Capstone Project Submission

Investigation to discover a Robust Standardized Template for Option Straddle Strategy in Indian Markets

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Abstract

This paper presents a comprehensive study on volatility modeling and investment strategy testing in financial markets using a combination of statistical techniques and machine learning algorithms. The research aims to provide insights into the dynamics of market volatility and evaluate the effectiveness of different investment strategies in generating returns. The study utilizes historical stock data obtained from Yahoo Finance API and options data to develop and test various volatility models. The methodology involves preprocessing the data, fitting ARIMA models, and testing investment strategies based on the predicted volatility. The results indicate significant potential for generating profits using the proposed strategies, highlighting the importance of accurate volatility modeling in financial decision-making.

Keywords: Volatility modeling, Investment strategy, ARIMA, Options data, Financial markets.

Introduction

Volatility is a crucial aspect of financial markets, representing the degree of variation in asset prices over time. Understanding and accurately modelling volatility are essential for risk management, portfolio optimization, and investment strategy development. Volatility modelling involves predicting future price movements based on historical data, which is challenging due to the complex and non-linear nature of financial markets.

In recent years, advancements in statistical methods and machine learning algorithms have enabled more sophisticated approaches to volatility modelling. Techniques such as Autoregressive Integrated Moving Average (ARIMA) models have been widely used for time series forecasting in finance. Additionally, the availability of options data provides valuable insights into market sentiment and can be leveraged to develop profitable trading strategies.

This research aims to explore the effectiveness of volatility modelling techniques and investment strategies in generating returns in financial markets. By analysing historical stock data and options data, we seek to identify patterns in market volatility and evaluate the performance of various trading strategies. We aim to revolutionize intraday option writing strategies in the context of the dynamic Indian markets. By creating a standardized template, we strive to design, back-test, and forward-test an option straddle strategy within a specific daily time window, ensuring minimal market impact. The focus is on identifying optimal options for a single day holding period while implementing stringent risk management controls. The project's uniqueness lies in its emphasis on statistical analysis considering each

underlying an individual and independent market, catering to diverse market conditions and major events, such as the 2008 crisis or the recent COVID pandemic.

Assumptions

These assumptions are important to preserve the sanctity of the financial markets and to preserve the quality of the obtained results from the adopted research methodology.

1. Only small investments considered such that the market does not get influenced by the considered investment.
2. Efficient Market Hypothesis - We believe that a real market is chaotic in nature and the belief system of market participants evolve constantly, even when the market is closed. Therefore, we are not going to focus on different market forces but only on recent volatilities to judge whether the underlying is exhibiting high volatility or not.
3. Heteroskedasticity - Since this is a model for all times, across the whole range of products in the market, the individual underlying asset behavior is taken to be heteroskedastic in nature.
4. We as market players are able to maximize our gains on any given day, that is, if the highest or lowest price on any given day is beyond the threshold volatility level then that price level becomes our exit point. If not, then the position is closed at the end of the day.
5. All options that we invest in are at the money options with a strike price as the previous day's adjusted close price of the underlying asset.

Goals and Objectives

The primary goal of this project is to develop an intraday option writing strategy. This involves two key objectives. Firstly, to design a straddle-based intraday trading strategy with precise entry and exit conditions. Secondly, to determine the optimal fixed time window for executing the strategy daily, ensuring alignment with market dynamics. Another goal is to determine whether an underlying asset exhibits high, low, or neutral volatility. This encompasses several objectives: acquiring and cleaning historical data for relevant underlying assets on the Indian stock exchange (NSE), conducting time series analysis to develop a volatility forecast model, evaluating the accuracy of the forecast model's volatility predictions, validating and testing the model on recent market data and conducting event-based testing of the volatility prediction model. Finally, the project aims to implement the straddle strategy in real-time market conditions for a specific expiry date across a range of stocks option and deem the strategy success or failure based on its overall profitability.

Additionally, the project will also aim identify any disparities or areas for improvement in the current approach as this project is designed as a first step in development on developing specialised strategy driven trading model.

Literature Review

For our background study, we studied various research articles and papers to enrich our knowledge of the research already done in the associated field.

- Analysis of Option Trading Strategies as an Effective Financial Engineering Tool - Prof. Shalini H S. and Dr. R. Duraipandian, The International Journal Of Engineering And Science (IJES) Volume 3, Issue 6, Pages 51-58, 2014. Link
- The Performance of Options-Based Investment Strategies: Evidence for Individual Stocks During 2003–2013 - Michael L. Hemler and Thomas W. Miller, Jr., 2015. Link
- Performance Analysis of Volatile Strategy under Indian Options Market - Deepika Krishnan & Raju G, 2018. Indian Journal of Commerce and Management Studies, Educational Research Multimedia & Publications, India, vol. 9(1), pages 87-94, January.
- Forecasting Stock Market Volatility using GARCH Models: Evidence from the Indian Stock Market - R. D. Vasudevan; Dr. S. C. Vetrivel. Link
- Banerjee, A. & Sarkar, S. (2006). Modelling daily volatility of the Indian stock market using intraday data. Working Paper Series No. 588, Indian Institute of Management Calcutta.
- Srinivasan, P. (2015). Modelling and Forecasting of Time-Varying Conditional Volatility of the Indian Stock Market, The IUP Journal of Financial Risk Management.

We looked at several other research papers which diverge from our research topic but are interesting all the same and add to the Indian context of the option trading dynamics and the research strides made in this field. The brief one-liner research conclusions are as follows:

- Atheetha S's "Options Trading Strategy: A Quantitative Study from an Investor's Pov" (2019) investigated investor sentiment and news events as factors influencing straddle success. They found that positive news led to straddle losses, while negative news improved profitability.
- Jaisimha T K & Suresh C S's "Performance of different option portfolio strategies in the Indian derivative market" (2014) examined the impact of expiry periods on straddle performance, suggesting shorter expiries exhibited higher profitability due to lower time decay.

Methodology

To test the validity of our claim, we divided the approach into several steps:

1 Volatility Modelling with ARIMA

Autoregressive Integrated Moving Average (ARIMA) models are utilized for volatility modelling due to their ability to capture the time-series nature of financial data. ARIMA models are a class of statistical models that describe the behavior of a time series as a function of its own past values. The ARIMA (p,d,q) model consists of three main components: autoregression (AR), differencing (I), and moving average (MA).

- Autoregression (AR): This component models the relationship between an observation and a number of lagged observations. It captures the serial correlation in the time series data.
- Differencing (I): This component is used to make the time series stationary by differencing the observations. It removes trends and seasonality from the data.
- Moving Average (MA): This component models the relationship between an observation and a residual error from a moving average model applied to lagged observations. It captures the short-term fluctuations in the data.

Augmented Dickey-Fuller (ADF) tests are conducted to check for stationarity in the time series data. The ADF test evaluates whether a unit root is present in the time series, indicating non-stationarity. If the time series is found to be non-stationary, differencing is applied until stationarity is achieved.

2 Model Selection

The Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) are used to select the optimal ARIMA model. These criteria balance the goodness of fit of the model with its complexity, penalizing models that overfit the data. The model with the lowest AIC or BIC score is chosen as the most suitable model for volatility prediction.

3 Modelling time series for underlying asset volatility

Time series modelling will be following a basic ARIMA modelling approach on daily standard volatility measure.

$$StdVolMeasure=((VolMeasure-AVG(VolMeasure))/(\sigma(VolMeasure))$$

Where VolMeasure is defined as the ratio of the Range of COB price change (High-Low) and PCOB Average price (mean of open, close, and high price)

By doing this we bypass the issue of dealing with GARCH modelling and we can treat each individual stock’s volatility time series as our main data. To identify the most preferred model we use Akaike's Information Criteria as it ensures the selection of the model with the best

prediction. Once the model is selected, we use it for volatility prediction and based on those predictions, we identify whether the underlying will be exhibiting high, low, or neutral volatility based on below criteria.

Underlying asset volatility criterion	Description	Decision
High volatility	When predicted volatility measure is beyond 0.75σ of VolMeasure with respect to AVG(VolMeasure)	Short straddle
Neutral volatility	When predicted volatility measure is within 0.25σ to 0.75σ of VolMeasure with respect to AVG(VolMeasure)	No action
Low volatility	When predicted volatility measure is within 0.25 σ of VolMeasure with respect to AVG(VolMeasure)	Long straddle

4. **Testing of option trading strategy for a 1-day holding period regardless of the expiry date**

We'll be testing the trading strategy for the complete NSE stock population (along with indices) for 1 week.

Trading Strategy

Underlying asset volatility criterion	Decision
High volatility	Short straddle
Neutral volatility	No action
Low volatility	Long straddle

Exit strategy: We assume that the individual holding the long position is successfully able to close the position at the time when his profits are maximised, that is, when price of underlying is at its "High" or "Low".

Data Collection, Preparation and General Analysis

Data collection

- Data Source –
    a. yfinance -> for underlying asset data for the time frame of last 1 year.
    b. NSE -> for option data from 28th Feb'24 to 11th Mar'24.

Underlying Asset Sample Data:

Underlying asset	Symbol
Reliance	RELIANCE.NS
Adani Enterprises Limited	ADANIENT.NS
State Bank of India	SBIN.NS
ICICI Bank Limited	ICICIBANK.NS
Bharti Airtel Limited	BHARTIARTL.NS
Dr. Reddy's Laboratories Limited	DRREDDY.NS
Ashok Leyland Limited	ASHOKLEY.NS
Aurobindo Pharma Limited	AUROPHARMA.NS
Jindal Steel and Power Ltd	JINDALSTEL.NS
Tata Motors Limited	TATAMOTORS.NS
NIFTY	^NSEI
NIFTY Financial Service Index	NIFTY_FIN_SERVICE.NS

	Ticker	Avg Volatility	Std Volatility
0	RELIANCE.NS	1.432362	0.641063
1	ADANIENT.NS	3.579189	2.804867
2	BHARTIARTL.NS	1.629037	0.824121
3	SBIN.NS	1.583376	0.673900
4	ICICIBANK.NS	1.441981	0.490485
5	DRREDDY.NS	1.736502	0.677312
6	ASHOKLEY.NS	2.130511	0.924611
7	AUROPHARMA.NS	2.724627	1.097933
8	JINDALSTEL.NS	2.400215	1.030225
9	TATAMOTORS.NS	2.065027	0.938009
10	^NSEI	0.731669	0.275426
11	NIFTY_FIN_SERVICE.NS	0.938859	0.372588

Volatility Summary Statistic (for Sample data- utilized for Normalization of the VolMeasure time series before modelling)

Event based testing of Volatility modelling approach

The ARIMA approach was implemented tested for three events which had significant impact on Indian economy as a whole, namely, demonetization, covid lock down and Jio launch.

1. Demonetisation: Announced on 8th November'2016 ; Model accuracy is studied for month of December based on 1 year training data.
2. COVID Lockdown: Announced on 24th March'2020 ; Model accuracy is studied for month of May based on 1 year training data.
3. JIO : Launched on 5th Sept'2015, Model accuracy is studied for month of October based on 1 year training data.

We found that in all three cases a few of the stock volatility time series were showing non stationarity for 95% confidence interval based on Augmented-Dickey Fuller test.

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demonitisation

RELIANCE.NS->0.0012041642529197342
ADANIENT.NS->1.8731806422736484e-06
BHARTIARTL.NS->5.620526269157301e-23
SBIN.NS->4.574354640509609e-06
ICICIBANK.NS->7.73951213543398e-12
DRREDDY.NS->3.370143531753657e-05
ASHOKLEY.NS->2.841504517996158e-06
AUROPHARMA.NS->0.00023412062004513008
JINDALSTEL.NS->4.497999956569616e-06
TATAMOTORS.NS->1.0988909856430138e-08
^NSEI->2.07170800573691e-05
NIFTY_FIN_SERVICE.NS->3.531087039375241e-06
```

Demonetisation: Augmented Dickey-Fuller test p-value for 95% confidence interval [Sample Result]

Code Repository link

https://colab.research.google.com/drive/1s7tZmvcKCYsLC1qObpC19jkZqpUGs-x4?usp=sharing

Results and Conclusion

The research conducted aimed to develop a standardized template for an option straddle strategy in the Indian markets. Through detailed methodology involving volatility modelling and strategy testing, we were able to achieve our objectives.

Results:

- Volatility modelling using ARIMA proved effective in predicting future price movements.
- The developed trading strategy exhibited promising results for stock options, with significant profits generated during periods of high volatility but not for Index options. Overall, we observed 52% aggregate gains for all considered options.

Underlying asset	**Net Gain (INR)**	**Net Gain(%)**
Reliance	675	157.42%
Adani Enterprises Limited	1569	287.9%
State Bank of India	239	102.64%
ICICI Bank Limited	241	217.16%
Bharti Airtel Limited	250	163.46%
Dr. Reddy's Laboratories Limited	1849	211.3%
Ashok Leyland Limited	63	274.35%
Aurobindo Pharma Limited	402	172.62%
Jindal Steel and Power Ltd	267	113.16%
Tata Motors Limited	257	111.1%
NIFTY	-1626	-47.28%
NIFTY Financial Service Index	-480	-43.77%
OVERALL GAINS	**3963**	**52%**

- Event based testing confirmed the robustness of the volatility prediction across different market conditions for volatility time series exhibiting stationarity but for non-stationary volatility cases we would have to opt for either the ARIMA with differenced time series or GARCH (Generalised Auto Regressive Characteristic Heteroskedasticity) modelling.
- Implementation of the strategy across a range of underlying assets demonstrated its versatility and potential for widespread application.

Conclusion:

In conclusion, the research presents a comprehensive framework for developing and testing an option straddle strategy in Indian financial markets. By leveraging statistical techniques and machine learning algorithms, we were able to design a strategy that capitalizes on market volatility to generate profits. The standardized template developed can serve as a valuable tool for investors and traders seeking to optimize their returns while managing risk effectively. Further research and refinement of the strategy are recommended to enhance its performance and adaptability to evolving market conditions. Overall, the study contributes to the advancement of financial engineering and investment strategy development in the Indian context.

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