OPTIONS TRADING AND HEDGING STRATEGIES BASED ON MARKET DATA ANALYTICS

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ABSTRACT

Based on mathematics and engineering point of view, we aim to explore the establishment of model structure, and thus calculate the benefits and risks of a financial product. Specifically, we exploit a large amount of market data of futures options so as to address two issues in this work. The first issue is to discover an appropriate product choice and timing for profitable trading. Without loss of generality, we investigate the effectiveness of several trading constraints and technical indicators by scrutinizing and back testing with the long-term market data. The second issue is to use the spread strategies for risk control when being an options seller. Note that a spread position is constituted where one buys an option and sells another option against it. In general, we develop a scheme to simulate different trading strategies and thus identify some simple but profitable strategies. Experimental studies show that our strategies yield good profit in the TAIFEX market during 2009 to 2018.

KEYWORDS

Data Analytics, Financial Engineering, Futures Options

1. INTRODUCTION

Since their launch more than 35 years ago, futures options (or options on futures) have attracted explosively interests for general investors, as evidenced by increasing year-over-year volumes and new product launches. Moreover, rising demand from institutions, electronification and improved market access may drive continuous volume growth. In other words, the futures options market may still be in relative infancy and has not experienced the growth in other similar market. Also, the market has evolved to become a trading arena that supports increasingly sophisticated investment strategies today.

A futures option is an option contract in which the underlying is a single futures contract (e.g., bonds, gold, soybeans, coffee or the S&Ps.) The option buyer has the right (but not the obligation) to assume a particular futures position at a specified price (i.e., the strike price) before the option expires. On the other hand, the option seller must assume the opposite futures position when the buyer exercises this right. One of the main reasons why investors trade options is to avoid the reverse fluctuation of market risk, resulting in loss of underlying assets and to arbitrage between the same target and different types of financial instruments, or using the underlying asset price change to make a profit. Thus, the primary function of futures options is to hedge stocks or index, which is the most commonly used tool for institutional investors [1].

A trading strategy is a method, based on predefined constraints, of buying or selling in the market. The usual rules in a trading strategy include indicators based on technical analysis, fundamental analysis, quantitative methods, or a combination of several factors. In this work, we investigate two crucial factors to determine an appropriate trading strategy. The first one is to discover the appropriate timing for profitable trading. There are many technical indicators being created to predict the trend and can be included in our strategy. The second one is hedging that is closely related to risk tolerance of an investor. Note that there are always risks in the financial market, especially for being a seller who earns the time value to the futures options [2].

The rest of this paper is organized as follows. Preliminaries and related works are generally reviewed in Sec. 2. Our proposed scheme is developed and illustrated in Sec. 3. To evaluate the effectiveness of our approach, experimental studies based on real market data are explored in Sec. 4. Finally, this paper concludes with Sec. 5.

2. PRELIMINARIES

To understand some basics of the financial market, some brief descriptions are provided in Sec. 2.1. Next, to know how to hedge, the method of hedging is discussed in Sec. 2.2. Moreover, prior works on identifying future trends using different technical indicators are explored in Sec. 2.3.

2.1. BASICS OF FUTURES OPTIONS

In finance, a futures contract is a contract between two parties to buy or sell a specified asset of standardized quantity for a price agreed upon today with payment and delivery occurring at a future date. The trading of futures options can be modeled as a zero-sum game. In other words, the gain of one party necessarily implies the loss of the other party, i.e., gains and losses on both sides sum up to zero [3].

Options represent the right, but not the obligation, to take some action on the specified date [4]. There are two types of options, i.e., call and put. In European options, a call option is bought when the investor expects the underlying value will rise before the expiry date, and also gives the trader the right to buy an asset at a strike price on the expiry date. This is opposite of a put option, which bought when the trader expects the underlying value will plunge before the expiry date, and gives the trader the right to buy an asset at a strike price on the expiry date. And there are two sides to each of the option transaction – the party of selling the options, and the party of buying the options. Each side takes its own risks and has a different portfolio. The relationship of the payoff of a call option and the price of the underlying investment is shown in Fig. 1. Figure 1.

Figure 1. Payoff of a call option

In prior works, a number of options trading and hedging strategies are developed, including single trading strategy, bullish strategies, bearish strategies, neutral or non-directional strategies. In

practice, investors usually choose a strategy based on relevant information since different strategies work in different situations.

The trading volume of futures options is more than that of any other derivate product. For example, futures options account for over 50 percent in trading volume in Taiwan [5]. It is reported that 75% to 80% of options held through expiration will indeed expire worthless [6]. However, before that, those options are valuable no matter for time value or hedging value.

An futures option is a derived and volatile trading tool that a trader can either be the buyer or seller [7]. The seller in the futures options like an insurer, if there is not an unexpected situation appears they can obtain a stable profit and the buyer on the contrary. In other words, the buyer and the seller have different views of the volatility. If buying and selling different options at the same time, it can combine a strategy to reduce the volatility risk. However, Specifically, being the options seller has several advantages [7], including

> (1) The odds are in the favour;
> (2) Taking profits becomes simple;
> (3) Time is on the side;
> (4) Being close is good enough;
> (5) Perfect timing is no longer necessary; and
> (6) Definable risk control.

2.2. PREDICTING THE TREND

Predicting the trend in financial markets is always a crucial goal for investors. There are two types of analysis which investors perform in the stock. In fundamental analysis, the intrinsic value of a security is measured by examining related economic and financial factors, which can be both qualitative and quantitative. On the other hand, technical analysis is a kind of method used to evaluate investments and determine trading opportunities by analyzing demographic trends gathered from trading activities, such as price movement. In short, fundamental analysis is mostly based on the underlying value of the investments in the long-term. On the contrary, technical analysis is more focused on current trends and is thus more appropriate for short-term trading.

In prior works, several technical indicators combined with machine learning methods are used to predict stock price index movement [12]. In addition, Bollinger bands can be used as a measure of market trend and the parabolic SAR can be used as the momentum determinant to indicate an entry/exit point [13]. Exponential moving average (EMA) is also used to develop options trading strategies [14]. Several technical indicators are used to decide which strategy to use.

2.2. CONTROLLING RISKS WITH HEDGING STRATEGY FOR OPTIONS

As an investment, options have the risk of losing money, and sellers may lose infinitely. Although the winning rate of being an options seller is about 75% to 80%, what to do with the other 20% still matters. To control the risk, there are five primary techniques [7]:

> (1) Spread the market;
> (2) Set an exit point based on the value of the options itself;
> (3) Rolling options;
> (4) Basing risk on value of underlying; and
> (5) Take profits early.

Options spread involves building the basic blocks of two or more different options as a trading strategy. In the simple language, a spread position is formed by buying and selling in the same timing, same asset, same underlying security but with different strike prices or expiration dates. The aim of the spread strategy is expanding profit interval to earn stable profits. There are some advantages including less risk and provides the trading edge, lower volatility risk. As we have known, being an options seller need to take the unlimited risk. In light of that, using the spread strategy helps to limit the risk [8]. Besides, we can use a different combination to create different profit interval to formulate an appropriate trading strategy. Furthermore, the options values and volatility are in direct correlation. By entering the spread, the position is noticeably less sensitive to changes in implied volatility

There are many researches to dig into the diversified spread strategies. The fast Fourier transform is used to extend the original Black-Scholes model to price the generic spread options [9]. Trinomial tree model is used to price the spread options [10]. The spread strategy is used to hedge in commodity price risk management [11].

3. PROPOSED TRADING AND HEDGING STRATEGIES

The strategy we use is a specific technical indicator like EMA and VIX to decide where we should access to the market and using spread to hedge our risk and determine the final parameter by back testing the ten-year data.

3.1. USING TECHNICAL ANALYSIS TO DETERMINE TREND

We use two types of technical analysis to determine the market trend. First is the moving average (MA). In statistics, a moving average is a calculation to analyze data points by creating a series of averages of different subsets of the full data set. The simple moving average (SMA) is the most widely known one. It's the un weighted mean of the previous n data. The prices are $Pm, Pm-1, ..., Pm-(n-1)$, the formula is as follows:

$$\bar{P}_{Sm} = \frac{P_m + P_{m-1} + \cdots + P_{m-(n-1)}}{n} = \frac{1}{n}\sum_{i=0}^{n-1} P_{m-i}$$

However, SMA is considered to be a relatively slow response indicator. It is often seen the trading signal after the price is reflected. Therefore, there is another indicator derived from SMA that can be more sensitive to the trend. It is called exponential moving average (EMA). In EMA, the weighted influence of each value decreases exponentially with time. That means the more recent data, the more influential, but the older data also gives a certain weight. In other words, EMA is more sensitive on market trends.

The other technical indicator is the CBOE Volatility Index (VIX). it is known as the fear index. It is a regular measure of the stock market's expectation of volatility indicated by the S&P 500 index options. In other words, it approximately reflects the expected trend of the S&P 500 in the next 30 days. When the volatility of the market is high, this index rises. Fig. 2 shows the relationship between VIX index and TAIEX index since 2009. It can be seen that the VIX index rises rapidly when the TAIEX index changes significantly.
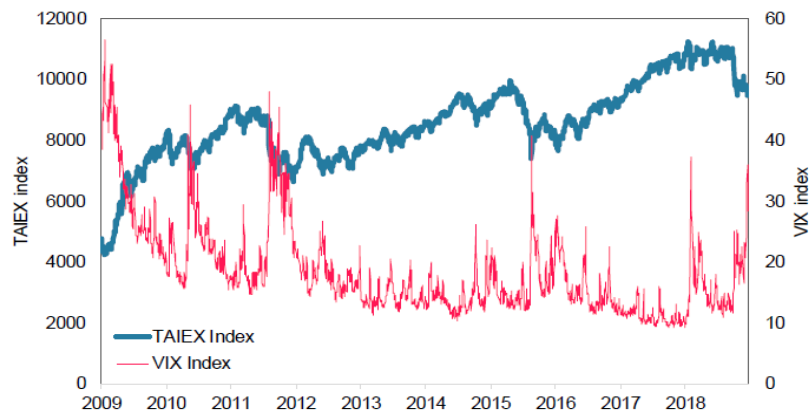
Figure 2. Relationship between VIX and TAIEX indices

Because VIX can show the current turmoil in the market, we think it can be used as a reference for the number of commodities at the time of trading, because when the market volatility becomes higher, the risk of trading increases.

3.2. SPREAD AS A HEDGING STRATEGY

Options can be categorized into three types, including out of the money (OTM), at the money (ATM), and in the money (ITM). If an option has intrinsic value, it is called an ITM option. In the opposite, if the option does not has intrinsic value, it is called an OTM option. The premium of the ITM option is higher than the OTM option because the ITM options' premium includes intrinsic value and time value and the OTM options only include time value. In other words, we can use less money to reach the same purpose. As the view of the seller, the OTM option is more different to reach than the ATM option. It means the winning rate of the OTM option is higher than the ITM option. For the above reasons, we decide to use OTM options to be our main trade options.

The spread strategy we use to hedge is that for each OTM option including call and put search the other option which OTM degree is higher than a protected option to combine to a spread which including selling a lower OTM option and buying a higher OTM option. The spread example shown in Fig. 3 is using the two different strike price of the call options to combine to a bull call spread. The way we search is using the 10 to 40 percent premium which we get from selling the lower OTM option. In other words, if there is an OTM option whose premium is 10, 20, 30 or 40 percent that of the other OTM option then we trade the spread strategy by selling the lower OTM option and buying the higher OTM option. If we cannot find the higher OTM option which matches the condition (the premium of the higher OTM option is too high, or the lower OTM option is too low), then we give up this opportunity.

Given that another factor the rest date to the expiration date, we divide nearby month and back month to research the difference of their profit ratio and explore are there any characteristic we can expand to use in our work.

Figure 3. Bull Put Spread

3.3. PROPOSED SCHEME

In this work, we integrate three strategies, including spread strategy, VIX strategy, and EMA strategy, to make a unique strategy and compared it with its sub-strategies to find the difference Profit or Loss Stock Price at Expiration with the integrated strategy. Our proposed scheme can be divided into four parts (as shown in Fig. 4).

Step 1: The OTM points and the minimum premiums are set to be constraints. For step one, we attempt to determine whether being sellers or buyers has more profits and is there more profit in the OTM options.

Step 2: The technical indicators are set to build the strategy and we back test different OTM options and different minimum premiums data to find the best parameters.

Step 3: The spread strategy is added to hedge. The different percent of premiums are used to buy another option to combine into a spread strategy for controlling risk.

Step 4: We compare the various combination strategy and the sub-strategies profit and risk and recommend different strategies for different needed investors.
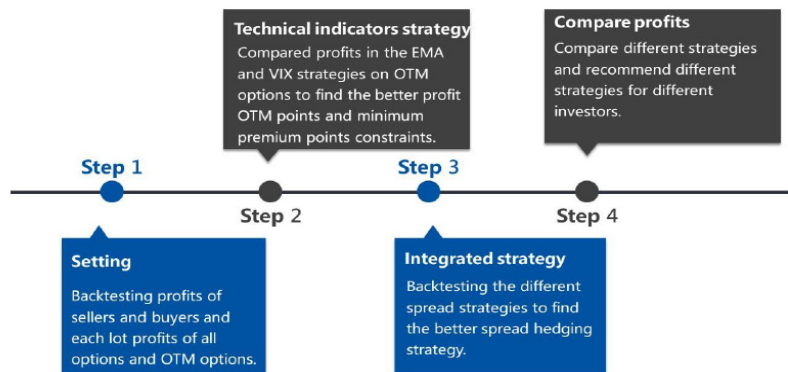Figure

Figure 4. Flows of the proposed scheme

4.   EXPERIMENTAL STUDIES

In the section, our development environment is firstly introduced. Then, we evaluate that whether sellers in the options market get better results in winning rate and the total profit. Furthermore, we compare the spread and naked strategy and confirm the spread strategy is better than naked when the market encounters some issues.

4.1. EXPERIMENTAL ENVIRONMENT

Taiwan stock index options (TXO) is selected to be our target product. Note that TXO is an index option, i.e., a kind of futures options whose underlying is an index. In other words, no actual stocks are bought or sold. The corresponding market data is crawled from Taiwan Futures Exchange website. The daily open price, close price, high price, low price and expire month are included. Moreover, TXO is evaluated by points, and one point equals to 50 NTD.

We select all contracts between January 2009 and December 2018 based on two conditions: (1) transaction volume is not zero; and (2) dates between the expiring date of this month and the expiring date two months ago.

Table 1 shows our experimental environment in this work. Generally speaking, we develop our scheme using Python language on a desktop computer.

Table 1. Experimental Environment

	Description
OS	Microsoft Windows 10 Pro
CPU	Intel Core i7-6700
RAM	32GB DDR4
GPU	MSI RX-470 4GB
Programming Language	Python 3.6.6
Database System	MySQL

4.2. FEASIBILITY OF BEING A OPTION SELLER

In this section, we attempt to verify the hypothesis, i.e., to be a seller is better as the product settled. To determine whether being a buyer or a seller is better, the first thing we would like to know is which monthly mean profit (as shown in Fig. 5) is higher than the other one. One may easily notice that the seller has a positive profit in most of the time. However, the seller may encounter a rather huge loss in some months. In general, we can roughly observe that in Fig. 5 the profit of a seller is greater than that of a buyer.
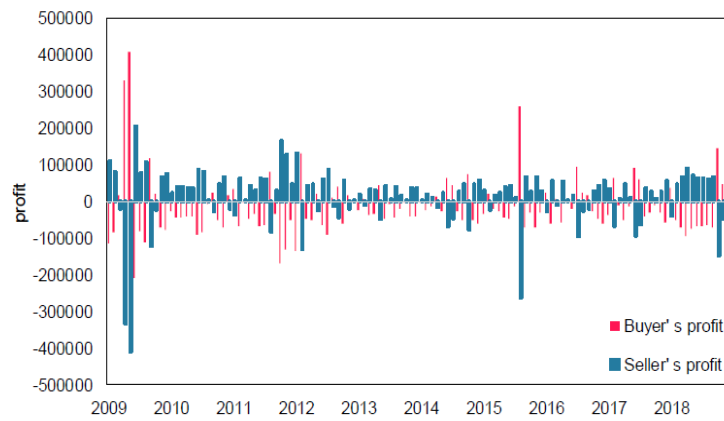
Figure 5. Monthly profit of being a buyer and a seller

Furthermore, we qualified the number of trades, winning rate, and the accumulated profit in Table 2. It shows that the winning rate of the seller over ten years is 79.2%, and also having more accumulated profit than the buyer. Besides, Fig. 6 shows that the gain of the seller is positive most of the time; even more, the profit is usually stably increasing; in contrast, the gain of the buyer, and the profit is almost negative in every time. The result shows that being a seller is indeed better than being a buyer.

Table 2. Statistics of being a buyer and a seller

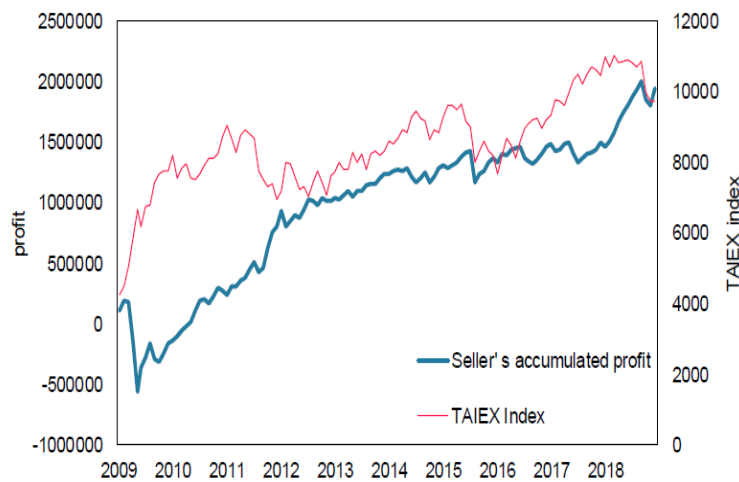| Total Amount	# of Buyer's Positive Profit Trades	# of Seller's Positive Profit Trades	Buyer's Accumulated Profit (point)	Seller's Accumulated Profit (point)	Buyer's Winning Rate (%)	Seller's Winning Rate (%)
229731	46925	181906	-1952849.7	1952849.7	20.4	79.2

Figure 6. Accumulated profit of being a seller

In Sec. 3.2, we have investigated why seller most likely to trade the OTM options. In Table 3, we back test with market data from 2009 to 2018 to obtain the results of selling all the options, selling ATM and ITM options, and selling only OTM options, respectively. Table 3 shows that the highest profit per trade and the winning rate both have a significant effect on the OTM options.

Table 3. Comparison of selling all options and OTM options

	# of Trades	Accumulated profit (point)	Profit per trade (point)	Winning rate
All options	229731	1952849.7	8.5	79.2%
ATM and ITM options	82356	448851.5	5.4	53.2%
OTM options	147375	1503998.2	10.2	93.7%

4.3. EFFECTIVENESS OF USING TECHNICAL INDICATORS

For the average of VIX index about 20, the initial experimental parameter is set at 30 of VIX index, plus one standard deviation which is about 10 points, in all the experiment below to reduce the risk from big waves.

VIX strategy and EMA strategy are combined as a new strategy which achieves conditions of both EMA and VIX strategies simultaneously. To find the more exactly trading timing, we use the technical indicator EMA. We set the 6-days EMA to be concerned because there are six expiry days in weekly options. We are using the daily highest price and the daily lowest price to set an interval. If the daily highest price is higher than the EMA highest price, it is determined to bull position then sell an OTM put option. If the daily lowest price is lower than the EMA lowest price, it is determined to bear position then sell an OTM call options.

First, we set the OTM degree constraint. We choose the OTM degree from 100 to 500 points options, and every 100 points are set at an interval and only transaction the premium more than 10 points options and choose both nearby month and back month options. Table 4 shows that similar values of profit per trade can be obtained when varying the OTM degree. However, because of the # of trade, the accumulated profit of the OTM 100 points options is more than the accumulated profit of OTM 500 points options. However, compared to the winning rate, the OTM 500 points is higher than the OTM 100 points.

Table 4. Statistics of different OTM points

OTM degree (point)	# of trades	Accumulated profit (point)	Profit per trade (point)	Winning rate
100	22874	384288.5	16.8	88.5%
200	18832	310201.0	16.5	90.7%
300	15163	245456.5	16.2	92.6%
400	11952	188388.5	15.8	94.0%
500	9248	143348.0	15.5	95.0%

Second, we set the minimum premium constraint. We choose the OTM 500 points options and set the minimum premium on 10 to 30 points. Every 10 points are set an interval and choose both nearby month and back month options. Table 5 shows that there is a better profit per trade when the minimum premium is higher. However, through the minimum premium arise, the winning rate declines, and the # of trade decrease, causing the accumulated profit decline.

Table 5. Statistics of different premium points

Min. premium (point)	# of trades	Accumulated profit (point)	Profit per trade (point)	Winning rate
10	9248	143348	15.5	95.0%
20	4996	106964	21.4	93.2%
30	3067	78922	25.7	91.9%

The historical data show that when selling all the OTM options, the profit per trade is 10.2 points. If adding the OTM degree and premium constraint base on VIX strategy, the profit per trade is 25.7 points. So we can obviously find combining the EMA indicator in the strategy can substantially improve our strategy, and we can observe the phenomenon that if adding the OTM degree and premium constraint at the same time, through the OTM degree becomes higher, the winning rate becomes higher. Through the OTM degree become lower, and the winning rate become lower. However, the accumulated profit is higher because the # of trade is higher.

4.4. EFFECTIVENESS OF USING THE SPREAD STRATEGY

To reduce risks of big waves in TAIEX and to test if it is more profitable, the experimental parameter is set from 10% to 40% with the interval of 10% of the premium to do spread strategies and to compare with the strategy without doing spread. The experiment is also based on the result of the previous section, the EMA strategy, and observed which strategy is the most profitable one.

It is presented the accumulated profits of naked and spread strategies in Table 6. As the result shown in Table 6, it can be told that the spread strategy with 30% of the premium has the highest profit per trade among all four strategies. Otherwise, the 40% one has the highest total profit and the highest winning rate, but each lot profit is 1.3 points less than the 30% one because nearly half of the premium is to pay for risk control.

Table 6. Premium rate from 10 to 40 points result

Percent of premium (%)	# of trades	Accumulated profit (point)	Profit per trade(point)	Winning rate
10	728	8177.6	11.2	89.3%
20	1010	15499.0	15.3	90.6%
30	1169	18796.0	16.1	91.1%
40	1293	19174.0	14.8	91.4%

4.5. GENERAL COMPARISON OF VARIOUS STRATEGIES

After several separate experiments, some better parameters were found, such as VIX threshold over thirty points in VIX strategy, OTM degree over five hundred points in EMA strategy and using thirty percent of the premium for hedging, etc. However, combinations of strategies are also

the topic of concern about whether better results are found. In this section, the combination of the strategies was explored for comparison with the previous experiments.

Furthermore, the conditions in the new strategy are selected according to each lot profit, which was better than other conditions in previous experiments. Next, the new strategy was added the hedging mechanism-Spread. The thirty percent spread condition was selected because of higher each lot profit.

The results under the conditions of the best profit from each strategy are selected to compare. Table 7 shows the detail information of conditions in each strategy.

Table 7. Detail information of conditions in each strategy

	VIX threshold	OTM	Min. premium	Percent of premium (%)
VIX + EMA	30	500	30	n.a.
VIX + EMA + Spread	30	500	30	30

In the beginning, we cut in from the perspective of total profit. Table 8 shows the results of the comparison. It can be found that selling all options strategy has the highest accumulated profit. However, one may note that the number of trades 229,731 requires too large trading capital for an individual investor and the winning rate 79.2% is lower than other strategies.

To solve this contradiction, we use the accumulated profit divided by the total number of trades to get each lot profit, and It can be found that the strategy EMA under the technical indicator VIX more than 30 constraint has the highest profit per trade of 25.73 points. The strategy also has a better winning rate with 91.9%. Nevertheless, we consider that except profit per trade, the profit's volatility is another significant concern for a reasonable investment strategy. Consequently, the monthly profit percentage standard deviation is used to calculate the risk indicator, whose meaning is the variation range of monthly profit. If the risk indicator is lower, it means the risk is lower. In the opposite, if the risk indicator is higher, it means the risk is higher. Fig. 7 shows that the strategy EMA combined with the spread strategy, which bases on VIX constraint, has the lowest risk indicator of 2.5% and the second highest profit per trade of 16.08 points. Comparing to the EMA spread, we decline our risk by reducing the profit.

To sum up, the strategies explored in this work are with different features. Each of these strategies has different risk and profit. They all have their strengths in different orientations. We can use different investment strategy depending on different funding amount or condition, subjective and objective risk tolerance for the investor, and the investment time range.

Table 8. Comparison of all strategies

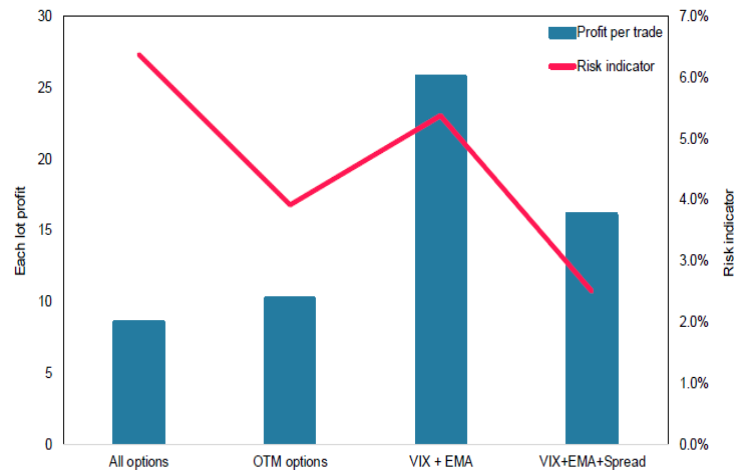|	# of trades	Accumulated profit (point)	Profit per trade (point)	Winning rate	Risk indicator
All options	229731	1952849.7	8.5	79.2%	6.4%
OTM options	147375	1503998.2	10.2	93.7%	3.9%
VIX + EMA	3067	78922.0	25.7	91.9%	5.4%
VIX + EMA + spread	1169	18796.4	16.1	91.1%	2.5%

Figure 7. Comparison of profit per trade of different strategies and risk indicator

5. CONCLUSIONS

We have explored the establishment of the model structure and calculated the benefits and risks of futures options. In this work, we have exploited a large amount of market data of futures options to address two issues, the spread strategies for risk control and the appropriate timing for profitable trading. We have investigated the effectiveness of several technical indicators by scrutinizing the market data. In this work, we have developed some simple but effective strategies for being options sellers.

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