 1st, 2018.

Other performance metrics, such as Maximum Drawdown, Beta, Alpha, Returns to Maximum Drawdown Ratio, Sharpe Ratio, Sortino Ratio, and Annualized Returns, also demonstrated the strategy's effectiveness. A statistical hypothesis testing method was also used to check if the strategy was effective. The limitations of the methodology were also discussed. The study also employed Kurtosis and Skewness Analysis to highlight the limitations of Sharpe and Sortino Ratios and suggested using the Returns to Drawdown ratio as an alternative. To minimize downside risk, it was always recommended to avoid high-risk trades.

After all the tests conducted throughout the study keeping in mind the limitations of those tests, the authors conclude that the hypothesis is correct.

Remarks

The strategy presented in the study was found to be less effective in a universe of non-volatile stocks or during sideways market trends, indicating that it was intended for active trading and not suitable for a market environment with limited price swings and a reduced likelihood of significant price movements.

A potential improvement to the strategy could be integrating it with volume analysis, which would give traders a more comprehensive understanding of market sentiment and enable them to make more informed decisions. Additionally, incorporating candlesticks or chart patterns could enhance the strategy's consistency and profitability.

Future Markets Case Study

The previous section of the paper only tested the hypothesis on the most volatile equities in the stock market. However, the scope has now been expanded to include the Bank Nifty Index using futures contracts. It was found that the hypothesis holds up well in this context.

Futures are financial agreements that require the buyer to buy or the seller to sell an asset, such as a commodity or currency, at a predetermined price in the future. They allow investors to speculate on future price changes or mitigate price risk. Futures are traded on exchanges and derive their value from the underlying asset.

The Bank Nifty Index represents the banking sector's performance in the Indian stock market. It comprises the 12 most liquid and highly capitalized banking stocks listed on the National Stock Exchange of India (NSE) from 2017 to 2018, serving as our reference timeframe.

The Bank Nifty Index is comprised of the following companies [8]

- State Bank of India
- HDFC Bank Limited
- ICICI Bank Limited
- Kotak Mahindra Bank Limited
- Axis Bank Limited
- Punjab National Bank Limited
- Bank of Baroda
- IndusInd Bank
- Federal Bank Limited
- YES Bank Limited
- City Union Bank Limited
- South Indian Bank Limited

Why BANKNIFTY?

The Bank Nifty Index was selected as the primary index for testing the hypothesis on futures due to its high level of volatility and trading activity. The Bank Nifty Index is a widely used benchmark for measuring the performance of the banking sector in the Indian stock market and is considered a reliable indicator of the health of the domestic economy. It is calculated using a free-float market capitalization-weighted method[15], and its level reflects the total market value of all the stocks that make up the index in relation to a specific base period.

Thus, the Bank Nifty Index is an ideal option for study as it offers a high degree of trading activity and provides a clear depiction of the Indian banking industry. As mentioned in the previous section, the hypothesis is most effective in markets with high price volatility. The index's volatility provides ample opportunities for traders to profit from market fluctuations, making it a popular choice among investors and traders.

15 - The free-float methodology is a calculation method used to determine the market capitalization of the companies underlying a stock market index.

Strategy Explanation and Risk Management on Futures

In the context of futures contracts, the Bank Nifty Index is split into two types: "Bank Nifty 1" and "Bank Nifty 2." "Bank Nifty 1" is a near-month futures contract with a closer expiration date compared to "Bank Nifty 2," which is a far-month futures contract with a more distant expiration date.

This difference in expiration dates results in a variance in volatility between the two contracts. Near-month futures are generally more volatile as they are more sensitive to short-term market movements and changes in investor sentiment. Conversely, far-month futures offer a more stable investment opportunity and are less volatile, making them attractive to long-term investors.

The strategy was tested on the more volatile segment of BANKNIFTY – "BANKNIFTY 1" to validate the claim that a gap-up opening and the possibility of a trend reversal, indicating favorable investor sentiment, strongly predict positive trading outcomes for high-volatility assets.

Calculated Volatility for BANKNIFTY 1 – 0.12232

Average Volatility for Equity Market Selected Universe – 0.5514

As BANKNIFTY has a volatility of 0.122, which is lower than the average volatility of our equity universe, there is no need for a trailing stop-loss. Misuse of effective tools can result in unintended triggers and undesirable loss booking.

Further Methodology for Risk Management is precisely like the equity markets.

The strategy enters a long position if the current bar opens above the previous bar's close or if the first candle has a body length greater than 1% of the open and the contemporary bar is green with a body length greater than 1% of the open. The strategy squares off the trade if a red bar occurs or a Bearish Doji Star is formed.

The strategy uses a stop-loss of 3% (the position is squared off if the market price goes below 3% of the buying price or if the loss incurred exceeds 3%) and a profit booking value of 50%.

The strategy also implements a 0.3% charge for the commission and brokerage. (A cost of 0.3% is within the industry standard range for traders. Traders dealing in high volumes may prefer brokers with fixed charges over brokers charging a specified percentage.)

Since we are trading in highly liquid, volatile stocks using limit-based algorithmic trading, slippage is minimal even though we have considered a slippage of 0.002%. This means that the trading price may differ from the market price by a maximum of 0.002%.

3 Percent Stop-Loss Reasoning -

Stop-loss is an order to sell an asset when it reaches a specified price point, used to limit loss. This strategy uses a stop-loss of 3%, which aligns with the industry standard of 2-5%. However, in a volatile market with frequent trend reversals, the stop-loss is likely to be triggered unnecessarily. If the stock price falls more than 5%, the likelihood of trend reversals is low, leading to excessive losses.

It is important to remember that the strategy involves taking both long and short positions on the BANKNIFTY 1 Futures, whereas the strategy was long only for the equity market.

Statistical Strategy Testing for BANKNIFTY 1

Upon carrying out the tests, it was found that variation in "**TAKE PROFIT**" was not affecting trading outcomes. Therefore, the number of trials was reduced to 5, with only the risk factor being varied.

The methodology for Statistical Testing for the BANKNIFTY is like the equity markets.

Bonferroni corrected threshold p-value = 0.05 / 5 = 0.01

Highest Sharpe ratio = 1.83.
Corresponding t-statistic = 3.17
Corresponding p-value = 0.016929

Risk Factor	Take Profit	Returns %	Alpha	Beta	Sharpe	Drawdown	Capital
20	50	26.80%	0.07	0.1	1.83	-2.93%	5000000
40	50	59.63%	0.14	0.21	1.74	-7.16%	5000000
60	50	102.51%	0.22	0.32	1.8	-10.57%	5000000
80	50	140.97	0.28	0.44	1.71	-14.48	5000000
100	**50**	**197.44**	**0.37**	**0.55**	**1.71**	**-18.2**	**5000000**

The p-value of the t-statistic associated with the highest Sharpe ratio is more than the established threshold p-value. This implies that the null hypothesis cannot be rejected, and the strategy is ineffective on BANKNIFTY 1 Futures.

However, it is essential to acknowledge that a very stringent test was utilized in this case. Some testing combinations may pass less severe tests, such as the Holm test or the BHY test.

It is also worth considering that the validity of the results can be influenced by many factors, including the sample size, the time frame of the data.

Please refer to the Statistical Testing limitations from the Equity Market Section for limitations of Statistical Testing limitations.

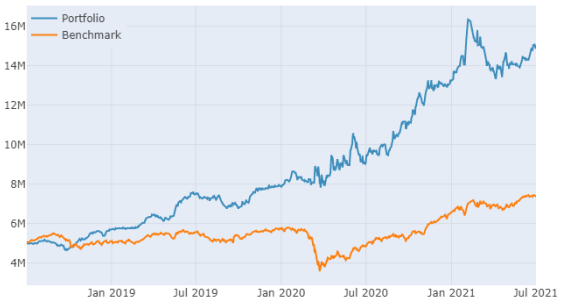


Fig 11. – Sharpe 1.71 | Risk Factor 100%

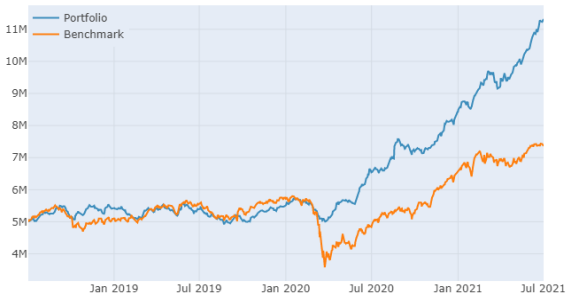


Fig 12. – Sharpe 1.8 | Risk Factor 60%

Abstract Strategy Testing for BANKNIFTY 1

This section examines various commonly used metrics to assess the performance of a trading strategy. These ratios are widely employed in the industry to compare the returns to the risks associated with the strategy and include specific indicators pertinent to the strategy's performance, offering more precise insights.

Sharpe Ratio

The Sharpe ratio for the given strategy is **1.71** - indicating high risk-adjusted returns. A high Sharpe ratio signifies that the strategy delivers high returns while carrying a higher level of risk. The Sharpe for Futures is less than Equity Markets and can be directly related to the volatility difference between equity markets and future markets.

Sortino Ratio

For the strategy, the Sortino ratio comes out to be **2.65** - This indicates that the strategy provides high returns for the given level of downside risk. The Sortino Ratio for Futures is lower than that of Equity Markets, which can be attributed to the difference in volatility between equity and futures markets.

Details about the ratios mentioned above were explained in detail in the Abstract Testing Section of Equity Markets.

It is crucial to remember that the Sharpe and Sortino ratios rely on the assumption that investment returns follow a normal distribution. However, the nature of dynamic trading strategies can result in a skewed and non-normal distribution of returns, characterized by high skewness and Kurtosis. This deviation from a normal distribution can impact these ratios' accuracy as risk-adjusted returns measures.

Thus, it is essential to consider the distribution of returns when interpreting these ratios carefully and to use alternative measures, such as the Returns to Drawdown ratio, which can provide a more comprehensive assessment of the risk-adjusted performance of a trading strategy.

Kurtosis

In a normal distribution, the Kurtosis is equal to 3. However, in the case of the returns from the trading strategy under consideration, the Kurtosis equals **6.38** - resulting in a low positive excess Kurtosis (leptokurtosis). This suggests that outliers, or deviations from the mean, are not frequent but still exist.

Skewness

The skewness of the dynamic strategy under examination is calculated as **0.14** - indicating a positive skew. This shows that the returns are heavily concentrated towards the left of the mean, with a longer right tail and more outliers present on the right side of the mean.

In summary, the high Kurtosis and skewness of the returns for the given strategy indicate that the returns do not follow a normal distribution. Therefore, the Sharpe and Sortino ratios may not accurately reflect the risk involved with the strategy and must be considered accordingly.

RoMaD can be used instead of the Sharpe and Sortino ratios to solve the issue of high Kurtosis and skewness. RoMaD measures the risk involved in a strategy, making it a suitable alternative.

RoMaD (Returns over Maximum Drawdown)

The maximum drawdown measures the most significant drop in a portfolio's value from its peak to its low point. It is a common way of expressing the risk involved with a portfolio. The returns over maximum drawdown (RoMaD) is a risk metric used to evaluate a portfolio's performance.

RoMaD = (Portfolio Return / Maximum Drawdown)

The given strategy has a RoMaD of **10.85** - significantly better than the typical industry benchmark of 2-3. This outstanding performance can be attributed to the strategy's focus on investing in volatile universe, which can generate high returns in a short period but also come with a higher level of risk.

Fig 13. Overall Performance Curve

For the three years of July 2018 to July 2021, this strategy achieved annual returns of **45.03%** and cumulative returns of **197.5%**, outperforming the benchmark significantly. The strategy's annual volatility was **23.4%,** with a Stability of Time series of 96.7%, suggesting that the strategy delivers consistent returns, which is advantageous for traders.

Conclusion

The National Stock Exchange's (NSE) Bank Nifty futures were utilized in this research to examine the efficacy of a particular hypothesis. The hypothesis is an active trading strategy best suited for market conditions with increased price volatility, as discussed in the equity market section.

Out of all the indexes listed on the NSE, Bank Nifty was selected for this study due to its relatively high level of volatility. The parameters used to evaluate the hypothesis were broadly consistent with those used to test equity strategies, including Maximum Drawdown, Beta, Alpha, Returns to Maximum Drawdown Ratio, Sharpe Ratio, Sortino Ratio, and Annualized Returns.

However, the statistical study results depicted that the P- Value derived from the highest Sharpe value was not crossing the threshold P – Value, this possibly means that the strategy is ineffective on the lesser volatile BANKNIFTY Futures.

Remarks

The back-testing results indicate that the strategy has great potential in the Indian financial markets.

A high degree of market volatility is essential for the strategy to be successful. While we have selected the most volatile stocks confidently, there is room for improvement in choosing these stocks, which could enhance the strategy's performance.

Interestingly, the practical returns in future market would have been much higher if leverage was allowed as in practical trading a leverage of around 5 – 10 % would have exponentially improved the results.

It is worth noting that although the results from statistical testing may indicate that the hypothesis is not significant, this could be due to the strictness of the tests used. Using less stringent tests may result in a significant hypothesis. This highlights the importance of considering various tests and carefully evaluating their results.

Strategy for Equity Markets – **LONG ONLY**

Leverage Used on Equity Market - NO

Blueshift Source Code (Equity Markets) – Google Collab link

Strategy for Futures – **LONG – SHORT BOTH**

Leverage Used on Futures – NO

Blueshift Source Code (Futures) – Google Collab link

Team Members Contribution

The success of any project is largely dependent on the collective effort and contributions of its team members. In this project, each member brought unique skills and perspectives to the table, enabling the team to work together effectively and achieve the desired results.

For instance, some team members were responsible for conducting research and analyzing data, while others were responsible for presenting findings and making recommendations. There were also team members who played crucial roles in project management and coordination, ensuring that deadlines were met and tasks were completed efficiently.

Overall, each team member made significant contributions to the project, and their combined efforts were instrumental in driving the project to a successful conclusion. Their hard work, dedication, and teamwork serve as a testament to their commitment to the project and its goals.

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