



# A Detection of Mispricing in Chinese Option Market

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**Abstract.** As a new market in 2015, the Chinese options market has the characteristics of information asymmetry. Therefore, searching for a general investment pattern is important. This article analyzes all Chinese stock index options data and reveals the statistical law of the calendar effect in the option market. The article conducts regression analysis on unreasonable volatility, building delta hedge and straddle option strategies, and using regression analysis on options yield to verify that the market makers neglect the influence of the difference between expiration date and purchase date. The pricing difference caused by the calendar effect of options does exist, but unlike the US options market, investors cannot just use simple strategies to obtain a robust positive return in the Chinese market through the calendar effect.

**Keywords:** Options Calendar Effect · Chinese Option Index Market · Mispricing

## 1 Introduction

A stock index option is a contract between the option seller and the buyer. Due to the poor efficiency of the option market, it remains an essential challenge in option pricing. Several recent studies have tried to detect mispricing in the option market. Boyer et al. (2014) find that the ex-ante skewness of options predicts negative option abnormal returns [3]. Jones et al. (2018) documented a weekend effect in option pricing, which they attribute to the incorrect treatment of non-smoothness in stock return variance [10]. Investor inattention in equity markets, such as weaker investor reaction to a firm's earnings announcement on days with many earnings announcements, is also an essential reason for mispricing found by Hirshleifer et al. (2009) [9]. Deng et al. (2017) pointed out that the Chinese options market has the characteristics of late establishment, single varieties, and slower development [11]. Chinese stock index option markets are divided into Huaxia 50ETF (510050) options issued by the Shanghai Stock Exchange. Huatai-Pinebridge 300ETF (510300) options, issued by the Shanghai Stock Exchange. Jiashi Hushen 300ETF (159919) issued by Shenzhen Stock Exchange and Hushen 300(000300) issued by China Financial Futures Exchange. The options issued by the Shanghai Stock Exchange and the Shenzhen Stock Exchange use the fourth Wednesday of each month

as the expiration day, and the options issued by the China Financial Futures Exchange use the third Friday of each month as the expiration day. Therefore, there are 4 weeks or 5 weeks, two possible time periods between the two expiration dates. Based on the Black-Scholes' study in 1973, an extra week will result in a 5% to 10% difference in option value [2]. However, market makers only care about the year and month of the option expiry date, so that they often ignore such differences. This phenomenon of option value difference is called the calendar effect in the US market. Assaf Eisdorfer et al. (2017) showed that the calendar effect of the US market is significant, and investors can benefit from that using simple options strategies [7]. This article examines this phenomenon in the Chinese market. First, the original options data is cleaned and then two option strategies are constructed. Finally, the regression analysis is implemented to verify the guidance factor.

## 2 Analysis of the Original Data

### 2.1 Data Description

The main data source of the article is the WIND database, which provides all stock index options data in Chinese market. Since Huaxia 50ETF options went public in 2015, and the other three index options launched in 2019. Therefore, there are total 120 months' data, including the daily settlement price, volume, open interest, greek letters value, implied volatility, and historical volatility in the past 30 days, etc. [4]. Since investors cannot invest in the next round before exercising, ETF index options are retained the fourth Wednesday data of each month, and the other three index options are retained the third Friday data of each month. Since options with 0 volume and open interest have relatively low liquidity, they are deleted from our dataset [1]. In addition, when considering the return of investment strategy, this article only considers options whose absolute value of delta is either greater than 0.1 or less than 0.9, and the option implied volatility is greater than 0 and less than 0.45 [5].

### 2.2 The Rule of Transaction

The difference between ask price and bid price has a greater influence on return, but there is no authoritative public historical data recording. The alternative method is to use the average of the real-time data ask price and bid price for one month as an estimate [6]. As a result, the ask price-bid price for a contract of ETF options is 12.5 yuan, and the ask price-bid price for Hushen 300 call options is 50 yuan, and the ask price-bid price for put options is 0.2 yuan.

The Chinese option market has unique transaction cost. Firstly, the transaction cost for the Shanghai Stock Exchange and the Shenzhen Stock Exchange for purchasing stock index options is 1.3 yuan for each contract, and for the China Financial Futures Exchange to purchase stock index options is 15 yuan each contract. In addition, for the delta-hedged investment strategy in call option, short selling is required, with the transaction cost of 8% annualized (that is 0.667% per month), and the margin is 1.1 times the short-selling price.

### 3 Testing the Option Mispricing

#### 3.1 First Detection of Mispricing

The price of an option is determined by many factors. Some statistical properties of options are listed in Table 1.

Table 1 shows that both the volume and open interest are large, in other words, the options have good liquidity. Both implied volatility (IV) and the difference between implied volatility and historical volatility (IV-HV) are indicators to measure the level of option pricing. Regardless of call option or put option, the four-week IV and IV-HV are both significantly higher than the five-week IV and IV-HV, the IV of the four-week option is on average significantly higher than the IV of the five-period weight by about 5%, which preliminarily concludes that there may be mispricing in the Chinese market due to the calendar effect.

#### 3.2 Regression Based Evidence of Mispricing

To further explore the calendar effect in the Chinese options market, a linear regression with implied volatility as the dependent variable is performed. In our first regression, the only independent variable is a dummy variable that equals 1 if there is 5 weeks between two adjacent expiration dates and equals 0 if the option expires on a day that is 4 weeks

**Table 1.** Summary Statistics

	4-Week Cycle			5-Week Cycle		
	#Obs = 863			#Obs = 680		
	Mean	Median	STD	Mean	Median	STD
VOLUME	24084	3919	46707	13873	3110	30985
OPEN INTEREST	25196	8662	36567	18413	6907	29305
IV	25.415%	23.950%	12.216%	20.509%	19.590%	10.671%
IV-HV	1.446%	1.685%	8.700%	-0.358%	1.418%	10.864%
VEGA	0.209	0.181	0.163	0.239	0.222	0.168
GAMMA	1.006	0.817	0.846	1.202	0.975	1.063
	4-Week Cycle			5-Week Cycle		
	#Obs = 1128			#Obs = 563		
	Mean	Median	STD	Mean	Median	STD
VOLUME	16205	1473	35850	10798	2274	22890
OPEN INTEREST	16334	4322	24926	14393	7075	17481
IV	33.799%	28.760%	21.689%	27.146%	25.000%	12.065%
IV-HV	10.723%	7.230%	17.266%	5.208%	4.996%	9.522%
VEGA	0.228	0.209	0.149	0.265	0.251	0.159
GAMMA	0.857	0.696	0.695	1.082	0.897	0.871

after the prior expiration day. In the second regression, the first independent variable is the dummy variable defined above. In addition, the control variables include VOLUME and OPEN INTEREST. The regression coefficients and t-statistics (in parentheses) of each variable are recorded as follows.

The regression results show that the independent variables' coefficients of call option and put option are all negative, and the t-statistics is less than  $-2$ , indicating that the pricing of 4-week options is significantly higher than the pricing of 5-week options. It also indicates that the Chinese stock index option markets have a remarkable mispricing phenomenon due to the calendar effect. However, the regression coefficients of other indicators (such as HV and DELTA) indicate that the Chinese option markets still have some randomness.

### 3.3 Summary on Option Strategies

Based on the conclusions of Table 1 and Table 2, a natural thought arises that investors can use the above evidence of mispricing to obtain positive returns. In order to capture the difference in returns of simple investment strategies (straddles, delta-hedged calls, and delta-hedged puts) during 4-week or 5-week expiration cycles, daily chemical yields of the 4-week and the 5-week options are computed by dividing yields by the corresponding number of days. Using daily chemical yields aims to eliminate the influence caused by the time differences between the 4-week and the 5-week options. In addition, the options are divided into two subsamples according to the positive and negative yields. And their daily chemical yields are compared.

**Table 2.** Regression of Implied volatility

	Calls	Puts
INTERCEPT	0.279 (29.760)	0.413 (24.93)
5 WEEKS BETWEEN EXPIRATION DAYS DUMMY	<b>-0.085</b> <b>(-6.587)</b>	<b>-0.145</b> <b>(-6.384)</b>
INTERCEPT	0.194 (12.00)	0.028 (0.993)
5 WEEKS BETWEEN EXPIRATION DAYS DUMMY	<b>-0.039</b> <b>(-4.124)</b>	<b>-0.098</b> <b>(-5.929)</b>
DELTA	-0.169 (-11.22)	-0.059 (-2.090)
HV	0.666 (18.15)	-0.059 (-2.090)
VOLUME	0.027 (1.045)	-0.144 (-2.387)
OPEN INTEREST	-0.089 (-2.878)	-0.009 (-0.132)

**Table 3.** Daily chemical yield

	Straddles		DH Calls		DH Puts	
4 WEEKS BETWEEN EXPIRATION DAYS	Profit	3.648%	Profit	0.351%	Profit	0.231%
	Losses	-1.776%	Losses	-0.143%	Losses	-0.115%
5 WEEKS BETWEEN EXPIRATION DAYS	Profit	2.023%	Profit	0.252%	Profit	0.160%
	Losses	-1.447%	Losses	-0.130%	Losses	-0.094%
DIFFERENT	Profit	1.625%	Profit	0.099%	Profit	0.071%
	Losses	-0.329%	Losses	-0.013%	Losses	-0.021%

Table 3 shows that either before or after classification, the daily chemical yields of the two investment strategies have not realized the expected results that 4-week options have relatively high pricing and low returns compared with 5-week options. On the contrary, there is large randomness in the influence of pricing on daily chemical returns. In other words, the returns cannot be completely determined by pricing in Chinese stock index option markets. It is worth noting that the number of profitable options is less than half of the number of losing options in the three investment strategies. In other words, it is more likely to lose money in the Chinese stock index options market.

**3.4 Regression on Option Strategies**

To effectively demonstrate the rationality of the above conclusions, a linear regression with the daily chemical returns as the dependent variables is complemented for the overall dataset and the two subsample sets divided by positive and negative yields. The independent variable is the same as in Table 2. The control variables include VOLUME, OPEN INTEREST, and IV-HV. The regression coefficients and t-statistics are listed in Table 4.

It can be concluded that the coefficient signs of the dependent variable and control variables in the single-factor regressions and the multi-factor regressions are not fixed. In addition, the t-statistics show that the mispricing caused by the calendar effect does not have a significant influence on the daily chemical yield. Therefore, the relationship between the returns of the Chinese stock index option markets and pricing is uncertain. Furthermore, though the mispricing does exist, it cannot guide investors to obtain positive returns with simple options strategies, which is different from the U.S. market.

Goyal and Saretto (2009) found that a zero-cost trading strategy that is long (short) in the portfolio with a large positive (negative) difference between historical realized volatility and at-the-money implied volatility measures produces an economically and statistically significant average monthly return [8]. In the above-mentioned multi-factor regression, the coefficient signs of IV-HV are relatively fixed, and the significance level is high. There is a simple intuition that the IV-HV factor has a good guiding significance for simple investment strategies in the Chinese market.

**Table 4.** Regression of Daily chemical yield

Profit			
	Straddles	DH Calls	DH Puts
INTERCEPT	0.037 (-14.330)	0.004 (-6.310)	0.002 (-9.401)
5 WEEKS BETWEEN EXPIRATION DAYS DUMMY	<b>-0.016</b> <b>(-4.636)</b>	<b>-0.001</b> <b>(-1.149)</b>	<b>-0.001</b> <b>(-1.892)</b>
INTERCEPT	0.036 (-13.100)	0.004 (-7.045)	0.002 (-8.318)
5 WEEKS BETWEEN EXPIRATION DAYS DUMMY	<b>-0.017</b> <b>(-4.313)</b>	<b>0.000</b> <b>(-0.550)</b>	<b>-0.001</b> <b>(-2.571)</b>
VOLUME	0.002 (-0.238)	-0.001 (-0.807)	-0.002 (-2.898)
OPEN INTEREST	-0.001 (-0.048)	-0.001 (-0.649)	0.003 (-2.942)
IV-HV	-0.016 (-0.608)	0.008 (-1.619)	-0.004 (-1.893)
Losses			
	Straddles	DH Calls	DH Puts
INTERCEPT	-0.018 (-20.860)	0.000 (-1.828)	-0.001 (-18.450)
5 WEEKS BETWEEN EXPIRATION DAYS DUMMY	<b>0.003</b> <b>(-3.217)</b>	<b>-0.001</b> <b>(-19.780)</b>	<b>0.000</b> <b>(-2.370)</b>
INTERCEPT	-0.018 (-18.200)	-0.001 (-16.730)	-0.001 (-14.300)
5 WEEKS BETWEEN EXPIRATION DAYS DUMMY	<b>0.003</b> <b>(-3.217)</b>	<b>0.000</b> <b>(-1.471)</b>	<b>0.000</b> <b>(-2.625)</b>
VOLUME	-0.006 (-2.489)	0.000 (-2.450)	0.000 (-0.777)
OPEN INTEREST	0.006 (-1.579)	0.001 (-3.171)	0.000 (-0.808)
IV-HV	0.007 (-0.847)	-0.002 (-3.272)	0.002 (-2.334)

## 4 Finding the Guidance Factor

### 4.1 Comparison on the Volatility

In order to verify the above idea, this section divides different investment strategies into two subsamples according to the signs of daily chemical yields and compares the average level of IV-HV. The results are shown as follows.

Through Table 5, it illustrates that the difference between the implied volatility and historical volatility of each part of the profitable option is higher than that of the losing option. Therefore, IV-HV may be an effective indicator to guide option selection. In other words, investors are more likely to achieve higher returns when IV-HV is lower.

**4.2 Regression on the IV-HV**

To further verify the influence of IV-HV on daily chemical returns, a linear regression is implemented. The independent variable is IV-HV. The control variables include DELTA, VOLUME, and OPEN INTEREST. To exclude the possible impact of option money-ness, the dataset is divided into three subsamples according to DELTA. The regression coefficients and t-statistics are shown in Table 6.

The regression results show that the regression coefficients of IV-HV are negative, and the absolute values of t-statistics are large, which means the significance level is high. It further indicates that the option with the lower level of IV-HV gains higher daily chemical returns under the investment strategy of straddle and delta-hedged portfolios. It is concluded that IV-HV can be an effective indicator to guide investors to obtain higher returns even though through simple strategies.

**Table 5.** The Difference of IV-HV between Profit and Loss

	Straddles		DH Calls		DH Puts	
4 WEEKS BETWEEN EXPIRATION DAYS	Profit	0.720%	Profit	-0.923%	Profit	4.820%
	Losses	2.736%	Losses	0.916%	Losses	5.889%
5 WEEKS BETWEEN EXPIRATION DAYS	Profit	-2.280%	Profit	-7.407%	Profit	1.858%
	Losses	1.612%	Losses	0.883%	Losses	3.977%
DIFFERENT	4 week	-2.016%	4 week	-1.839%	4 week	-1.069%
	5 week	-3.892%	5 week	-8.290%	5 week	-2.120%

**Table 6.** Regression of Daily chemical yield (IV-HV)

	Straddles	DH Calls	DH Puts
INTERCEPT	0.089 (-3.797)	0.000 (-3.134)	0.000 (-3.674)
IV-HV	<b>-0.522</b> <b>(-1.679)</b>	<b>-0.005</b> <b>(-3.244)</b>	<b>-0.003</b> <b>(-2.751)</b>
INTERCEPT	0.134 (-1.748)	0.001 (-1.759)	0.000 (-1.763)
IV-HV	<b>-0.549</b> <b>(-1.748)</b>	<b>-0.005</b> <b>(-3.320)</b>	<b>-0.003</b> <b>(-2.495)</b>

(continued)

**Table 6.** (continued)

	Straddles	DH Calls	DH Puts
DELTA	–	–0.001 (–2.874)	0.000 (–0.609)
VOLUME	0.768 (–0.654)	0.002 (–0.419)	–0.009 (–2.067)
OPEN INTEREST	–3.300 (–1.832)	0.000 (–1.629)	0.000 (–2.090)
	DH Calls [0.1, 0.35)	DH Calls [0.35, 0.65)	DH Calls [0.65, 0.9]
INTERCEPT	0.000 (–0.101)	0.000 (–3.470)	–0.001 (–7.250)
IV-HV	<b>–0.008</b> <b>(–2.053)</b>	<b>–0.004</b> <b>(–2.468)</b>	<b>–0.004</b> <b>(–3.210)</b>
INTERCEPT	0.001 (–0.633)	–0.001 (–0.781)	0.000 (–0.077)
IV-HV	<b>–0.008</b> <b>(–1.945)</b>	<b>–0.004</b> <b>(–2.395)</b>	<b>–0.004</b> <b>(–3.154)</b>
DELTA	–0.001 (–0.301)	0.001 (0.446)	–0.001 (–0.736)
VOLUME	0.007 (–0.597)	–0.003 (–0.705)	–0.002 (–0.315)
OPEN INTEREST	–0.017 (–1.255)	–0.002 (–0.219)	0.002 (–0.165)
	DH Puts [–0.9, –0.65)	DH Puts [–0.65, –0.35)	DH Puts [–0.35, –0.1]
INTERCEPT	0.000 (–2.272)	0.000 (–0.937)	0.001 (–2.966)
IV-HV	<b>–0.001</b> <b>(–1.487)</b>	<b>–0.006</b> <b>(–2.693)</b>	<b>–0.004</b> <b>(–1.370)</b>
INTERCEPT	–0.002 (–2.114)	0.000 (–0.531)	0.000 (–0.381)
IV-HV	<b>–0.001</b> <b>(–1.392)</b>	<b>–0.006</b> <b>(–2.691)</b>	<b>–0.005</b> <b>(–1.557)</b>
DELTA	0.002 (–2.263)	–0.001 (–0.447)	0.002 (–0.530)
VOLUME	0.002 (–0.318)	–0.004 (–0.583)	–0.022 (–1.908)
OPEN INTEREST	0.010 (–1.046)	0.008 (–0.655)	0.023 (–1.768)

## 5 Conclusion

This article verifies that the Chinese option market has a mispricing phenomenon caused by the calendar effect. The result manifests that besides the calendar effect, the underlying stock index volatility in the Chinese market has also performed a large impact on option returns. Investors cannot easily obtain a positive return using simple strategies by calculating the return of simple option strategies such as the straddle and delta-hedged. Meanwhile, this article finds that investors can combine the two volatility factors: the market volatility and historical volatility to invest. In other words, investors can choose options that just have a slight difference between implied volatility and historical volatility. Its economic significance can be easily seen from our results. In addition, the difference between implied volatility and historical volatility can be used as an effective evaluation factor for options in the Chinese market.

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