

# Intraday Trading Patterns in the SSE 50 ETF Option

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**Abstract:** The purpose of this article is to explore the Shanghai Stock Exchange (SSE) 50 ETF Option's intraday trading patterns which include return and volatility. We get the SSE 50 ETF option's intraday trading patterns by charts, descriptive statistics and Wilcoxon rank sum test. We find that the call option's return has no obvious intraday pattern and the put option's return roughly follows an LM-shaped pattern; The call option's volatility roughly follows an L-shaped pattern and the put option's volatility roughly follows an LM-shaped pattern.

**Keywords:** the SSE 50 ETF Option, intraday trading patterns, return, volatility.

## 1. Introduction

To explain the intraday patterns in financial market, scholars have developed several micro-structure theories. With the development of electronic trading systems, the availability of high frequency data is greatly improved. Presently, it is hot to research the market microstructure by using high-frequency data.

## 2. Literature Review

The 50 ETF Option was launched on February 9, 2015 and is traded on Shanghai Stock Exchange. The 50 ETF Option whether has intraday trading patterns, what the intraday trading patterns are and what factors cause the intraday trading patterns are interesting problems that need to be solved urgently.

Various studies have researched the intraday trading patterns in different market. Peterson (1990) examines the return intraday patterns in call options and put options traded on the Chicago Board Options Exchange (CBOE). He find that call options have relatively high returns late in the trading day and put options have low returns late in the trading day. Sheikh and Ronn (1994) reveal an intraday U-shaped pattern in the variances of adjusted option returns in CBOE. Tian and Guo (2007) find an L-shaped intraday return volatility pattern in the Shanghai Composite Stock Index. Gordon and Karen (2010) examine The Tracker Fund of Hong Kong's intraday premiums patterns and they find the pattern of the measures (range, SD and number of transactions of the Tracker Fund of Hong Kong premiums) follows either a double-U shape or an asymmetric W-shape across the time interval of a day. Li et.al. (2012) find a U-shaped and an L-shaped intraday pattern for trading volume and return volatility in benchmark ETFs, leveraged ETFs, and leveraged inverse ETFs. Mishra and Daigler (2014) find the intraday trading patterns for two closely related index options-SPX and SPY are quite different, and they find trading measures, including returns, volume, bid-ask spreads, and volatility of SPY options show the U-shaped pattern, whereas SPX not.

Most previous researches reveal that the returns, volatility, and other microstructure variables have U-shaped intraday pattern. The SSE 50 ETF Option as China's first stock option was launched on 9 February and there is no research studying the intraday pattern of the SSE 50 ETF Option so far. This article will reveal the SSE 50 ETF Option's intraday trading patterns including the returns, and

the volatility to fill the blanks as well as to provide a reference for investment decision-making and market regulations.

### 3. Sample and Methods

In this study, the sample is during 9 February, 2015 to 22 May, 2015 and the data is got from Shanghai Stock Exchange. The trading time in a day is from 9:30 to 11:30 and from 13:00 to 15:00. This article divides the trading time into sixteen successive 15-minute intervals. Using 15-minute intervals rather than 1-minute intervals or others is concerning that the new option's trading is not that active and this time interval allows us to obtain estimates of variables even for less actively trades options without much loss of data synchronicity. Besides, we roll over to the next nearest contract when it emerges as the most active contract to avoid thin markets and expiration effects.

Compound interest is used to calculate returns and the formula is as follows:

$$r_t = \ln(P_t/P_{t-1}) \tag{1}$$

Where  $P_t$  is the close price in time period  $t$ ;  $P_{t-1}$  is the close price in time period  $t-1$ .

In order to contain more information, we use Garman-Klass (GK) statistic to measure volatility as Booth and Raymond do. The calculation method of GK is as formula (2):

$$GK_t = 1/2(P_t^{High} - P_t^{Low}) - (2\ln 2 - 1)(P_t^{Close} - P_t^{Open})^2 \tag{2}$$

Where  $P_t^{High}$  is the natural logarithms of the highest price in time period  $t$ ;  $P_t^{Low}$  is the natural logarithms of the lowest price in time period  $t$ ;  $P_t^{Close}$  is the natural logarithms of the close price in time period  $t$ ;  $P_t^{Open}$  is the natural logarithms of the open price in time period  $t$ . The volume and the open interest can be get from the original data.

### 4. Results and Discussion

Fig.1 demonstrates the intraday pattern in returns of the SSE 50 ETF options for 15-minutes intervals in a trading day.

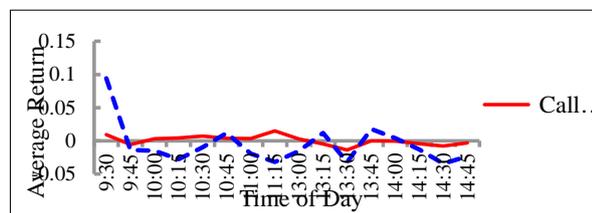


Fig.1 The average rate of return for each 15-minutes intervals of the trading day

From the graphs, we can get that the average rate of return of the put options is more volatile than the call options. The return of put options is high at the open time and then it declines at 9:45-10:00. At the following time, it fluctuates below zero at most time. The return of call options fluctuates around zero in a small amplitude. Subsequent test is pending to check whether the phenomenon is general or it is affected by certain extreme data. Table 1 reports the descriptive statistics and the rank tests of returns of the SSE 50 ETF call and put options for each fifteen-minute interval in a trading day.

Table 1 Return of the options

Time	The SSE 50 ETF Call Option						The SSE 50 ETF Put Option					
	Mean	Median	JB	P(JB)	Rank-sum	P(R-S)	Mean	Median	JB	P(JB)	Rank-sum	P(R-S)
9:30	0.010	0.026	12.8	0.00	1.12	0.26	0.094	-0.025	8272.8	0.00	-0.16	0.88
9:45	-0.006	-0.022	286.1	0.00	-1.42	0.16	-0.014	0.004	166.4	0.00	1.58	0.11
10:00	0.003	-0.002	3.1	0.22	0.00	1.00	-0.015	-0.011	401.1	0.00	0.00	1.00
10:15	0.004	0.009	55.0	0.00	0.78	0.44	-0.028	-0.002	456.7	0.00	0.71	0.48
10:30	0.007	0.007	20.7	0.00	0.73	0.47	-0.010	-0.013	0.6	0.74	0.34	0.73
10:45	0.004	-0.004	1.2	0.54	-	-	0.012	0.000	1908.9	0.00	1.16	0.25
11:00	0.004	0.007	0.6	0.75	-	-	-0.019	-0.015	543.6	0.00	0.26	0.80
11:15	0.015	0.004	8.3	0.02	0.79	0.43	-0.032	-0.019	330.3	0.00	-0.26	0.80
13:00	0.003	0.003	129.3	0.00	-0.09	0.93	-0.015	-0.001	142.4	0.00	0.47	0.64
13:15	-0.005	0.001	2.3	0.32	-	-	0.012	0.005	46.0	0.00	2.18	0.03
13:30	-0.014	-0.015	26.4	0.00	-1.61	0.11	-0.032	0.001	4905.9	0.00	1.09	0.28
13:45	0.000	-0.004	53.0	0.00	-0.38	0.71	0.018	0.000	3999.6	0.00	1.66	0.10
14:00	0.000	-0.003	78.1	0.00	-0.39	0.70	0.004	0.000	8.4	0.02	1.51	0.13
14:15	-0.004	0.006	11.4	0.00	0.06	0.95	-0.013	-0.014	390.6	0.00	0.47	0.64
14:30	-0.008	-0.005	334.7	0.00	-0.50	0.62	-0.034	-0.001	3301.4	0.00	0.97	0.33
14:45	-0.003	0.000	30.4	0.00	-0.39	0.70	-0.023	-0.007	867.2	0.00	0.54	0.59

Since the probability of JB in time 10:00-11:15 and 13:15-13:30 for call option is bigger than 0.1, returns in these time intervals follow a normal distribution. Wilcoxon rank-sum test is not proper to test the difference between time 10:00-10:15 and other time interval. T test is then used to test the difference between 10:00-10:15 and the other three time intervals and the result is as table 2.

Table 2 Test for some call time intervals

Time	T Test		
10:45	Ha: mean(diff) < 0 Pr(T < t) = 0.4727	Ha: mean(diff) != 0 Pr( T  >  t ) = 0.9454	Ha: mean(diff) > 0 Pr(T > t) = 0.5273
11:00	Ha: mean(diff) < 0 Pr(T < t) = 0.4859	Ha: mean(diff) != 0 Pr( T  >  t ) = 0.9717	Ha: mean(diff) > 0 Pr(T > t) = 0.5141
13:15	Ha: mean(diff) < 0 Pr(T < t) = 0.7213	Ha: mean(diff) != 0 Pr( T  >  t ) = 0.5575	Ha: mean(diff) > 0 Pr(T > t) = 0.2787

From the Jarque-Bera statistics, we can get that the call option's intraday returns follow a non-normal distribution in most time intervals. From Wilcoxon rank-sum test and the T test, we can get that all  $p > 0.1$ . This shows that there is no significant difference between 10:00-10:15 and other time interval. Combined with Figure 1 and the statistical data, we can get that the call option's return has a slight fluctuation around zero. The return of the call option's intraday pattern is not obvious. Table 1 also shows that put returns in most time intervals except 10:30-10:45 follow a non-normal distribution. Then non-parametric test is suitable to test the difference between 10:00-10:15 and other time intervals. From the Wilcoxon rank-sum test, we can get that in time 9:45-10:00, 13:15-13:30 and 13:45-14:00, the return have significant difference with in time 10:00-10:15. Combined with the statistical data and Figure 1, we can see that in time 9:45-10:00, 13:15-13:30 and 13:45-14:00, the return is all higher than in time 10:00-10:15. The put option's return roughly follows an LM-shaped pattern. At the opening time in the morning, much overnight information is absorbed by the market and the market trading is active. The return is relatively high at the opening time in the morning. At the opening time in the afternoon, the investors take a wait-and-see attitude, so the trade is not that active which induces the return is unrealistically high.

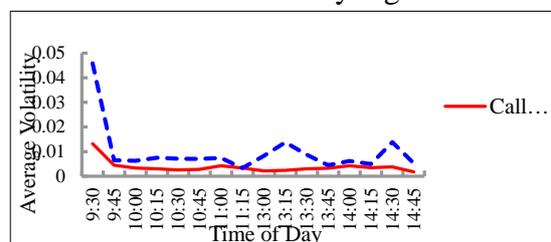


Fig.2 The average volatility for each 15-minutes intervals of the trading day

Fig.2 demonstrates the intraday pattern in GK volatility of the SSE 50 ETF options for fifteen-minute intervals in a trading day. From the graphs, we can get that the call and put options both have a high volatility at the opening time in the morning. The call option's volatility is relatively stable compared with the put option. Subsequent test is pending to check whether the phenomenon is general or it is affected by certain extreme data.

**Table 3 Volatility of the options**

Time	The SSE 50 ETF Call Option						The SSE 50 ETF Put Option					
	Mean	Median	JB	P(JB)	Rank-sum	P(R-S)	Mean	Median	JB	P(JB)	Rank-sum	P(R-S)
9:30	0.013	0.005	861.7	0.000	4.51	0.000	0.046	0.005	11411.5	0.000	3.18	0.002
9:45	0.005	0.002	9597.2	0.000	0.40	0.069	0.007	0.002	1692.5	0.000	0.41	0.679
10:00	0.003	0.001	3179.4	0.000	0.00	1.000	0.006	0.002	975.6	0.000	0.00	1.000
10:15	0.003	0.001	1631.5	0.000	-0.87	0.384	0.008	0.001	1163.0	0.000	-1.15	0.250
10:30	0.003	0.001	125.3	0.000	-1.19	0.235	0.007	0.001	7260.9	0.000	-1.87	0.061
10:45	0.003	0.001	136.7	0.000	-0.13	0.898	0.007	0.002	1326.9	0.000	-0.22	0.829
11:00	0.004	0.002	1330.2	0.000	0.59	0.557	0.007	0.002	1838.5	0.000	-0.14	0.891
11:15	0.003	0.002	298.1	0.000	0.96	0.336	0.003	0.002	254.4	0.000	-0.08	0.934
13:00	0.002	0.001	830.7	0.000	-1.55	0.122	0.008	0.001	7295.4	0.000	-2.18	0.030
13:15	0.002	0.001	1173.9	0.000	-1.08	0.279	0.014	0.001	10575.5	0.000	-1.26	0.207
13:30	0.003	0.001	386.9	0.000	-0.99	0.321	0.009	0.001	2547.5	0.000	-0.86	0.392
13:45	0.003	0.001	4589.6	0.000	-0.53	0.598	0.004	0.001	4210.2	0.000	-1.17	0.242
14:00	0.004	0.002	4165.4	0.000	0.57	0.570	0.006	0.002	4875.1	0.000	-0.24	0.807
14:15	0.003	0.001	285.1	0.000	-0.75	0.452	0.005	0.001	718.5	0.000	-1.26	0.210
14:30	0.004	0.002	449.3	0.000	0.93	0.354	0.014	0.001	6149.8	0.000	-1.03	0.301
14:45	0.002	0.001	170.9	0.000	-1.98	0.048	0.005	0.001	1342.2	0.000	-1.84	0.067

Table 3 reports the statistics as well as the Wilcoxon rank-sum test of the volatility for call and put options. From the rank-sum test in table 4, we can get the volatility of call option in time 9:30-10:00 is quite different from time 10:00-10:15. Combined with the statistics, we find the volatility in 9:30-10:00 is large than 10:00-10:15. By the same method, we find the volatility in time 14:45-15:00 is slightly smaller than in time 10:00-10:15. The volatility of the call option roughly follows an L-shaped pattern. From the Wilcoxon rank-sum test in table 5, we can get that the volatility of the put option in time 9:30-9:45, 10:30-10:45, 13:00-13:15 and 14:45-15:00 is quite different from 10:00-10:15. Combined with the mean and median statistics, we find the volatility in 9:30-9:45, 10:30-10:45, 13:00-13:15 is larger than 10:00-10:15. The volatility in 14:45-15:00 is smaller than in time 10:00-10:15. The volatility of the put option roughly follows an LM-shaped pattern. At the opening time in the morning, much overnight information is absorbed by the market and the market trading is active. The volatility of call and put options are both large in this time. At the closing time, investors adjust their positions to avoid overnight risk that reduces the market volatility.

## 5. Conclusions

This paper examines the SSE 50 ETF Option's intraday trading patterns in return and volatility. Rather than U-shaped trading pattern as other markets', the SSE 50 ETF Option presents different intraday patterns. The return of the call option's intraday pattern is not obvious and the return of the put option roughly follows an LM-shaped pattern. The volatility of the call option roughly follows an L-shaped pattern and the volatility of the put option roughly follows an LM-shaped pattern. The volatility in the morning opening time is significantly higher than in other periods, which indicates that investors likely take the trading point and facilitate trading cluster. Investors can use the above intraday patterns to guide their investment decisions and regulators can use the above intraday patterns to monitor the market more effectively.

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## References

- [1] Peterson D R. a transaction data study of day-of-the-week and intraday patterns in option returns [J]. *Journal of Financial Research*, 1990, 13(2):117-131.
- [2] Sheikh A M, Ronn E I. A Characterization of the Daily and Intraday Behavior of Returns on Options [J]. *The Journal of Finance*, 1994, 49(2):557-579.
- [3] Tian G G, Guo M. Interday and intraday volatility: Additional evidence from the Shanghai Stock Exchange [J]. *Review of Quantitative Finance and Accounting*, 2007, 28(3):287-306.

- [4] Gordon Y. N. Tang, Karen H. Y. Wong. A note on the intraday and intraweek patterns in premiums of exchange-traded funds: evidence from Hong Kong [J]. *Applied Economics Letters*, 2010, 17(8):753-760.
- [5] Li M, Klein D P, Zhao X. Empirical Analysis of ETF Intraday Trading [J]. *Financial Services Review*, 2012, 21.
- [6] Mishra S, Daigler R T. Intraday Trading and Bid–Ask Spread Characteristics for SPX and SPY Options [J]. *Journal of Derivatives*, 2014, 21(21):70-84.