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Profitability of Initial Delta Neutral Strategies in the Option Market Under Different Market Conditions

Initial Delta-Neutral Strategy in Nifty 50

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Abstract

This thesis explores the performance of long and short initial delta neutral straddles to find whether short straddles produce a risk premium over the risk-free rate, consistent with the past theory that traders should be paid for taking option selling risk. To measure the performance of these strategies, I used metrics such as the Sharpe ratio and the overall maximum drawdown of both strategies with statistical significance using paired t-tests, ANOVA tests, and Indian VIX regression analysis to find the overall result. These matrices also show descriptive analysis to check Nifty Fifty market liquidity, open interest, and volume.

Finally, the result shows that both straddles hold negative Sharpe ratios, which imply that these two strategies do not produce risk-free rates. Similarly, statistical tests also found these strategies are not statistically significant from each other with all market regimes, and simple regression shows that the Indian VIX has very small participation in the performance of these strategies, but the results show a weak positive and negative effect on long straddle and short straddle.

About these results, weekly short straddles make overtime a constant result, but in monthly, more volatile, On the other hand, a long straddle faces maximum drawdown, and constantly negative returns show theta decay in both time periods, weekly and monthly, but overall both strategies do not give a risk-free return, which supports the theory of the efficient market hypothesis that the Nifty Fifty is a semi-efficient market. Finally, this study has some limitations with a limited data sample, which may affect the results. Future research could analyze using a larger dataset and using alternative measures of volatility and market sentiments.
[1]

[1] **Keywords**: Initial delta-neutral straddle, Indian volatility, Nifty50, Sharpe ratio, Simple regression test

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1. Introduction

1.1 Background of the Study

In the last few decades financial markets have evaluated different kinds of instruments to make a reliable income source in the future. An option is a good example, more often used by speculators and fund manager hedgers (Hull & White, 2017). An option is a derivative instrument that is derived from stocks, indexes, and commodities. Under derivatives are different types of instruments in the financial system for example, futures, options, forwards, and swaps. This study mainly focuses on options and, more deeply, on initial delta-neutral strategies that give probability to generate income with low directional risk on the consolidation phase.

Options are very sensitive to expiries and other factors such as intrinsic and time value, implied volatility, and option Greeks. In the globe, developed economies have a trillion-dollar options market with high volume and great liquidity. As a similar developing country in Asia, India is one of the most glowing options markets in the world, with billion-dollar transactions and trading in one day. According to data from the National Stock Exchange of India (NSE), around the last decade, the Indian stock market, especially options, boosted because Foreign Institutional Investors (FII), Foreign Portfolio Investors (FPI), and Domestic Institutional Investors (DII) increased their activities, and a big number of retail traders have come into the options market, which provides easy-to-buy-and-sell options with less slippage, especially in the Nifty Fifty Indices in the options market (NSE India, 2023).

Nifty Fifty is the biggest Indian market cap company with daily option trading contracts in millions of dollars (NSE India, 2023). These points are given as the best practice to develop and test the effectiveness of delta-neutral strategies in developing economies. An option mainly comes in to secure a future price movement and is mostly used by hedgers, but nowadays more big institutions are using similar strategies, such as delta-neutral strategies, to minimize the exposure from one-sided risk and for hedging

purposes. In the options market, traders can make many types of strategies, including naked and initial delta-neutral strategies and rebalanced delta-neutral strategies, according to different markets and different approaches.

This study mainly focuses on long and short straddles, mainly buying and selling at-the-money option strikes, both call and put, with the same expiry. According to Schmitt and Kaehler (1996) and Natenberg (2013), long straddles are more profitable in big market price movements of the market with rebalancing delta. This study is going to find that only initial delta-neutral strategies, like delta-neutral sell and buy at the money with the same expiry, are not rebalanced until maturity. While the past studies define the delta-neutral and initial delta-neutral techniques well, they are understood but less studied and investigate their results in different market conditions. In the financial market, in the field of financial risk management and options for compensation, these activities must take precedence.

Despite its importance, the study has analysed current and complex option pricing models with a view of their appropriateness for option pricing purposes. One of the best option pricing models is the Black-Scholes model (1972, 1973), which takes from the strike price of an option with price information in the form of future volatility of the underlying instrument. An option IV implied volatility is important in academic finance as well as in the trading of options, but in the Black-Scholes model, modern theoretical frameworks take buying and selling transaction costs, bid-ask spreads, and commissions into account, which are missing (Swidler and Diltz, 1992; Stephen Figlewski, 2018).

Black-Scholes theory is well-defined, but initial delta-neutral strategies are affected by many other factors, mainly transaction cost, execution slippage, implied volatility, and Greeks, mainly gamma sensitivity and Vega, especially under high volatility conditions (Mohanti & Priyan, 2014). This study focuses on the profitability of initial delta-neutral straddle (long and short) returns on different market regimes (bullish, bearish, and

volatile) on the Indian stock market NSE using real historical option chain data with weekly contracts, open interest, and volume.

1.2 Purpose of the Study and Hypotheses

This thesis's primary goal is to analyze the statistical delta-neutral strategies in the Nifty Fifty indices to determine whether option holders receive excess returns for assuming option selling risk. Rather than identifying the best performance strategies, this study focuses on the relationship between risk-adjusted returns and important key factors such as the effect of volatility, Gamma and Vega risk, and transaction cost (one-time buy-sell cost); all these points affect the overall result. The focus is on both initial delta-neutral strategies (weekly and monthly) without rebalancing delta until contract maturity to find their weekly and monthly returns under different markets. This thesis is guided by modern portfolio theory by Markowitz (1952), which states that traders or investors require higher excess returns as compensation for higher risk.

H1. Short straddle strategies outperform long straddles.

H2. (Null): The performance of long and short straddles is the same under bullish, bearish, and volatile markets.

H2. (Alternative): The performance of straddles is significantly different across market regimes.

1.3 Scope and Limitation

The study focuses closely on the Indian option market and uses data regarding the NSE Nifty Fifty Index, which is the most liquid index in the Indian stock market; it is derived

from stocks of the fifty most significant blue-chip companies in India. The basis of this research only finds straddle performance because of these strategies used with retail traders and big investment bankers, especially in the Indian option market.

These strategies are tested using the historical end-of-day (EOD) data from the downloaded National Stock Exchange of India from the past four years (2021-January 2024-June). This study also considered internal and external factors to examine market nature and trends over this period in the Nifty Fifty indices, mostly market fluctuation factors and fixed transaction costs (broking and tax). Normal transactions are looked at in terms of net income, Sharpe ratio, maximum drawdown in these strategies over a period, and the percentage of wins and losses.

About limitations, there are several boundaries in the study. Firstly, historical data, which is used in this study, misses the exact entry and exit points regarding the movement in the intraday live market price. Secondly, the Greeks are more important for these strategies, but these factors are missed overall in this study. Lastly, the live market can lead to slippage when executing a market order in this study.

1.4 Structure of the Thesis

This study goes through six steps with academic structure from the introduction of this study to the conclusion. Firstly, introduce this report, the purpose of the study and the hypotheses, and the study scope and some limitations. The next chapter goes through an option overview, delta-neutral strategies, option Greeks, the BSM model, and the Indian VIX, and the following step focuses on a literature review of the past studies in the same field from academic papers on EMH (efficient market price) theory and research gaps.

Chapter four is methodology and data collection, strategy execution, and rules, Sharpe ratio, t-test, and ANOVA test with descriptive statistics. The next chapters result in a

discussion about straddles, hypotheses, the Indian VIX and findings, and in the last key insights, further research and discussion, and references used in this study.

2. Options

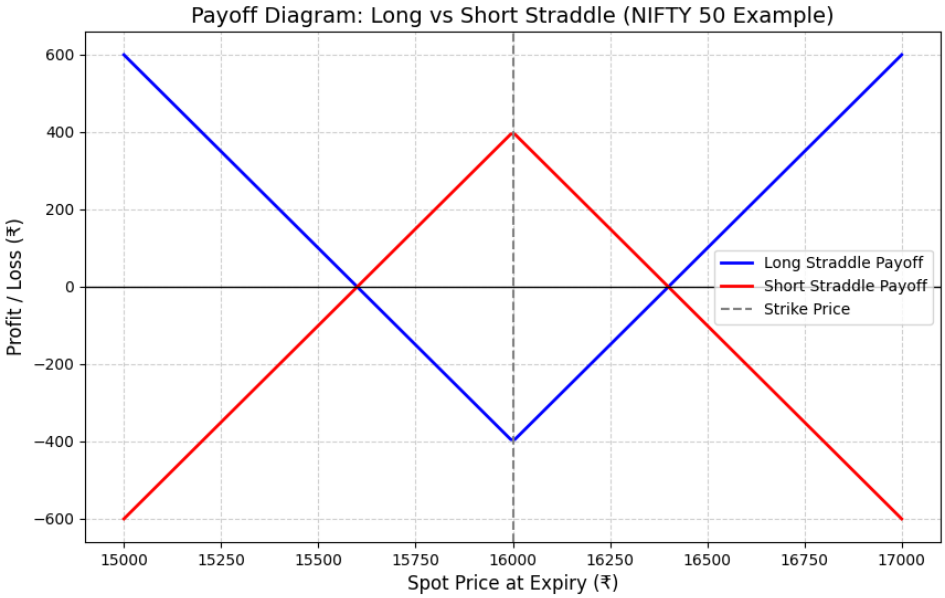
2.1 Option and Delta-Neutral Strategy

Options are under the derivative instrument, which is derived from stocks, indices, and commodities. The theory-defined option gives the trader the right to buy and sell options at different strikes and different expiries. In derivatives there are two types of options, such as European options and American options. The European options mature on a fixed expiry date. On the other hand, there is an American option with a fixed expiry date, but these are also available for everyday expiry. European options are easy to understand in general because an option buyer and seller have no conflict about when to sell and buy back until maturity, but on the other side, an option trader thinks about when to strike sell or buy (James, 2003).

Options work to minimise drawdown risk for portfolio hedgers and for traders and speculators to predict a future value of stocks or sectors and take a bet for some minute, day, week, or even month. (Hull & White, 2017, p. 31; Black & Scholes, 1973), was also mentioned as a theoretical formula of the option pricing and valuation of European options under assumptions of constant volatility, normal distribution, and frictionless market prices. An initial delta-neutral strategy in the option market is a strategy to decrease the risk of one-sided direction and is also used to hedge the portfolio to keep zero-balanced delta. In this strategy, holders buy or sell similar strike and same expiry positive and negative delta positions.

In the options market, the widely used delta-neutral strategy is straddle and strangles (short-long). However, these two strategy options and Greeks work closely together.

Figure 1. Long and Short Straddle payoff Diagram



[2]

2.2 The Option Greeks

The option traders and hedgers create a strategy, especially in hedging prospective; they calculate option Greeks such as gamma, delta, Vega, and theta most often because these Greeks define different risks on an option. Greek's calculations also work with option pricing models. In the financial market different types of option valuation models are present, but mainly the BSM model is used. According to the model and measuring Greek speculators, they define volatility as like the current IV (Hull, 2022).

Delta (Δ)

The definition of delta is the rate of change of an option premium put or call with respect to the deriving assets. For example, if a put option seller sold at a strike where delta is negative 0.5, then that put strike price increases when the market price decreases by a small amount, and then it changes 50% of that time. In the delta-neutral strategy, the option Greek delta is not continually balancing or constant because of price movement,

[2] Figure 1 The Long and Short Straddle Payoff Diagram was created using Python and downloaded.

and traders need to adjust delta according to price direction and future aspects (Hull, 2022, s. 421; Wilmott, 2006).

Gamma (Γ)

The Greek of gamma defines a change of rate, and the change of Greek delta to move one dollar price movement in the deriving assets. According to theory and well-defined research (Hull, 2022, p. 429) about gamma, if this Greek is relatively small, then delta does not change suddenly, and then the delta-neutral portfolio does not need frequent rebalancing of delta, but if gamma shows a high number of positives and negatives, then delta is very sensitive, and with delta strike prices moving far from each other, the delta-neutral strategy becomes more risky (Broadie et al., 2009).

Theta (Θ)

The option Greek theta defines an option time value and intrinsic value over the period of option maturity. An option rate of change of the valuation of the folio with the time near close to the expiry with other factors remaining equal. In general, theta indicates how much time is left for a specific option contract and the time decay. In option straddles, especially in short positions, theta works with strategy, but it is not a change or rebalancing similar to delta (Ni et al., 2008; Schmitt and Kaehler, 1996, p. 7; Hull, 2022, p. 421).

Vega (ν)

According to the Black-Scholes-Merton (BSM) model, the assumption is that the volatility of stocks, commodities, currency, and indices are constant options. So, IV, an option that is the main factor of option pricing, is also the same and equal based on this assumption, but in the real world volatility increases and decreases over the period. In practical options, prices change because of volatility movements as well as near maturity; these movements rise. So, in simple terms, Vega Greek is an option if the changing rate in it is in valuation with the asset volatility. In the short-straddle strategy, Vega has

negative exposure because of increased volatility, and Vega works with gamma, which means sudden spike movements create risk (Hull, 2022, p. 434; Ni et al., 2008).

Rho (ρ)

The rho is simple and less used by short-term traders and investors because of this Greek work with interest rate changes, and interest rates do not change often. In European options, the risk-free rate expiry is like the options (Schmitt and Kaehler, 1996, p. 7).

2.3 The Black-Scholes Model

About theoretical information the past studies, using the model, the Black-Scholes-Merton model, found many financially related journals and studies, especially about options pricing. According to authors Hull & White (2017), Black & Scholes (1973), and Hull (2022, p. 338) (1970), they were developing a valuation of European options. This model is very close to mainly being about hedging derivatives and getting full attention in financial markets. The BSM model is uses CAPM to find a relationship between the market risk-free required return on the specific equity and on the option.

2.3.1 Assumptions of the Black-Scholes Model

European call and put options mature on a specific date in the future, and these assumptions are according to the European style.

1. The first assumption of this model is that there are no transaction costs and other fixed taxes.
2. The underlying assets do not make any dividends until maturity.
3. No arbitrage possibilities.
4. Risk-free rates equal all expiries.
5. The price of the underlying is constant, and returns are equal with time.

6. Volatility is constant with implied volatility.

2.3.2 The Black-Scholes Pricing Formula

So, the formula for the Black-Scholes formula for pricing a European call and put option is

Call Option Price (C):

$$C = S_o \times N(d_1) - K \times e^{(-rT)} \times N(d_2) \quad (1)$$

Put Option Price (P):

$$P = K \times e^{(-rT)} \times N(-d_2) - S_o \times N(-d_1) \quad (2)$$

d_1 and d_2 are as follows:

$$d_1 = [\ln (S_o / K) + (r + \sigma^2 / 2) \times T] / (\sigma \times \sqrt{T})$$

$$d_2 = d_1 - \sigma \times \sqrt{T}$$

Where **σ** is the volatility of returns on the underlying asset.

C = Price of European call option

P = Price of European put option

S_o = The present value of the underlying asset

K = Strike price

r = Risk-free interest rate

T = Time to expiration (in years)

These formulas cause the theoretical value of an option to involve the known input values. They also make it possible to calculate the Greeks needed for risk management purposes and delta neutral trading. Although these practices are due to unrealistic

assumptions, constant volatility, and frictionless markets, the Black-Scholes model forms one of the foundations of quantitative finance and is invaluable in pricing and hedging derivative instruments (Wilmott, 2006; Hull & White, 1987; Hull, 2022, s. 352).

2.4 Implied Volatility

The Black-Scholes-Merton model cannot describe one of the main characteristics of option pricing, which is the volatility of the underlying asset's price. Past studies mention that option holders rely on implied volatility, including defining two kinds of volatility, historical and implied. Previous research (Hull, 2022) points out that most traders focus on implied volatility rather than option price because it is less variable and more convenient. Implied volatility works as both a call and put option are similar in strike prices and time left to expiry, which is called a volatility surface.

The volatility smile was used by option traders after the 1987 market crash in different equity and option indices. "This is sometimes referred to as a volatility skew." A simple logic behind this statement is that, when volatility decreases, then the option strike price increases according to different strikes with different deltas (Hull, 2022, p. 457). In the last, volatility smile is of maximum significance for deep-ITM-call options and far-OTM-put options and fully opposite deep-in-the-money-put and out-of-the-money-call options. A simple understanding of the reason behind the volatility smile is the negative correlation with price and volatility.

2.5 Limitations of the Black-Scholes Model

According to the BSM model, some assumptions cannot determine real-time financial market points, which shows some inaccuracies in this model. The BSM model assumption factors are equal and constant volatility, logarithmic price movements,

trading without stop and no transaction and other fixed costs, a risk-free rate until maturity, and only one type of option for European options. About inaccuracy, the Black-Scholes-Merton model defines volatility of the underlying assets as not increasing or decreasing until option expiry, but the paper (Hull & White, 1987) shows that over time volatility changes among periods of market cycles.

In the model assume no transaction cost and no other taxes, and define the market as frictionless, but in practical and real-time trading these costs are fixed mainly for retail traders, not institutional investors (Swidler & Diltz, 1992). According to the paper author (Bakshi et al., 1997), a delta-neutral straddle holder needs to continually rebalance delta between both legs. This may lead to increased cost and slippage and affect overall results.

Another main assumption is the L-normal distribution on asset returns; past research (Tankov, 2003) proved that asset returns tend to have fat tails; hence, the BSM model defines thin tails without any jump. This cause directly underestimates the tail risk with different strike prices. In addition, the BSM model works on European-type options because these are exercised at the end of maturity, but according to flexibility, American-style options are more flexible and exercised whenever during the option period.

2.6 Indian VIX

“Options give an investor an opportunity to trade on a view regarding the underlying security price and its volatility” (Goyal & Saretto, 2009). If the VIX has a higher number or value, that indicates higher volatility in the future, while a lower one shows a stable market, and investors are not under any fearful situation. The theory about volatility indexes can be found in the authors (Fleming et al., 1995) who define model-free implied volatility, which can estimate stock market volatility more accurately than historical forecasts.

Accordingly, their research IV is derived from option prices and future expectations. The Indian VIX index is the measure of volatility given by the NSE (National Stock Exchange) of India, which measures the market's future expectations of volatility for the next thirty days in the future and is known as a fear indicator by investors and traders. In short and long straddles, Indian VIX is a very important factor because VIX shows volatility, and volatility work with Vega (Hull, 2022, p. 359).

3. Literature Review

3.1 Previous Main Studies

A good literature review is required in framing any empirical study, specifically in the financial derivatives. This section focuses on past academic studies and empirical literature conducted on the delta-neutral method and the Black-Scholes-Merton model, which is necessary for learning options and market behavior. Authors Christian Schmitt and J. Kaehler (1996) conducted research on the German index DAX, focusing on the volatility trading strategy depending on volatility (short and long straddle). The process starts with the main theoretical aspects of options pricing and hedging, progresses to the empirical research around delta-neutral profitability without rebalancing, before ending with an overall examination of the gap in research on the Indian Nifty 50 options market.

Many studies have categorized option trading strategies from developed markets, such as Schmitt and Kaehler (1996), Swidler & Diltz (1992), and Hull & White (2017), but limited research has been conducted on emerging economies like India in empirical finance literature. According to research by Christian Schmitt and J. Kaehler (1996), they buy an at-the-money straddle (a call option and put with similar maturity) according to volatility, but if volatility is too high, then they do the vice versa, meaning the strategy depends on volatility accordingly, and rebalancing is the most important part of this strategy because if the price is too far from ATM, then they close one leg position and execute a new straddle position. This paper also mentions some past studies conducted by Engle, Noh, and Kane (1993); they missed this balancing factor. Schmitt and Kaehler (1996) also summarized initial delta-neutral strategy performance.

In the case of the Black-Scholes model, the market does things that make such strategies hurt the delta-neutral and gamma-positive trades alike. This is due to the Black-Scholes model assumptions. The past research illustrated the volatility smile in which implied

volatility depends on both moneyness and time to maturity, and option pricing models make implausible assumptions about zero transaction costs, a flat risk-free interest rate, no stock dividend, and constant variance of stock return by Crépey (2004) and Swidler & Diltz (1992). This is because there is a non-zero correlation between changes in the price of the derived asset and changes in the volatility of the asset. The minimum variance delta accounts for changes in price and how much volatility is expected to shift in response to change in price (Hull & White, 2017).

3.2 Theoretical Basis of Option Pricing and Hedging

3.2.1 Derivatives Pricing and EMH

The Efficient Market Hypothesis concludes that the financial markets show all information, but maximum return cannot be obtained by fundamental and technical analysis (Fama, 1991, p. 1575). In the paper, the author writes about the weak, semi-strong, and strong forms of market efficiency, which mean if the market is efficient, not even advanced strategies, speculators, or traders using technical analysis and fundamental analysis cannot beat the market. On the other hand, (Thaler, 1999, p. 16) supports behavioural finance and crosses the EMH. The theory argues that financial market irrationality, volatility clustering, and human behaviours can drive prices and generate profitable conditions under efficient market theory. So, in the end, the EMH theory described how advanced strategies like delta neutral cannot generate abnormal risk-adjusted returns, but the behavioral theory of prospective volatility and market sentiment provides opportunities for investors.

According to writers Vipul (2009) and Mohanti & Priyan (2014), the Indian market shows pricing inefficiencies, transactions, and market frictions, so even the safest delta-neutral strategies fail to make positive returns over the long period of time, but increasing FII and DII investments and an increased number of retail trader activities can give short-term opportunities. It means the Indian market supports the EMH theory. However,

behavioral finance still creates market inefficiency due to trader and investor sentiments in the Indian stock market.

Many studies are conducted about the initial delta neutral strategy and delta neutral strategy in developed economies. For example, C. Schmitt and J. Kaehler (1996, p. 16) conducted a study about delta-neutral strategies with volatility on the German DAX indices, using intraday price data. According to the study result, they found that profits are significant while volatility was high, but the same transaction cost increased because of rapidly balancing data-zero. Similarly, Broadie et al. (2009b) found rebalancing delta neutral still does not perform well in a trending market, and one of the Greeks on the long side is theta decay, which is the imperfect hedging issue. In contrast, the study found a profit when the price trended with sharp and sudden reversal moves. Ni et al. (2008b, p. 1083) performed an empirical test on a straddle, and the result was the same: a negative return on long and a positive return on short because of theta, but under stable volatility, an increase in volume and volatility supports the long straddle.

3.3 Research Gap and Assumed Contribution of the Study

Most of the delta-neutral strategy studies are on the BSM model; a much smaller number of studies focus on the behavioral perspective of the delta-neutral study. The past two pieces of research, by Swidler & Diltz (1992) and Hull & White (2017), continue the hedging models with considered market frictions, including transaction cost, misestimation of volatility, and market uncertainty. Moreover, Crépey (2004) and Goyal & Saretto (2009) found that volatility (volatility smile and stochastic volatility) has a problem with delta hedging and invalidates the BSM model assumption of constant volatility until maturity and, after continuing zero delta rebalancing, leaves volatility risk.

After reviewing past studies and results, I found a gap between continued straddle rebalancing and the increasing costs, especially in the Indian market, where there is price

consolidation in a specific price range. Therefore, I propose examining the direct delta-neutral strategy that can be backtested as an initial delta-neutral approach. This may lead to maximum drawdown and positive return, but in practice, with risk management, one can identify opportunity with less cost. Based on this theory, to address this gap, backtest initial delta-neutral strategies with actual Nifty Fifty historical data from the years 2021-2024 with different market regimes.

Secondly, this statistically shows the result and measures the overall profit and loss statement using the Sharpe ratio, t-test, and ANOVA test to determine if this strategy works significantly or not but has some limitations, which lead to a change in the overall result. First, the historical back-testing in financial markets has a well-known bias problem in which past market performances cannot predict the future price movement, and secondly, live market order slippage occurs according to volatility.

4. Methodology and Data

4.1 Introduction

The last chapters discuss delta-neutral strategies in the option market and the Black-Scholes-Merton model and assumptions to understand option pricing. This thesis follows a similar approach (Schmitt and Kaehler , 1996) to evaluate the profitability of initial delta-neutral straddles to use index options. In that paper, the author used different variables to find volatility trading on straddles with continually rebalancing the Greek delta with intraday options, but in my thesis, I use the Nifty Fifty index weekly and monthly option closing price every expiry without rebalancing. This approach examines accordingly the Indian stock market, which is most of the time under the consolidation period, to find if the delta-neutral strategy gives significant results under weekly and monthly long and short straddles.

Secondly, researchers (Mohanti & Priyan, 2014), analysed option trading hedging effectiveness in the Indian market with a similar approach to find Indian stock market efficiency by using the BSM model. They are focused on transaction cost, margin requirement on selling, and implementation of strategies. So, this study also considers similar ways to assume bid-ask spreads, slippage on live markets, and performance metrics (Sharpe ratio, etc).

In this thesis, I use quantitative and simulation-based research and find how initially created delta-neutral strategies are effective for the Nifty Fifty index option in different regimes. Moreover, this study uses a systematic backtesting method with predefined assumptions and rules about trading, risk-free rate, and fixed transaction cost because of the initial delta-neutral strategy in a small time frame to ensure it covers every aspect inspired by two studies, which I described earlier in this part, and evaluates the result using the Sharpe ratio, maximum drawdown, and descriptive statistics.

4.2 Sources, Data Collection and Preparation

The end-of-day (EOD) historical option data used in this study are the Nifty 50 Indices from the official database of the National Stock Exchange (NSE) of India. I am using data from January 2021 to June 2024, which covers post-covid reaction and a bull/bear and a consolidated market. The raw option weekly contract base data was downloaded from the NSE website, which includes call and put strike prices, open interest, volume, total contracts, and Indian VIX (volatility index) monthly data taken from the Yahoo Finance website. Although this is enormous intraday raw data, it is cleaned per week and then per week to per month using Excel and Python to convert CSV raw data to clean structured data.

Dataset including

At the money spot price of the Nifty 50 index.
At the money option strike (call and put weekly and monthly).
Open interest and contracts were shown under descriptive statistics to find liquidity.

Data cleaning

Zero volume and low OI contracts are deleted.
Manage intraday data on a weekly and monthly basis.

4.3 Straddles

A straddle is combined with one European call and a put with the same expiry and same strike price, depending on whether the trader buy or sell if they buy, it is a long straddle, and if they sell, it is a short straddle (J. Hull, 2021, p. 259). It is executed under different volatility periods to get maximum return. For example, if a long straddle is created and volatility is down and the price is near the strike price, then the long straddle loses value

because of theta decay. However, if there is a sudden great move in either direction, then generate profit, and vice versa, in short straddle. Straddle give an edge to speculators when they know the price has moved dramatically but do not know which side, then they create straddle (J. Hull, 2021) (P et al., , 2022) research mentions that "Studies by Chen & Leung (2003), Guo et al. (2020), and Fullwood et al. (2021) analyzed the performance of straddle strategies and found significant positive returns, and a study done by (Bhat, 2021), short straddle and strangle give positive returns."

Table 1. Straddle Payoff

Range of stock price	**Payoff from call**	**Payoff from put**	**Total payoff**
S_t < K	0	K - S_t	K - S_t
S_t = K	0	0	0
S_t > K	S_t - K	0	S_t - K [3]

4.4 Trade Execution Assumptions with Payoff Calculation

For the data backtest, I assumed some basic rules and fixed costs, which define the overall clear result. For example, weekly data executes straddles on every Thursday until the next Thursday on the closing day of weekly contracts and on for monthly expiry to the next monthly expiry. About a lot size equal to 50 shares from the NSE exchange, and assuming broking and some fixed costs are 25 rupees per execution, so in a straddle, with two option positions open and closed, the total transaction cost was 100 per

[3] This table adapted from J. Hull (2018) and long and short straddle diagram show in page number 13.

straddle In India. According to J. Hull (2021, p. 79), a good approach to valuing option returns is that at the end of the year the return should be the risk-free rate, so in my thesis I used the interest rate of Indian government bonds as a risk-free rate. The 10-year government bond interest rate is 6%, which I used to determine whether these strategies provide a risk-free return or not.

The estimated net profit for a short straddle is calculated as follows:

For short straddle

Profit = credit – call strike payoff + put strike payoff + fixed cost

For long straddle

Profit = call strike payoff + put strike payoff – debit – fixed cost

4.5 Evaluation Metrics (Sharpe Ratio)

The aim of this study was to find risk-adjusted return with different strategies, which aimed at summarizing both points: profitability and risk aversion. In addition, find the win rate percentage of weekly and monthly (short-long straddle) with maximum drawdown of both strategies. To compare risk-adjusted performance I used the Sharpe ratio, which measures the overall return for a portfolio, to compare risk-adjusted return performance of different strategies (Sharpe, 1994 ; Sharpe, 1966). One of the finest risk-free return ratios is the Sharpe ratio. According to (Bodie et al, 2014), this ratio divides (average portfolio excess return – risk-free rate) / portfolio standard deviation over the period. This ratio allows us to find if portfolio excess returns justify the risk-free rate or not to continue the same strategies over the period.

This study, apart from applying the descriptive statistics of returns, volumes, and open interest, also applies three statistical tools, the Sharpe Ratio, the t-tests, and the ANOVA tests, to analytically examine the profitability and risk and return profile of delta-neutral straddle strategies**.**

4.5.1 Sharpe Ratio Calculation

The Sharpe Ratio is used to assess the risk-adjusted returns of both short and long straddle strategies. It is defined as

Sharpe Ratio = (Rp – Rf) / σp

$$\text{Sharpe Ratio} = \frac{\text{Average Portfolio Return-Risk-free Rate of Return}}{\text{Standard Deviation of Portfolio Return}}$$

In the present work, use is made of the weekly amount of risk-free rate calculated from the annualized Indian 10-year government bond yields (6.5%) converted to weekly (0.121%) and monthly (0.54%) equivalents. Excess returns are calculated by simply deducting the risk-free rate from strategy returns, and then, the Sharpe Ratio is calculated separately for short and long straddles for weekly and monthly horizons. A positive Sharpe Ratio means the returns are better than the risk-free benchmark; a negative value means that the method was not as good as the risk-free rates (Lo, 2003).

4.5.2 Paired t-Test

The t-test is used for finding the difference between two means, and there are also two types, the independent t-test and the paired-sample t-test. The first type of t-test is run when two means come from different parts or different findings. On the other hand, the paired-sample t-test compares two means with the same field or same entities (Field,

2013, p. 670). In my study, to find significant differences in the mean returns between both strategies, the paired test is used, and the null hypotheses are given as:

H0: Mean return of short straddles = Mean rate of return on long straddles
H1: Mean return of short straddles ≠ Mean rate of return on long straddles

The t-statistic is calculated as

$$t = (\bar{d}) / (Sd / \sqrt{n}) \quad (1)$$

Where:

$\bar{d}$ = The differences between means
Sd = standard deviation
n = number of paired observations

According to my sample, if a p-value is less than 0.05, then reject the null hypothesis, which means one strategy gives better performance than the other over the time horizon, but if this value is more than 0.05, it means no difference exists and do not reject the null hypothesis.

4.5.3 Analysis of Variance (ANOVA)

Analysis of variance applies when finding relationships between different variables to find significant differences between means with the help of F-statistics, and this indicates whether the group means are significantly different or not, and interpretation is:

The stats are calculated for the F-statistic of an Analysis of Variance (ANOVA) as[4]

[4] The F-statistic calculation adapted from Field, A (2013). Discovering Statistics Using IBM SPSS Statistics (4th ed). Saga publication, P. 786-796

(Variable 1 ≠ variable 2 ≠ variable 3) means significant difference.
(Variable 1 = variable 2 ≠ variable 3) 3 is different from other variables.
(Variable 1 ≠ variable 2 = variable 3) means of groups 2 and 3 are the same, but 1 is different.
(Variable 1 = variable 3 ≠ variable 2) means of groups 1 and 3 are similar but different from group 2.

F = MS between / MS within

Where:

MS between = variance of group means
MS within = variance in groups

According to my data, I used different market regimes, so the ANOVA test is best for finding profitability between bullish, bearish, and volatile market conditions. The hypothesis and interpretation given is:

H0: bullish=bearish=volatile
H1: Mean returns are not all equal.

After analysis, if the F-value is greater than the F-critical value and the p-value is less than 0.05, then the null hypothesis should be rejected, but if not, then fail to be rejected null hypothesis.

4.5.4 Indian VIX Simple Regression and Formula

$$R_{\{i,t\}} = \alpha_i + \beta_i D_{\{i,12\}} + \varepsilon_{\{i,t\}} \quad (1)$$

and

where $D_{i,12}$is a dummy variable to change with the VIX independent variable.

$$R_t = \alpha + \beta\, VIX_t + \varepsilon_t \quad (2)$$

R_t – Return (dependent variable)

VIX_t– Volatility index value (independent variable)

α – Intercept (average return when VIX = 0)

β - Slope

ε_t – Error term

This study continues with a similar structure from (Grobys et al, 2021). According to that paper, they used this model to find the momentum factor, so they used a dummy variable, but in my report, I am looking at the volatility effect on both straddles.

Interception

If β > 0

If β < 0

If the slope is more than zero, it means a positive outcome is best for long strategies and vice versa.

Table 2: Descriptive Statistics of NIFTY 50 Weekly Options

Statistics	Closing Price	Contract	Open Int

[5] This formulla originally proposed by study Factor momentum, option-implied volatility scaling, and investor sentiment by Grobys et al, 2021 to find momentum. In this paper, I used a simple regression to examine VIX effect on straddles.

Mean	1010.88	42601.39	157846.10
Median	1000.68	26824.87	114438.51
StdDeV	1283.70	464790.72	648902.82
Min	0.11	0.00	0.00
0.25	975.29	14626.55	96642.46
0.75	1049.92	63054.10	234003.45
Max	8861.32	17216831.14	12117677.59
Count	7232	7232	7232 [6]

4.6 Analysis of weekly Nifty options

Table 1 shows the weekly descriptive statistics in the Nifty Fifty option market. In weekly descriptive statistics, I used three variables (closing price, contract, and open interest) from my data. The main reason these parameters are used is because these variables are the main characteristics underlying the straddle strategy. For example, the closing price defines the final price of the strike price and is used to calculate overall price returns. Secondly, contracts show volume, mean numbers of contracts open per week and month, and define market activity with liquidity and trader interest. Lastly, open interest, which is a very important factor in options, especially for small periods. This shows the outstanding total number of contracts that are open (Hull. J, 2012).

According to descriptive statistics, the average premium closed is 1010.88, and the median premium is just 10 rupees less than the mean. A standard deviation is showing a large value, which is 1283.70, and a maximum value of premium around 8861 rupees shows significant data far away from the majority points, which represent ITM options without time value. Similarly, (Hull. J, 2012, pp. 215-216) mentions this behavior about

[6] Table 1. Weekly descriptive historical raw data is obtained from the National Stock Exchange of India website, followed by descriptive analysis conducted using Excel.

the wide gap between options prices, which are highly sensitive to change in moneyness and volatility.

Secondly, the median number of contracts traded in a week is 26,824, while the mean shows a larger number of contracts, around 42,601, driven by maximum liquid weeks showing 1.7 million contracts. On the other hand, open interest shows a median of 114,438 open contracts and an average of 157,846, with more than 1.2 million open contracts in some weeks. Accordingly, these findings show some strikes and some weekly maturities of liquidity around near ATM prices, which have a direct impact on delta-neutral strategies.

Figure 2. Histogram of Closing Prices (Weekly)

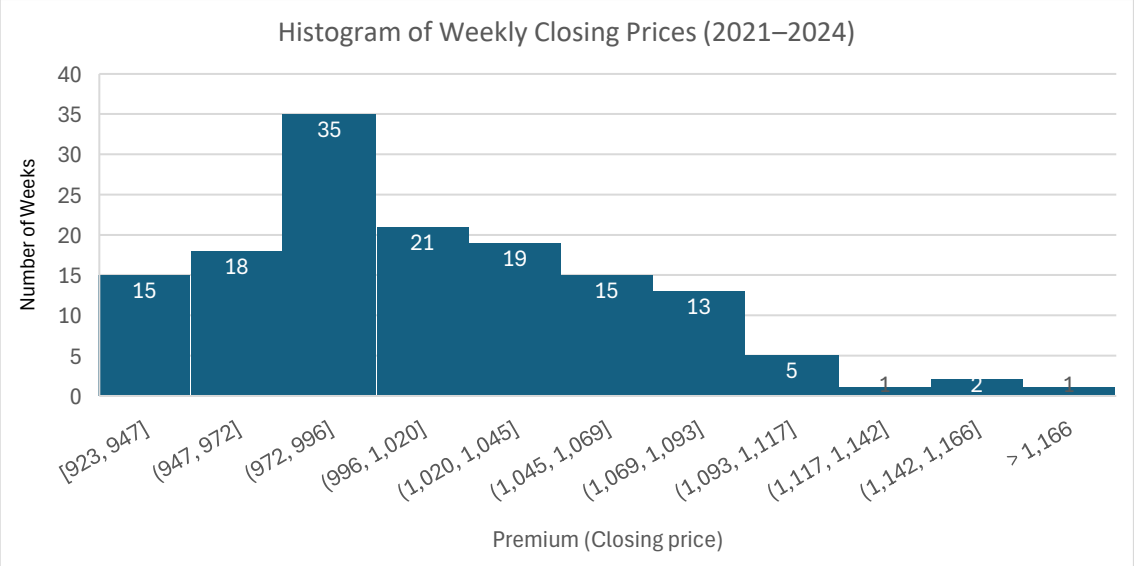


Figure 3. Histogram of Contracts (Weekly)

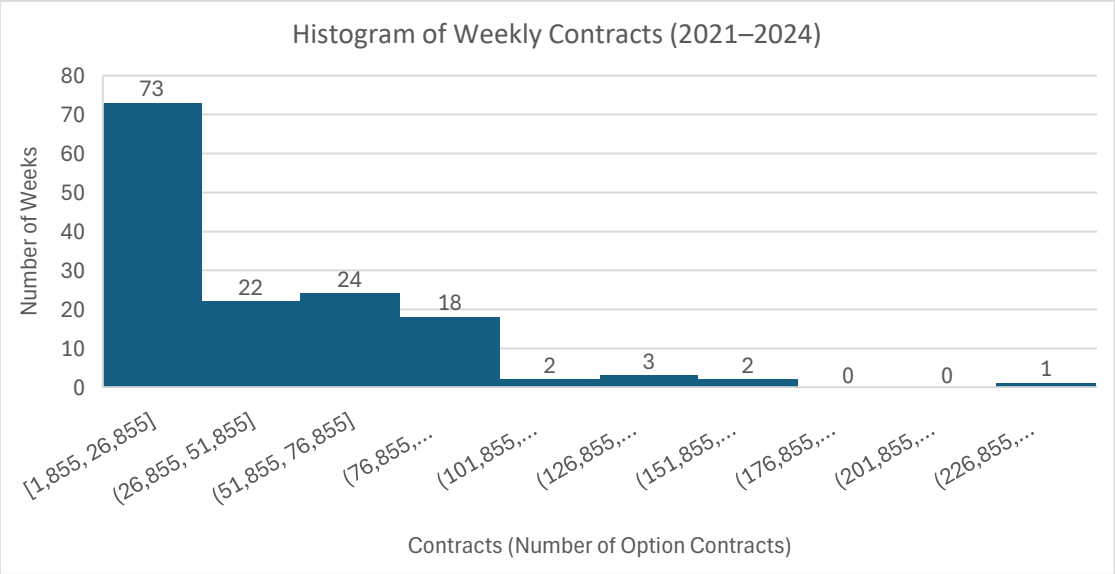
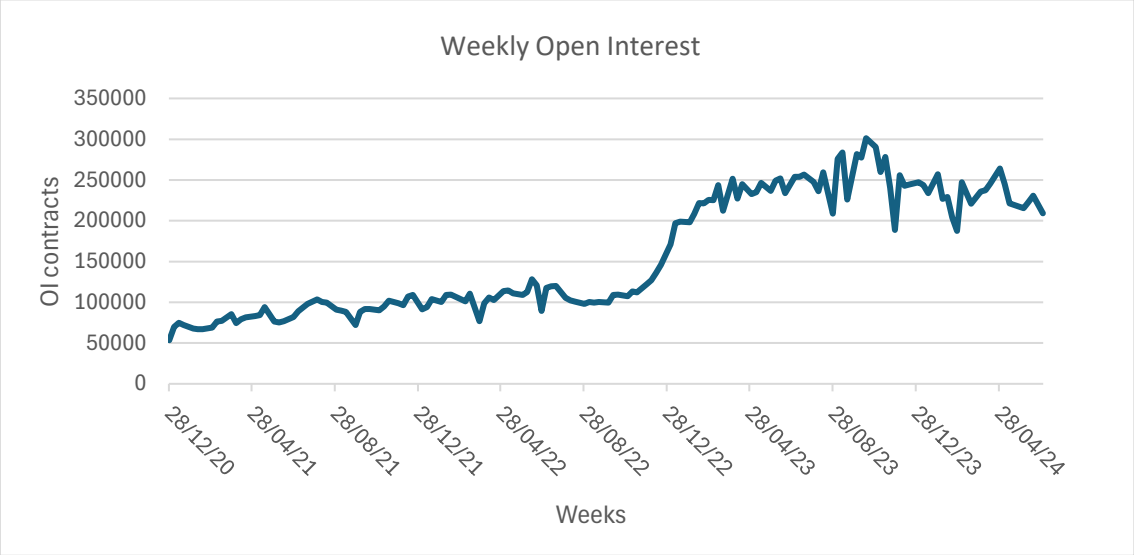


Figure 4. Trend of Open Interest (Weekly)



The weekly closing price shows a maximum (35) weeks price frequency of 972-996, and most of both strike premiums are around the 950 to 1050 price zone. Same right/tail distribution because the maximum number of weeks in a weekly contract is nearly 25,000. Some weeks when the contract increases around 200 thousand again, these extreme values show outliers. The weekly open interest graph shows a maximum OI max spread of 50,000–100,000 with a spread of 50,000–200,000. The data shows the great

number of weeks compared to 200,000 open contracts; these reveal that there is high open interest in out-of-the-money options.

Similarly, indicate descriptive statistics, the mean and median, 157,846 and 114,438, respectively, showing a skewed right-tail distribution. One more important thing: finding under the open interest chart indicates that, in the short term, on a weekly time frame, open interest fluctuates, showing traders often change or adjust their position according to market movements, showing higher and lower liquidity.

Table 3: Descriptive Statistics of NIFTY 50 Monthly Options

Statistics	Closing Price	Contract	Open Int
Mean	1014	44878	159523
Median	1001	27039	116697
StdDeV	201	475892	263773
Min	0.05	0	0
0.25	974	15889	97806
0.75	1060	68219	237903
Max	11037	87520278	35453700
Count	43	43	43 [7]

4.7. Analysis of Monthly Nifty options

Monthly descriptive statistics are most important to find market activity, open interest, and volume within different months. According to statistics, the mean and median of the monthly closing price of descriptive statistics are 1014 and 1001, respectively; like the

[7] Table 2. Monthly descriptive historical raw data is obtained from the National Stock Exchange of India website, followed by descriptive analysis conducted using Excel.

findings of the weekly analysis, most of the values concentrate near ATMs. In a relatively small standard deviation of 201, with outliers like the max closing price of 11,037, which indicates deep ITMs in volatile time periods.

The average value of contracts showing is 44,878, far above the median of 27,039. This number indicates most of the months are showing fewer participants and prices around the consolidation period, but in contrast, a few months feature extremely high participants and high market activity, with the maximum number of contracts being 87.5 million. This result confirms that most of the time when market activity is less, time volatility is also weak, so that a short-time-period short straddle is a perfect setup, and vice versa with a long straddle.

The third most important variable in this strategy is the open interest, and the mean is 159,523 and the median is 116,697 in every month. Apart from extreme months when OI is up to 35 million contracts that are opened, the arithmetic range of 97,806-237,903 suggests that most months OI remained steady. Finally, these findings show a right-skewed distribution.

Figure 5. Histogram of Closing Prices (Monthly)

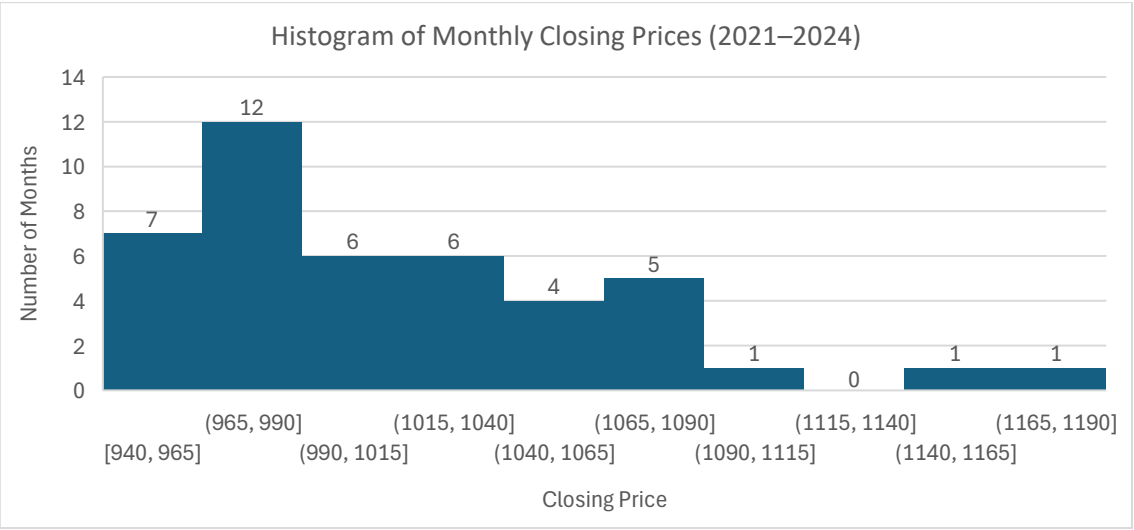


Figure 6. Histogram of Contracts (Monthly)

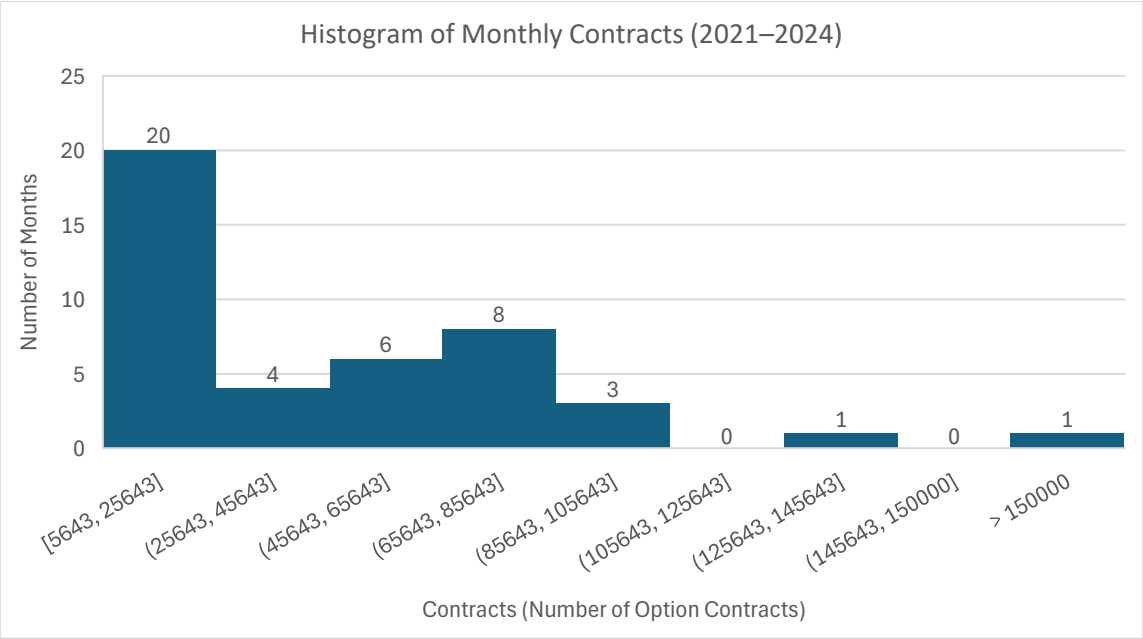
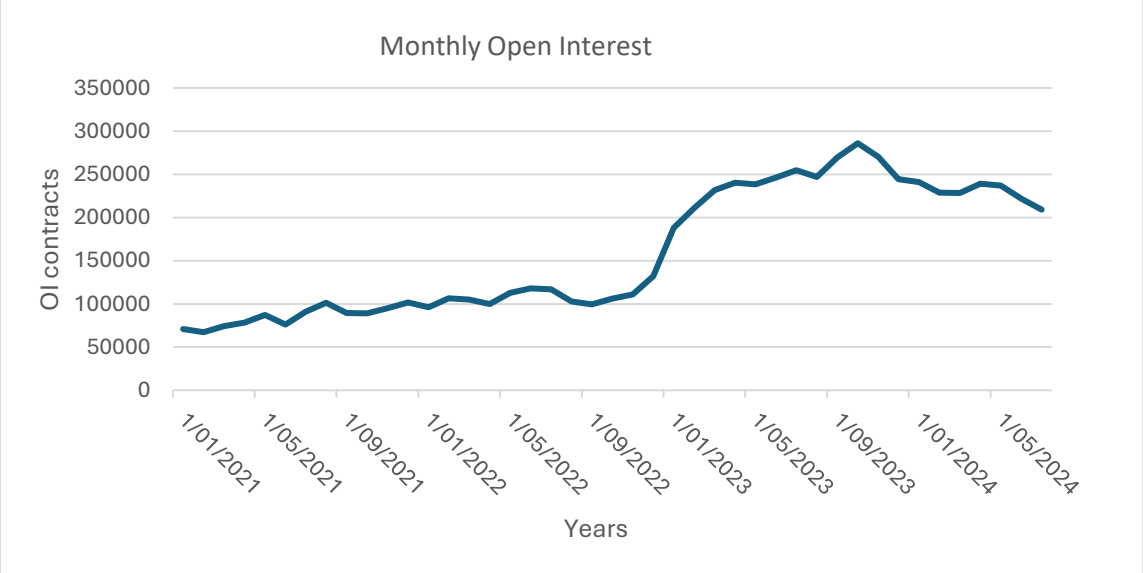


Figure 7. Trend of Open Interest (Monthly)



The same finding shows in these three variables in the histogram. About the maximum closing price around 940 and 1040, in contrast to the maximum number of months in the last four-year period, which is in the 965-990 range. In the contracts, there is a large

gap between monthly activities, like most months having less than 50,000 contracts and some exceeding over 100,000 contracts, which shows extremely active months. This shows that the option market experiences some big and maximum active trading volume. About monthly open interest, it shows a sharp uptrend movement until 2023. This shows that at the start of the time liquidity increases with market participants, and increasing liquidity is best for strategies like straddles. Overall, the mean of open interest shows market performance from participation and market liquidity, which is necessary for delta neutral strategies.[8]

[8] The Data obtained from National Stock Exchange website from India from January 2021 to July 2024 and all value in Indian rupees.

5. Results and Discussion

The result about extreme value is that, overall, excess returns are negative in both strategies and described as underperforming on a risk-adjusted performance. About returns, a short straddle has larger returns than a long straddle.

Table 4: Summary of Extreme Values

Statistics	Short-Position	Long-Position
Maximum P/L	62,450	47,500
Minimum P/L	-48,300	-63,450
Average Excess Return (w)	-0.05%	-0.25%
Average Excess Return (M)	-0.18%	-1.24%

5.1.1 Sharpe Ratio Analysis

The Sharpe ratio is used to find returns after adjusting the risk-free market rate for both weekly and monthly straddles.

Table 5: Sharpe Ratio Results

Frequency	Strategy	Average Excess Return	StdDeV of Returns	Sharpe Ratio
Weekly	Short	-0.05%	5.00%	-0.011
Weekly	Long	-0.25%	4.99%	-0.051
Monthly	Short	-0.18%	11.63%	-0.015
Monthly	Long	-1.24%	11.57%	-0.107

The standard deviation of returns shows weekly strategies, both short and long, are less volatile than monthly strategies, confirming that longer holding options indicate higher fluctuations in returns. Similarly, all Sharpe ratios are negative. which means both strategies were poor across weekly and monthly strategies, but according to values, short straddles have a higher Sharpe ratio in both time horizons, meaning they are better risk-adjusted than long straddles.

These results correlate with previous studies by Schmitt and Kaehler (1996), Swidler & Diltz (1992), and J. Hull (2021), which show that short straddle strategies outperform in low-volatility markets and option-buying straddle strategies give positive returns during high volatility.

5.1.2 Paired t-test

As a result, the paired t-test shows both initial delta-neutral strategies are not significant to each other, meaning both strategies have their own risk factors. About the result, showing both weekly and monthly, the p-value—0.7644 and 0.6882, which is much larger than 0.05—means the difference between average returns in both strategies is similar, there is not too much difference. Similarly, show t-statistic values, which are 0.2999 and 0.4042, smaller than the two-tailed t-critical values, which are 1.970 and 2.021, which show the null hypothesis fails to reject on both sides.

Table 6: Paired t-Test Results (Weekly-Monthly Straddles)

t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	-0.000529052	-0.00253477
Variance	0.002496975	0.002491114
Observations	223	223
Pearson Correlation	-0.998600291	
Hypothesized Mean Difference	0	
df	222	
t Stat	0.299979926	
P(T<=t) one-tail	0.382236582	
t Critical one-tail	1.651746359	
P(T<=t) two-tail	0.764473164	
t Critical two-tail	1.970707395	

	-0.08567	*0.07083*
Mean	0.000254	-0.01447
Variance	0.013676	0.013553
Observations	41	41
Pearson Correlation	-0.9986	
Hypothesized Mean Difference	0	
df	40	
t Stat	0.404211	
P(T<=t) one-tail	0.344105	
t Critical one-tail	1.683851	
P(T<=t) two-tail	0.68821	
t Critical two-tail	2.021075	

Table 7: ANOVA Results – Weekly Returns (Short-Long Straddle)

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	4.88E-15	2	2.44E-15	9.78E-13	1	3.009248
Within Groups	1.662985	666	0.002497			
Total	1.662985	668				

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	2.22E-15	2	1.11E-15	4.46E-13	1	3.009248
Within Groups	1.659082	666	0.002491			
Total	1.659082	668				

Groups	Count	Sum	Average	Variance
S. Bullish M return	223	-0.11798	-0.00053	0.002497
Bearish M return	223	-0.11798	-0.00053	0.002497
Volatile M return	223	-0.11798	-0.00053	0.002497

Groups	Count	Sum	Average	Variance
L. Bullish M return	223	-0.56525	-0.00253	0.002491
Bearish M return	223	-0.56525	-0.00253	0.002491
Volatile M return	223	-0.56525	-0.00253	0.002491

Table 8: ANOVA Results – Monthly Returns (Short-Long Straddle)

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	8.88E-16	2	4.44E-16	3.29E-14	1	3.069894
Within Groups	1.662685	123	0.013518			
Total	1.662685	125				

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	2.22E-16	2	1.11E-16	8.29E-15	1	3.069894
Within Groups	1.647681	123	0.013396			
Total	1.647681	125				

Groups	Count	Sum	Average	Variance
S. Bullish Market R	42	-0.07525	-0.00179	0.013518
Bearish Market R	42	-0.07525	-0.00179	0.013518
Volatile Market R	42	-0.07525	-0.00179	0.013518

Groups	Count	Sum	Average	Variance
L.Bullish Market R	42	-0.52253	-0.01244	0.013396
Bearish Market R	42	-0.52253	-0.01244	0.013396
Volatile Market R	42	-0.52253	-0.01244	0.013396

5.1.3 ANOVA Analysis across Market Conditions

The analysis of variance test findings weekly and monthly F-statistics shows (9.78E-13-4.46E-13) and (3.29E-14-8.29E-15) are smaller than the critical F-statistics 3.009248 and 3.069894, and the p-value is more than 0.05, so the null hypothesis fails to be rejected. This result defines whether market conditions are bullish, bearish, or volatile and whether the strategies are statistically significant. Overall, all these findings show that for short and long straddles, weekly or monthly, both cases returns are negative for different reasons.

5.1.4 Correlation between Indian VIX and Monthly Straddles

Table 9. Indian VIX correlation Result

Strategy	Correlation	Interpretation
Short Straddle	–0.053	Weak negative correlation: short straddle returns decrease slightly as volatility rises
Long Straddle	+0.047	Weak positive correlation: long straddle returns increase slightly as volatility rises

The correlation finding in both strategies clearly shows that in a short position, Indian VIX has a small negative correlation (r = -0.0534), but on the long side, it has a small positive correlation (r = 0.047), meaning that an increase in IV marginally minimizes its returns, which show a tail risk on the short side. On the other hand, higher volatility is a little benefit to a long position.

5.1.5 Simple Regression between Indian VIX and Monthly Straddles

Table 10. Simple Regression Finding

Strategy	Coefficient (β_1)	R^2	t-statistic	Significance

Short Straddle	-1.09×10^{-5}	0.0029	0.114	Not significant
Long Straddle	$+9.65 \times 10^{-6}$	0.0022	0.089	Not significant

However, both correlations are near to zero, and regression coefficients are not significant, which is less than 1% This describes the Indian VIX as having very small participation in the performance of these strategies. Finally, volatility is a major factor of price movement but in the delta neutral strategies, especially in the Nifty Fifty are mostly driven by other major factors such as time value, entry and exit timing, etc.

5.2 Straddles outcomes

After all, finding the overall returns are negative, but across the data set, it shows that short straddles have profitable results most of the time, while long straddles show the vice versa. As a result, maximum profit and drawdown in both strategies over the period January 2021–June 2024 is as follows: the short straddle has a 30,450 positive return, and the long straddle has a -59,005 negative return with the same cost that I assumed before backtesting. This show returns in a short straddle, which is positive but not as a risk-free rate. On the other hand, loss from long straddle mostly was theta decay, meaning in the Nifty Fifty implied volatility was not high enough to overcome theta decay in the long side.

However, a positive return from a short straddle does not define statistical significance because of unbalanced risk. The negative Sharpe ratio indicates that the short strategy has profit, but the average return per week was below the risk-free rate. Overall, the short delta neutral strategy has a positive point from time decay and mostly Nifty Fifty low volatility, but with this positive thing comes exposure to tail risk, which is also shown in this data result. For example, after so many weeks of profit, the market takes back

under a one-week drawdown. These findings align with prior studies by Natenberg (2013) and J. Hull (2021), which state that short position profits in a stable and less volatile market and long options work better in a high volatility environment.

5.3 Empirical result and Prior Literature

Finally, empirical findings provide important factors into the behavior of initial delta-neutral strategies across different markets. Delta-neutral strategies lose money to sudden and unpredictable volatility. For example, the result shows that whenever realized volatility spikes, the long straddle loses value because of sharp options price adjustments in the meantime and higher time decay, and if expiry is near, theta decay is higher. While the short straddle faces drawdowns because of gamma with negative Vega. This contradicts the finding by C. Schmitt and J. Kaehler (1996), which mentions positive returns in long straddles during volatile markets on the DAX indices. This divergence might be due to market structure differences, market efficiency, transaction costs, and volatility. In the Nifty Fifty, an increase in sudden volatility, especially short expiries, creates losses.

In financial theory, long straddles can make positive returns from directional moves, while short straddles make profit from range-bound markets and collecting premium from option time decay. However, according to this study and data, the Nifty Fifty shows moderate trends over the period with insufficient volatility for the long-side option to gain option premium, yet it is volatile enough to cause negative from the short-side. Similar findings from authors Mohanti & Priyan (2014), about delta-neutral strategies, a stable range is best for a short strategy, but directional moves that are not strong enough to make a long straddle positive instead underperform both strategies.

5.4 Graphical Analysis of Strategy Performance

5.4.1 Cumulative Profit and Loss (PnL) Curve

Figure 8. Cumulative Returns (Weekly)

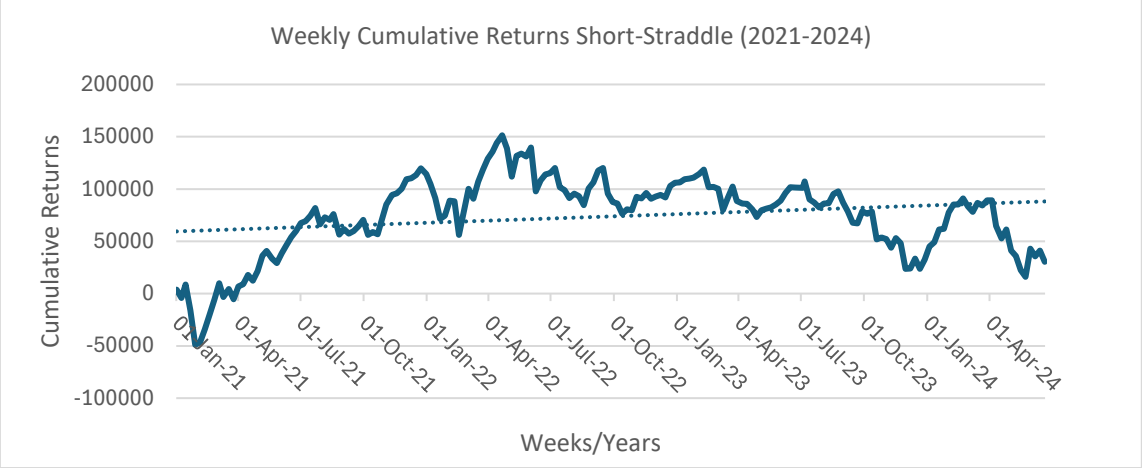


Figure 9. Cumulative Returns (Weekly)

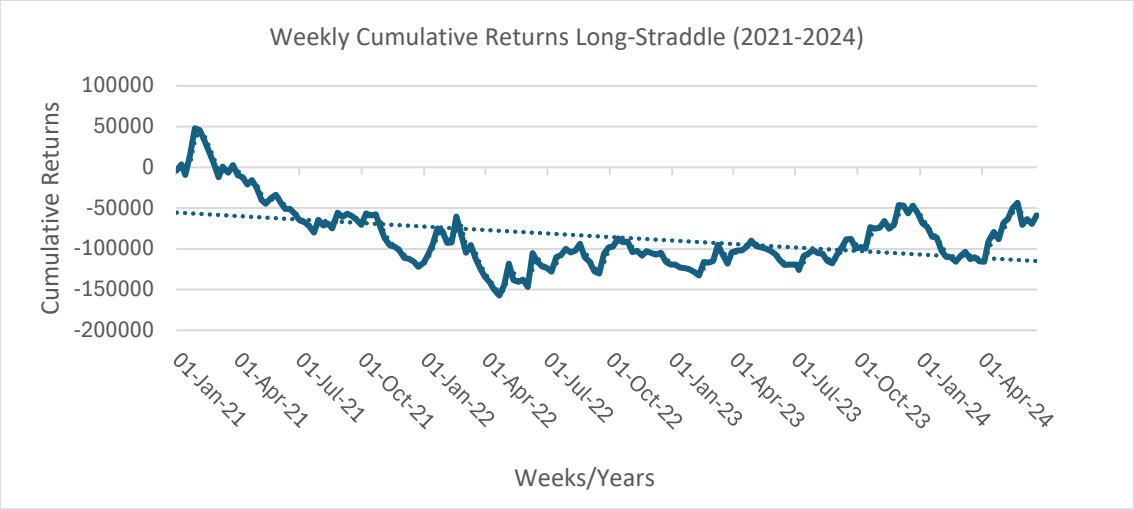


Figure 10. Cumulative Returns (Monthly)

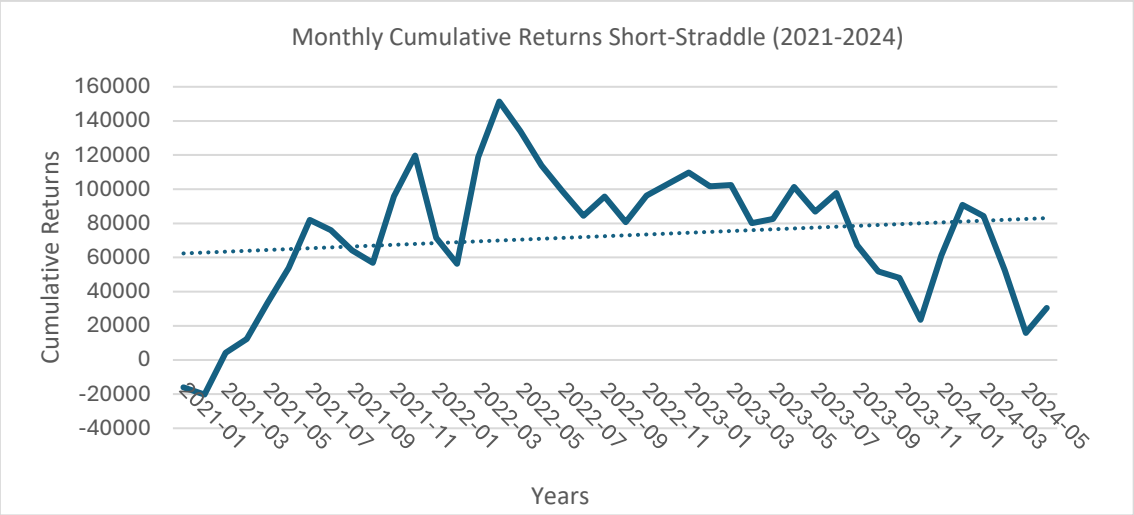
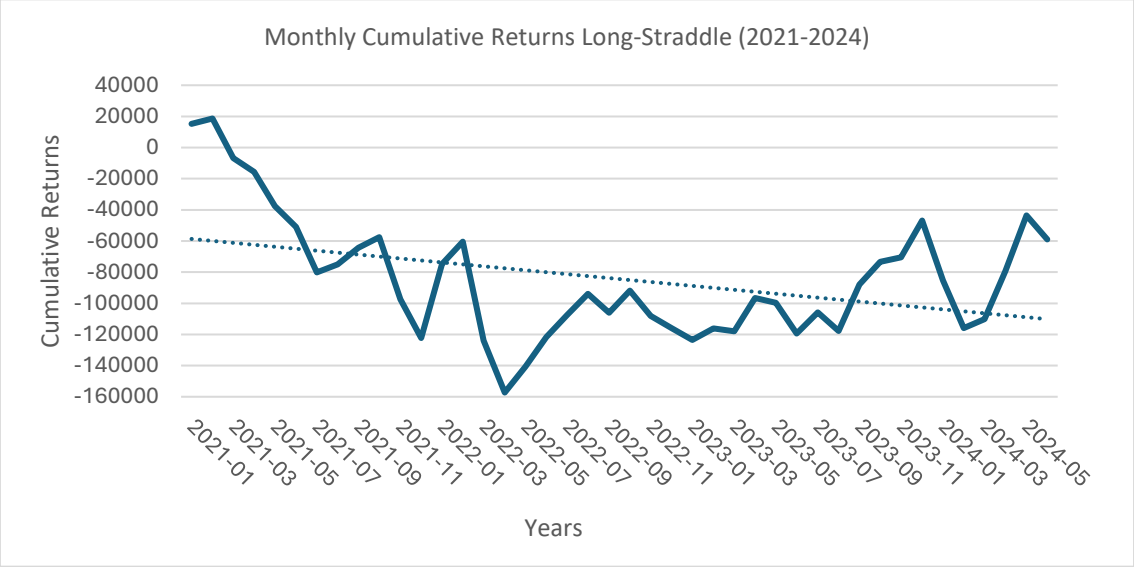


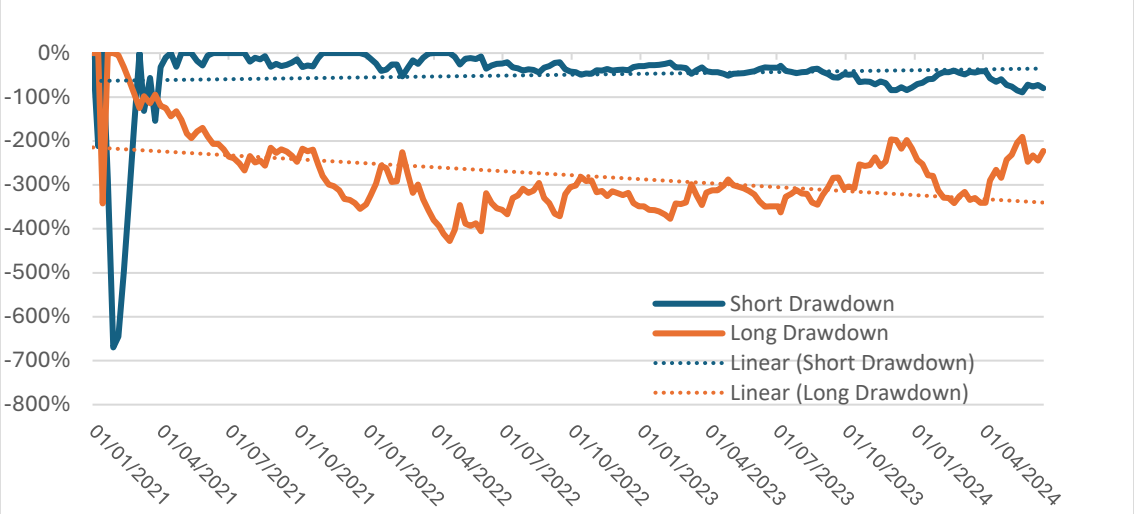
Figure 11. Cumulative Returns (Monthly)



The last four figures, weekly and monthly, show the cumulative profit and loss over the weekly time as well as monthly. These graphical charts show similar findings in the statistics section, in both weekly and monthly, short straddle is more stable and profitable but leaves risk under sudden volatility. To compare with long straddles in mid-2022 and early 2024, they show sharp movement upward, which indicates a high volatility period with large moves where long strategies give maximum profit. However, the overall return was negative on the long side because of less volatility and time decay.

5.4.2 Drawdown Curve Analysis

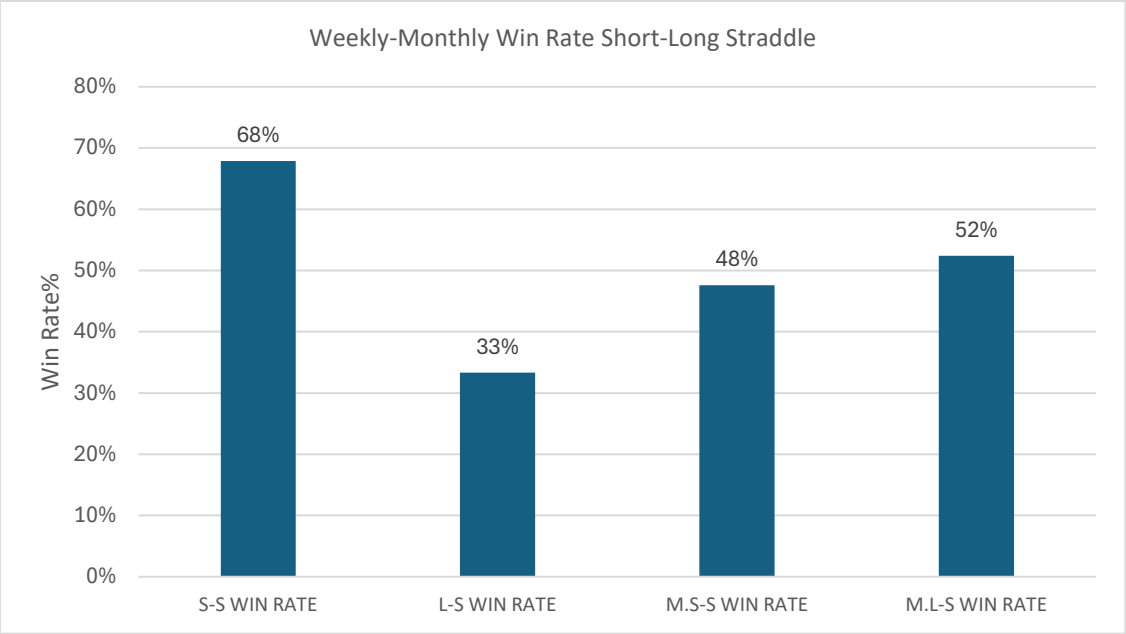
Figure 12. Maximum drawdowns of short and long straddle strategies (January 2021–June 2024).



The drawdown curve shows that both strategies have maximum and minimum losses, but specifically the long straddle shows a larger drawdown over the period and a maximum drawdown of 400% on the long side and around 700% on the short side at the start of the year 2022, meaning the cumulative loss reached down 4 and 7 times the initial premium. For example, if the initial value is 100 and this point value reaches negative 4x and 7x, which represent the worst points of these strategies, especially taking leverage on the long side. This result is shown in this chart starting in 2021 because of event shocks. So, both strategies have different risks in the short position tail risk and in the long-time decay risk. The weekly standard deviation also shows both strategies have the same numerical measurement of volatility, but the distribution of the losses is different.

5.4.3 Win Rate Percentage

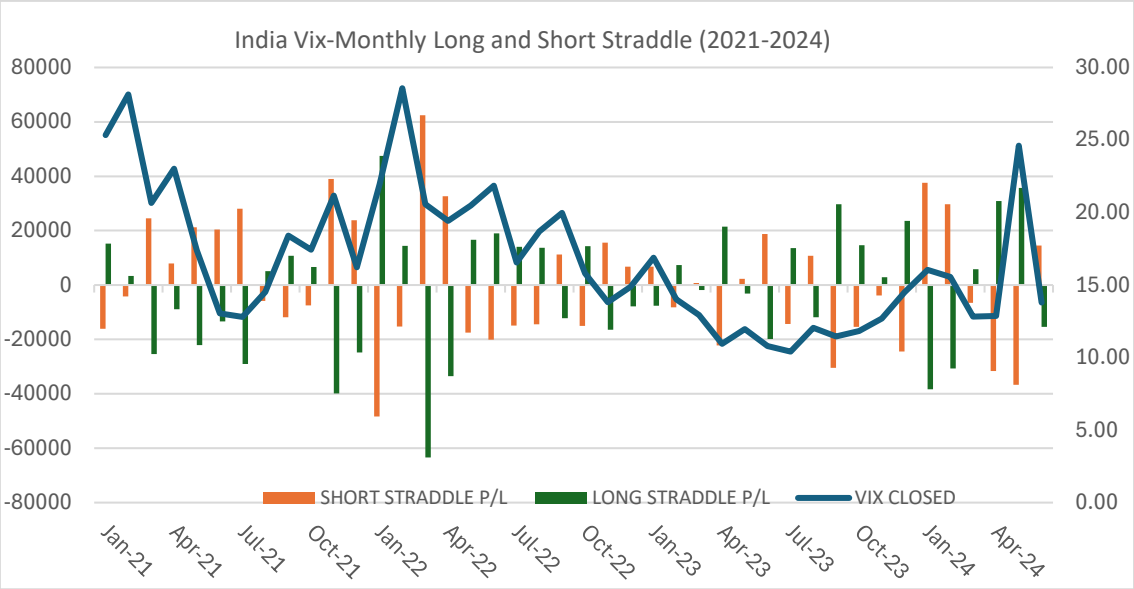
Figure 13. Weekly-Monthly win rate (%) of short and long straddle strategies



The bar chart indicates the weekly and monthly win rate of both strategies. Overall, weekly short straddles give around a 70%-win rate, which means short selling in weekly options is safer than buying. The short straddle has more consistent profit because of time value and short option maturity. In contrast, long straddles in weekly options have only a 33%-win rate, which means there is nearly a 70% chance of losing money. In monthly, both strategies have approximately the same win rate, but especially long straddles for monthly or more than monthly can be profitable in the long period of time because of less theta decay and the chance to increase volatility in the future.

5.4.4 Indian VIX effect on Monthly Straddle

Figure 14. Indian VIX effect on Monthly Straddle



In this period long straddles have positive outcomes, while short ones have negative returns. As the bar shows, this four-year time was mostly stable volatility, and with stable volatility, short straddles maintain small and consistent profit while long strategies lose value over time.

Overall, results define a weak positive impact on the long side and a weak negative link with short straddle returns, supporting regression and correlation results, which were discussed earlier in this chapter.

6. Conclusion

6.1 Summary of the Study

The aim of the study is that these two strategies, short and long straddles on weekly and monthly maturity, can produce a risk-free rate over different market conditions with the use of option variables like volatility, theta decay, and fixed cost.

To continue with these objectives, a quantitative and simulation backtesting research model is applied in this study. After performance was calculated using the Sharpe ratio, maximum drawdown, and win rate. For statistical validation, I used the paired t-test and one-way ANOVA test of the means of these analyses. Furthermore, to find the market volatility on these strategies outcomes, a simple regression analysis was performed using the Indian VIX index as an extra variable to find a deeper result in monthly straddles.

6.2 Key findings and Theoretical implications

To find the risk-free return, the Sharpe ratio indicates that both strategies produce negative risk-free results. For weekly and monthly, the Sharpe ratio was on the short side, at -0.011 and -0.051 for long straddle and -0.015 and -0.107, respectively. Since these values were negative, it means both strategies do not provide risk-free returns. The statistical test, the paired t-test, reveals that there was no statistically significant difference between the returns. In the same way, the analysis of variance test also shows that in all market regimes these strategies do not confirm any difference similarly past research and authors Broadie et al, (2009b) found same result on straddles.

Finally, for monthly straddle correlations, find a very weak positive in the long side and negative in the short strategy, and coefficients show that independently VIX has very little contribution to these strategies. About theoretical implication, the study supports

an important assumption of option theory about market efficiency (EMH), especially in the Indian option market and data shows Nifty Fifty is a semi-efficient market, which means the market partially reflects available information, and no one can predict future prices based on past historical data and price movement on future direction.

6.3 Study Limitations and recommendations for future research

Despite the study design and finding, this study has several limitations, for example, data availability. Firstly, further studies can take a longer period of sample data and contrast with other Indian sectors. Secondly, assumptions were used in the study, such as liquidity, slippage, and efficient execution when buying and selling. Third, using a simple regression model that did not define overall other relevant factors such as external macroeconomic announcements, which lead to change volatility. Lastly, used at the money straddles on the market closing price of the last maturity, which reflects the settlement price instead of the real price during market.

Future studies could extend the larger sample of the Nifty Fifty or other indices in the Indian option market. Further study will focus more on delta-neutral strategies with frequent rebalancing and different strategies such as butterflies, strangles, and straddles but with volatility conditions. For more analysis, volatility and external factors should use multivariable regression analysis.

In conclude, study indicate that initial delta-neutral strategies on Nifty Fifty Indices, do not provide the risk-free rate. According to this study analysis, the Indian option market behaves in a semi-efficient manner, showing that it reflects most available information and returns limited by fixed costs, volatility changes, and especially theta decay with long strategies. Which mean this study is support Fama, (1991) EMH theory. For, the future

study can use the volatility multi-factor framework, and continually rebalancing delta may show the efficiency and profitability of the Indian option market.

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