

Testing the Viability of Options Volatility Arbitrage Strategy in Real Market

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Abstract: As a matter of fact, the option is primarily used as a hedging tool for stock investment in recent years. Contemporarily, the underlying options now include almost all financial derivatives such as stock price, index, and exchange rate. With this in mind, the article will mainly discuss about the test for the volatility and profitability of option volatility arbitrage strategy in the options market. To be specific, a strategy is constructed to validate the feasibility for such strategy. According to the analysis, the limitations and strengths of the strategy will be analyzed through several indicators such as the Sharpe ratio, maximum return, and Calmar ratio. At the same time, one improvement will be made for the limitations of the strategy. In the meantime, the future development tools are proposed. Overall, these results shed light on guiding further exploration of option strategy designs and offer new insights for quantitative strategy designs.

Keywords: Option volatility, arbitrage strategy, option pricing.

1. Introduction

In the nearly half-century, option trading has become one of investors' most popular trading tools. In 2023, the options trading volume in the USA is over 108.2 billion hands. The option is now an important risk management and leverage tool in the investment. The market for options is now cosmopolitan, trading in lots of major capital markets around the world [1]. The underlying options now include almost all financial derivatives such as stock price, index, and exchange rate. The option is primarily used as a hedging tool for stock investment. At the same time, since its unique properties as a quite cheap investment tool to get obligatory to buy a large amount of stock, the option is also an ideal tool to leverage and do some speculative investment [2]. However, the high leverage property of options trading also raises its risk, especially for the stock or index underlying, whose volatility is quite high. Thus a stable and profitable trading strategy is essential for option trading. There exist lots of trading strategies in the options market. For example, Xi proposed his trading strategy based on the stationary process of the stock [3], mainly observing the performance of the options arbitrage strategy of stocks in a stationary process [4]. Figlewski has a contrary observation direction with Xi aiming to provide a valid option arbitrage strategy in an imperfect market [3, 5, 6]. Lei tried to test the viability of his long-term volatility forecast model in a market with investor sentiment [7]. Although there exist so many different trading strategies in the market, they share the same fundamental basement theory, which is the Black-Scholes-Merton Model, one of the most important models in the financial market first proposed by Fisher Black, Myron Scholes [8], and Robert Merton

[9] in 1968. The importance of the BS Model is not only because it provides an accurate pricing system of European stock options but also gives an elegant and easy way to calculate it. Almost all option strategies are established based on this model, including the strategy that will be investigated in the following essay: the Options Volatility Arbitrage(OVA) strategy [10]. The essay will investigate the profitability and volatility of profit of Options Volatility Arbitrage strategy. The data will be based on the real trading data from the SPX-500 index option trading market. The strategy model will be constructed based on the Black-Scholes model and the profitability will be tested using the Sharpe ratio and Calmar ratio.

2. Data and Method

The OVA strategy is a volatile trading strategy based on the relative difference between IV (implied volatility) and HV (historical volatility). The HV of the underlying will be calculated using the past 5-workday week data and the IV is calculated based on the price of the underlying and the BS model. With the formulas in BS model the price of call and put option of the stocks are:

$$c = S_0 CN(d_1) - Ke^{-rT} CN(d_2) \quad (1)$$

$$p = Ke^{-rT} CN(-d_2) - S_0 CN(-d_1) \quad (2)$$

$$d_1 = \frac{\log \frac{S_0}{K} + (r + \frac{\sigma^2}{2})T}{\sigma\sqrt{T}} \quad (3)$$

$$d_2 = \frac{\log \frac{S_0}{K} + (r - \frac{\sigma^2}{2})T}{\sigma\sqrt{T}} \quad (4)$$

where S_0 is the current index number, K represents the strike price and σ is the for volatility. Thus when the price of option and all parameters other than σ are known, the volatility of stock, which is called the IV, can be estimated through the function of BS model. After getting the HV ($\sigma_h(t)$) of stock price and the IV ($\sigma_i(t)$) an indicator of relative difference between the historical and implied volatilities can be calculated as follow:

$$i(t) = \frac{\sigma_i(t) - \sigma_h(t)}{\sigma_h(t)} \quad (5)$$

The trading rule of the Options Volatility Arbitrage strategy is that if $i(t) > 0.25$, short a call option at the end of this day; if $i(t) < -0.25$, then long a call option at the end of this day. The option exit strategy is: if the account has a non-zero position in the option and the indicator changes its sign to the opposite over the last two days, exit the option in the account at the end of the day. The underlying will used for the test is SPX index call and put option with expiration date 2024/01/19 and strike price 4600. The data will be chosen to analyze the SPX-500 index and its corresponding option from 2023/02/01 to 2024/1/19. Data will be used in the test is taken from Bloomberg including the r_0 (Risk – Free rate) and the d (Dividend Yield). The descriptions are shown in Table 1.. After the trading model is formed some indicators such as sharp ratio, maximum profit, and Calmar ratio will be used to evaluate the strategy's profitability and volatility.

Table 1: Descriptions of the data.

Index Ticker	Risk Free Rate, r_0	Dividend Yield, d
SPX	5.53%	1.34%

3. Results and Discussion

First of all, the IV and the HV are calculated using the information given. After getting the σ_i and σ_h , one can get the relative difference can be using the formula:

$$i(t) = \frac{\sigma_i(t) - \sigma_h(t)}{\sigma_h(t)} \quad (6)$$

Using the relative difference indicator, one can get the position of the trading portfolio of the strategy based on the trading rule, which is to short a call option if the relative difference is greater than 0.25 and long a call option if the relative difference is less than -0.25. The trending results are shown in Fig. 1. The positions, daily and cumulated PnL are shown in Fig. 2, Fig. 3 and Fig. 4, respectively. Since the long Call option profit formula is $\max(S_0 - K, 0) - C$ and formula for short call option is $\min(K - S_0, 0) + C$, where C is the market price of a call option contract. According to the real market data of the SPX-500 index from 2023/02/01 to 2024/1/19 one can calculate the daily P&L changes and the cumulated profit of the trading portfolio of the OVA strategy.

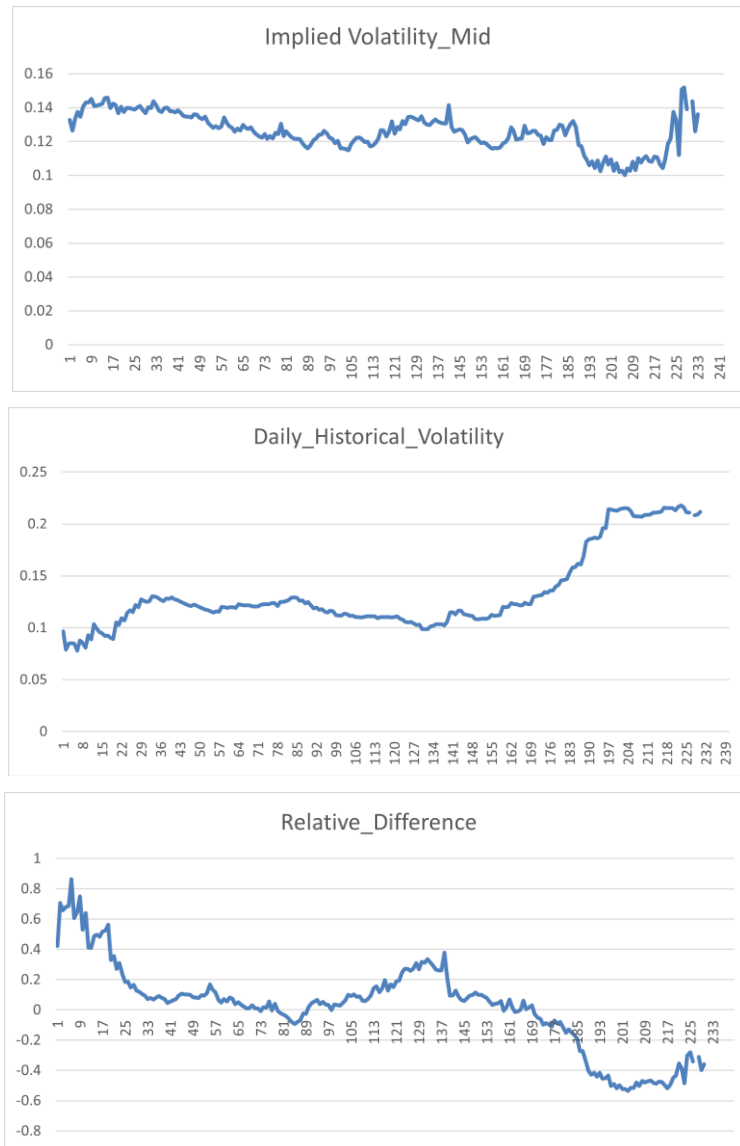


Figure 1: Illustration of trending data (Photo/Picture credit: Original).

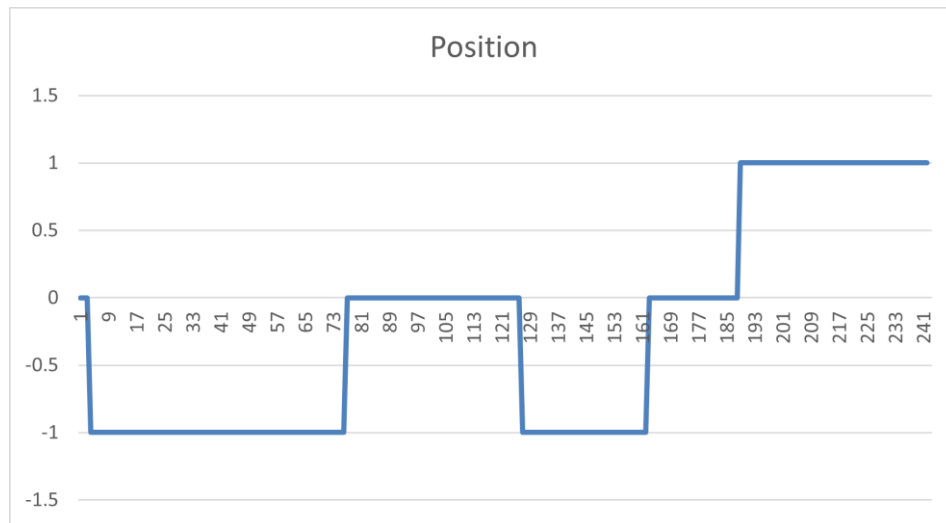


Figure 2: Position evolution for strategy (Photo/Picture credit: Original)

The cumulative P at the end of the period is 326.1, the maximum daily profit is 54.6 and the minimum daily profit is -53.2. The SD of the daily profit and loss is 12%. The average return on the daily profit and loss is 2%. According to Sharpe ratio formula $(R_p - R_f)/\sigma_p$. Since r_f is equal to 5.33%, the daily r_f is 0.014%, the Sharpe ratio of the Options Volatility Arbitrage strategy is 0.25, which is at a quite low level and the main reason is that the standard deviation of return is too high. Besides the Sharpe ratio, Calmar ratio can also be used to evaluate the performance of the strategy, *Calmar Ratio = Average Annual Rate of Return/Maximum Drawdown*. Since the daily average return is equal to 2%, the average annual r is equal to $2\% \times 252 = 500\%$. The maximum drawdown is 200% the Calmar ratio of the strategy is 2.5, which is quite high.

From the result of the Calmar ratio and the Sharpe ratio of the strategy, one can find the limit of the Options Volatility Arbitrage strategy, which is through the return of the strategy is excellent, the volatility of the strategy is too high and thus draw the Sharpe ratio down. To lower the volatility of the strategy, one can hedge the strategy by taking a long position in one call option with the same expiration date and strike price. After forming the new portfolio, one can calculate its daily profit and loss (seen from Fig. 5).

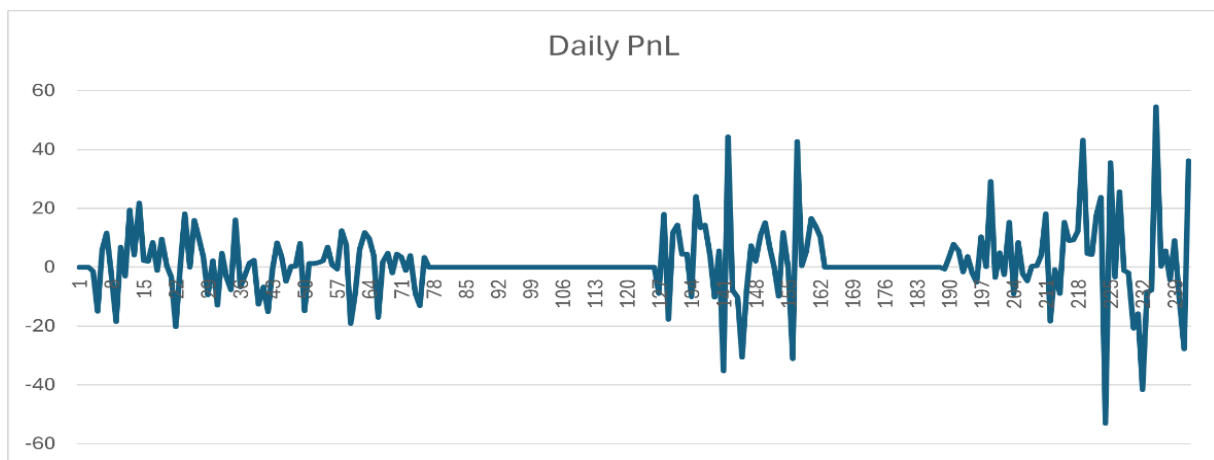


Figure 3: Daily PnL for strategy (Photo/Picture credit: Original)

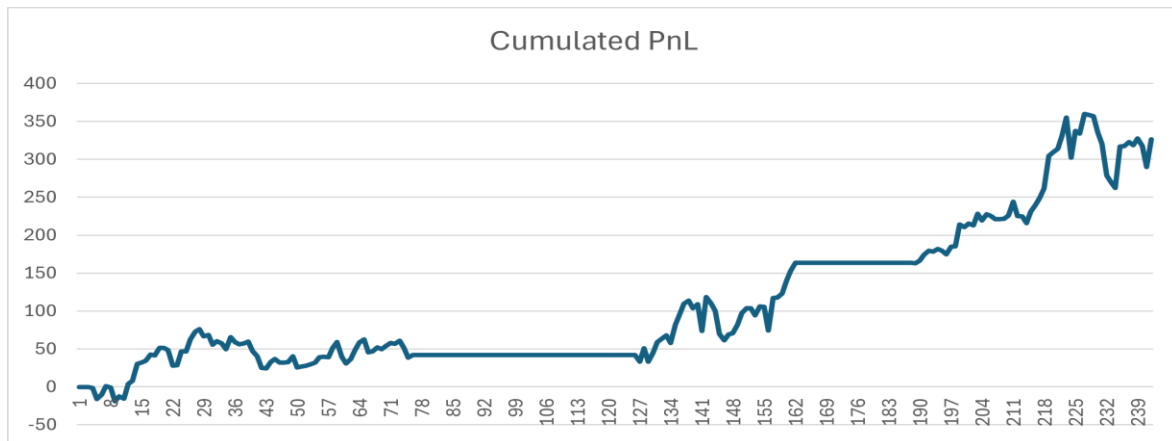


Figure 4: Cumulated PnL for strategy (Photo/Picture credit: Original)

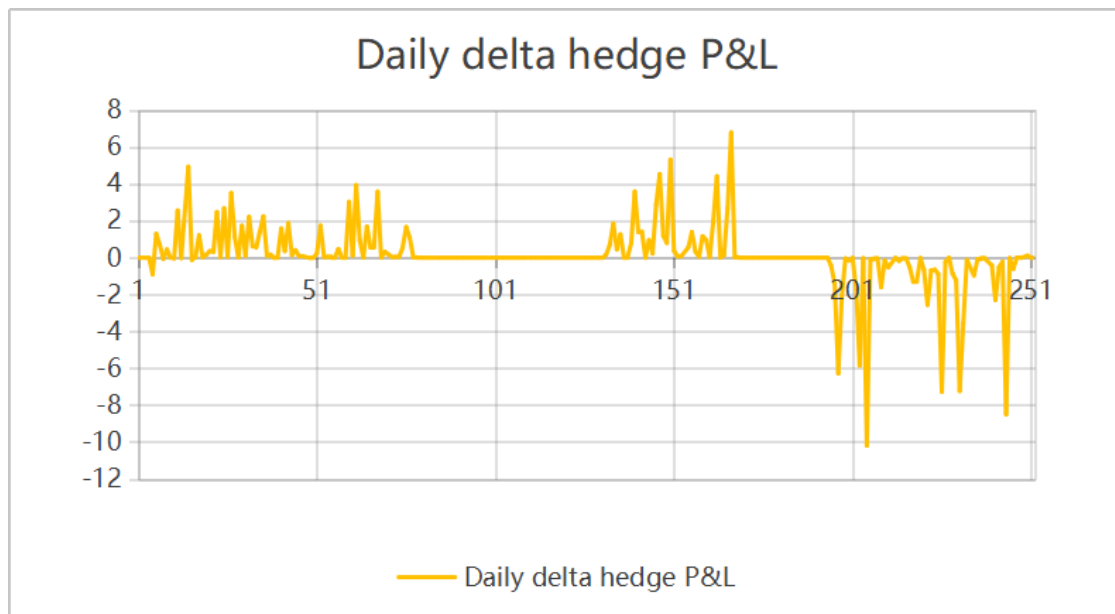


Figure 5: Daily delta hedge PnL for strategy (Photo/Picture credit: Original)

The total revenue of the hedged strategy increases to 357.1 and the standard deviation of the hedged profit is decreased to 10.89%. Since the return of the strategy increased with a decreased volatility. The Sharpe ratio is largely improved. Thus, the limit of the Options Volatility Arbitrage strategy-high volatility- can be properly solved through hedging and the hedged Options Volatility Arbitrage strategy will have good profitability and volatility.

4. Conclusion

To sum up, in the test of the volatility and profitability of the Options Volatility Arbitrage strategy, the strategy showed a high profitability and a relatively unstable return. This volatility limit can largely be solved by hedging the portfolio with a long position in the call option. One thing has to admit is the scope of data used for the test is not sufficient enough, only one year for the SPX-500 index, to derive a universal conclusion about the profitability of this strategy. At the same time, the data did not consider some extreme situations such as the financial crisis in 2008 and the pandemic

in 2020. However, despite some limits, the test still largely verifies the profitability and the volatility of the strategy based on the real market situation.

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