OPEN INTEREST AND EQUITY ABNORMAL RETURN ON EXPIRATION DATES

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Abstract

This paper focuses on the possible existence of a pricing inefficiency in stocks that have traded options. The idea is that because option writers are more sophisticated than option buyers, they may influence the underlying stock price in their desired direction. Since option writers are mainly financial institutions, they are able to open large positions in both the options and underlying stocks, and as such, have the ability and incentive to affect stock prices through transactions to benefit their short option position. Through our analysis, we find that options with a larger amount of net call-side open interest on the last trading day before expiration is negatively related to the underlying stock price change on that day. This result is consistent with the idea that the option writers have the capacity to move prices in their desired directions on the last trading day before expiration.

Keywords: open interest; option; expiration date; stock return

Executive Summary

Ever since options were introduced for the first time in the Chicago Board Options Exchange (CBOE) in 1973, there has been significant growth in option trading as well as researchers' interest whether option trading would impact the price of the underlying asset. Much existing literature examines the effect of option introduction on price and volatility of underlying stocks. However, these studies do not explain which kind of options might have the most significant influence on the return of underlying stocks on expiration dates and do not consider the possibility that sophisticated option writers might push the price of underlying stocks to benefit their option position.

Our paper focuses on the impact of option positions on the underlying stocks on the expiration dates to examine the possible existence of market inefficiency in stock market caused by option writers. We use empirical analysis to investigate the relationship between net (defined as calls minus puts) open interest of options with different moneyness on equity return on the expiration dates. We find that the net open interest of options has significant impact on the return of underlying stock on expiration dates, which can be explained by the incentive of option writers. The results are especially significant for net open interest of in-the-money option writers, since the underlying stock price of these options provide the largest incentives for writers to move prices.

Dedication

This thesis is dedicated to our beloved families and friends who always inspire the courage in us to embrace life.

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1. Introduction

Four decades have passed since options were initially introduced for the first time in Chicago Board Options Exchange (CBOE) in 1973. The introduction of options facilitates investors to use various strategies for hedging and income enhancement through option trading. After 45 years of high growth in option market, the daily volume of option trading has reached $20 million by November, 2018. As option trading volume increases, the interaction between option market and underlying assets arouses interests of many researchers.

The expiration date of the options is a focus of this paper. A standardized equity option contract represents 100 shares of the underlying security. These options are typically "physical delivery" options, meaning that there is a delivery of the underlying stock to or from the writer of the contract if the option is exercised. Options can be exercised at any time prior to the exercise deadline set by the investor's brokerage firm. Generally, this deadline occurs on the option's last day of trading. Before February 15, 2015, the expiration date for equity option was the Saturday immediately following the third Friday of the expiration month. Since February 15, 2015, the expiration date is the third Friday of the expiration month. If this third Friday happens to be an exchange holiday, then the expiration day is the day prior, i.e., the third Thursday of the month. The settlement of options will result in a delivery of the underlying stock on the second business day following the exercise date.

The option expiration date has long been a day with vibrant stock trading activities. Empirical evidence documents an enormous increase in stock trading volume on option expiration dates (Chin-Han, 2012) and finds that the closing price of optioned stocks tends to cluster at the option strike price on expiration dates (Ni, Pearson, and Poteshman, 2005). Therefore, it is reasonable to consider the possibility of a pricing inefficiency in which sophisticated option writers influence underlying stocks prices to benefit their option positions.

In this paper, we investigate how net open interest of options, defined as the number of call option contract minus put option contracts (and especially net open interest of in the money options) impacts the return of underlying stocks on expiration dates. Moreover, to differentiate the impact, we divide the options into various groups according to their moneyness (in-the-money, near-the-money, near-in-the-money, near-out-of-money).

The rest of the paper is organized as follows: In section 2, we review some related literatures. In Section 3, we describe our methodology and hypothesis. Section 4 illustrates our selection of data. An empirical analysis is presented in Section 5. Section 6 is the conclusion.

2. Literature Review

Ever since the establishment of derivatives markets four decades ago, there have been many discussions about the relationship between derivatives market and the underlying asset market. To investigate the relationship, existing studies typically focus on the impact of option on the underlying asset pricing attributes.

The first set of studies that focus on the impact of option trading on underlying stocks examines whether option introduction generates a one-time change in the underlying assets' price. Conrad (1989) analyzes whether the introduction of individual options would cause a permanent price increase in the underlying stocks and whether a decline in volatility of excess return can be observed, as expected by some theoretical models. Detemple and Jorion (1990) find that when new options are listed, the value of the market around the listing date of new options and the value of the industry index which excludes the optioned stock will increase. These findings, however, were reexamined by others and were not robust. Later on, Ho and Liu (1997) discover a significant reversal in price movement around the day when new options are introduced. Specifically, a series of negative excess return is observed during the two-day period prior to the introduction of the options. Sorescu (2002) finds that the positive abnormal return for optioned stocks only existed during the 1973 to 1980 period but disappeared and became negative in later years. Mayhew and Mihov (2004) observe a low volume of newly-listed options and find that there was no significant relation between signed option volume and abnormal stock returns around option listing days when comparing with the price changes of matched firms that do not have options being introduced.

The second kind of researches analyze whether there are systematic changes caused by option activities on or around the expiration date. Klemkosky (1978) examine weekly returns before and after expiration date and observed negative returns on underlying stocks in the week leading up to expiration dates, and positive returns in the week after expiration. However, Cinar and Yu (1987) review data of 6 blue-chips stocks and find that there is no significant difference between average return and volatility of options stocks on expiration Friday and non-expiration Friday. Later, Ni, Pearson, and Poteshman (2005) find that the closing price of optioned stocks seems to cluster at the option strike price on expiration dates, and returns are altered by at least 16.5 basis points on average.

Most related to this paper, Chin-Han (2012) provides evidence that stocks with a sufficiently large amount of deeply in-the-money call options would experience a significant return drop of 0.8 percentage point on option expiration dates and then have a short-term reversal of price movement. He attributes the negative return to the selling pressure from call option buyers who exercise deeply in-the-money calls and sell the acquired stocks immediately on expiration dates. However, he does not provide evidence that the negative return was caused by the moneyness of options. In addition, although equity options are physically delivered, the delivery of the underlying stock happens on the second business day following exercise. That means call option buyers will not receive the underlying stocks immediately after exercising. Therefore, his observation and explanation still need to be investigated.

The final set of studies about the impact of individual equity option on underlying stock price movement do not consider the expiration date as an important variable. Bansal, Pruitt, and Wei (1989) and Skinner (1989) conclude that there is a decrease in the total (but not systematic) risk of optioned firms led by option listing. However, Freund, McCann, and Webb (1994) argue that options do not affect the underlying stocks' volatility. Although there is some impact of options on the residual variance of underlying stocks' return, that is significant only for the time when options were initially introduced. Bollen (1998) discovers that the decrease in volatility caused by option introduction is actually observed in samples of matched control firms that do not have options introductions. Thus, the decrease of volatility is not caused by options. Later, Kraus and Rubin (2003) evaluate the effect of short sale constraint removal on a stock market. Their empirical analysis shows that volatility increased following the initiation of index options, consistent with the fact that short sales were prohibited in Israel when index options were introduced.

Overall, there is little evidence that option trading has a significant impact on underlying prices. The only compelling evidence is that the stock price is affected around the expiration date or at the time when options are introduced for the first time (e.g., Kraus and Rubin, 2003). However, the existing literature does not explain which kind of options might have the most significant influence on the return of underlying stocks on expiration dates. Therefore, to further analyze the impact of option expiration on underlying stocks, we study the relationship between the option writers and underlying stock returns. In this paper, we use net Call-Put open interest to quantify impact of option writers of various moneyness on underlying stocks' returns. The objective is to analyze the possibility of a pricing inefficiency due to the sophistication of option writers. Here, we make a hypothesis that option writers are more sophisticated than option buyers because option writers are usually institutional investors who tend to utilize more complex trading strategies that typical long investors do not. Moreover, institutional option writers possess large amount of funds and are able to open large positions in both the option and the underlying stock. If this hypothesis is true, option writers are incentivized to influence the underlying stock price for their benefit on expiration dates to avoid delivery of assets to option buyers and sacrificing the option premium.

3. Methodology

3.1 Hypothesis

We want to test whether the option writers have more impact than option buyers on the price of underlying stocks on the last trading day before expiration[1] regardless of their various option trading strategies (hedged or naked option positions).

According to CBOE, exchange traded equity options require “physical delivery” of underlying stocks. That says, if option writers are more sophisticated than option buyers, they would tend to push the underlying stock price so that they can collect the option premium without losing money in delivering the underlying stock at strike price.

If this assumption holds, then on the last trading day before expiration, the writers of options with more open interests would have more impact on the underlying stock price. For instance, if there are more open interest in call options than put options, the return on the last trading day before expiration should be negative because call option writers want to push down the underlying stock price so that call option buyers would not be able to exercise the call on the last available day. This effect should be even more significant for near-the-money options since there are strong incentives for call option writers to push the underlying asset price down to avoid the option being exercised. The predictions concerning put options, is opposite. Put option writers would want to push the price upwards so that put options will not be in the money. Therefore, the net Call-Put open

[1] Before February 15, 2015, the expiration date for equity options is the Saturday following the third Friday of each month. On and after February 15, 2015, the expiration date for equity options is the third Friday of each month. Thus, the last trading day before expiration is usually the third Friday except for the holidays that fall on these Fridays. Since stocks are not traded on Saturdays or holidays, we observe the price movement of underlying stocks on the last trading day (LTD) before the expiration time.

interest level is a proxy for the desire of sophisticated investors to push the underlying price downwards.

Figure 1. Illustration of Option Writers' Incentive to Move Underlying Stock Price

Call Option Writers	Put Option Writers
Incentive to push down the underlying stock price away from the strike price	Incentive to push up the underlying stock price away from the strike price

3.2 Net Open Interest of Options

We compare the stock price on the day before the last trading day before expiration (T_{LTD} - 1) with the option strike price and determine whether the option is in the money or near the money. According to our hypothesis, the moneyness of options on this day will affect the trading strategy of option writers on the following day, which is the last trading day before expiration (T_{LTD}).

Figure 1. Data Processing on the Two Critical Trading Days

T_{LTD} - 1	T_{LTD}
Compare the options' underlying closing stock price with strike price to determine the moneyness of the options	Observe the underlying stock return on this day

All of the options during the sample period (2007-2017) are divided into 4 different groups based on their moneyness on the last trading day before expiration (T_{LTD} - 1): total options, near-the-money (NTM) options, near-in-the-money (NIM) options and near-out-of-money (NOM) options.

Table 1. Option Group Classification

The number of near-the-money (NTM) calls/puts should equal to the sum of near-in-the-money (NIM) options and near-out-of-money (NOM) options

Option Group	Definition of Moneyness
Total Call (Put)	Total call (put) of an underlying stock on $(T_{LTD} - 1)$
NTM call (put)	$\frac{\lvert \text{The options whose underlying closing price on } (T_{LTD} - 1) - \text{strike price} \rvert}{\text{Underlying closing price on } (T_{LTD} - 1)} <$ 5%
NIM call (put)	$\frac{\text{The calls (puts) whose underlying closing price on } (T_{LTD} - 1) - \text{strike price}}{\text{Underlying closing price on } (T_{LTD} - 1)} <$ (-)5%
NOM call (put)	$\frac{\text{Strike price} - \text{the calls (puts) whose underlying closing price on (TLTD - 1)}}{\text{Underlying closing price on } (T_{LTD} - 1)} <$ (-)5%

Based on these groups, we further add up all the open interest (OI) amount of an underlying stock on an T_{LTD} for either call or put in each group. We then have 8 variables: sum of open interest for call (put), open interest for NTM call (put), open interest for NIM call (put) and open interest for NOM call (put). Since we want to test whether option writers have more influence on the underlying stock price than option buyers, we need to take the difference of call open interest and put open interest to obtain the "net power" of option writers on $T_{LTD.}$ For example, more open interest of call than that of put on T_{LTD} implies that call option writers have a larger incentive to influence stock prices, and a downward trend in stock price is expected to occur on T_{LTD}.

In addition, because the amount of trading in any option highly depends on the volume or size of the underlying asset, we need to standardize our proxies. We divide the difference of open interest amount (call - put) by 100 times the trading volume of underlying stock on T_{LTD} since one option represents 100 shares of underlying stock:

$$\text{Net Total OI} = \frac{\text{Sum of OI for call} - \text{Sum of OI for put}}{\text{Trading Volume of underlying stock on } T_{LTD} \times 100} \text{ (a)}$$

$$\text{Net NTM OI} = \frac{\text{OI of NTM call} - \text{OI of NTM put}}{\text{Trading Volume of underlying stock on } T_{LTD} \times 100} \text{ (b)}$$

$$\text{Net NIM OI} = \frac{\text{OI of NIM call} - \text{OI of NIM put}}{\text{Trading Volume of underlying stock on } T_{LTD} \times 100} \text{ (c)}$$

$$\text{Net NOM OI} = \frac{\text{OI of NOM call} - \text{OI of NOM put}}{\text{Trading Volume of underlying stock on } T_{LTD} \times 100} \text{ (d)}$$

Descriptive statistics of net open interest data are shown in Table 3 in appendix.

3.3 Stock Return Measurement on the Last Trading Day before Expiration

To measure stock returns on the last trading day before expiration, we run the Capital Asset Pricing Model (CAPM) regression for each firm, effectively obtaining ten different β and α for each of the firms during each of the years in our sample period (2007-2017). We then calculate the abnormal returns and excess returns for each firm on the last trading day before expiration:

$$\text{Abnormal Return}_j = \text{Stock Return}_j - \beta_i \times \left(\text{Market Return}_j - \text{R}_{\text{f}_j} \right) - \text{R}_{\text{f}_j} - \alpha_i \quad (1)$$

$$\text{Excess Return}_j = \text{Stock Return}_j - \text{R}_{\text{f}_j} \quad (2)$$

(i: 2007-2017;

j: the last trading day before expiration;

R_f: 3-month risk-free return measured on daily basis)

3.4 Regressions of Open Interest and Stock Return on Expiration Date

We then run regressions for each open interest group to test the relationship between raw return/abnormal return/excess return on the expiration date and our proxy for net open interest (call – put) open interest associated with the type of option (Total, NTM, NIM, NOM):

$$\text{Raw Return} = \beta_{R,T} \times \text{Net Total OI} + \varepsilon_{R,T} \quad (3)$$

$$\text{Raw Return} = \beta_{R,N} \times \text{Net NTM OI} + \varepsilon_{R,N} \quad (4)$$

$$\text{Raw Return} = \beta_{R,I} \times \text{Net NIM OI} + \varepsilon_{R,I} \quad (5)$$

$$\text{Raw Return} = \beta_{R,O} \times \text{Net NOM OI} + \varepsilon_{R,O} \quad (6)$$

$$\text{Excess Return} = \beta_{E,T} \times \text{Net Total OI} + \varepsilon_{E,T} \quad (7)$$

$$\text{Excess Return} = \beta_{E,N} \times \text{Net NTM OI} + \varepsilon_{E,N} \quad (8)$$

$$\text{Excess Return} = \beta_{E,I} \times \text{Net NIM OI} + \varepsilon_{E,I} \quad (9)$$

$$\text{Excess Return} = \beta_{E,O} \times \text{Net NOM OI} + \varepsilon_{E,O} (10)$$

$$\text{Abnormal Return} = \beta_{A,T} \times \text{Net Total OI} + \varepsilon_{A,T} \ (11)$$

$$\text{Abnormal Return} = \beta_{A,N} \times \text{Net NTM OI} + \varepsilon_{A,N} \ (12)$$

$$\text{Abnormal Return} = \beta_{A,I} \times \text{Net NIM OI} + \varepsilon_{A,I} \ (13)$$

$$\text{Abnormal Return} = \beta_{A,O} \times \text{Net NOM OI} + \varepsilon_{A,O} \ (14)$$

Furthermore, to test whether this relationship is related to underlying stock's volatility and company size, we add two dummy variables in the previous regressions:

$$\text{Raw Return} = \alpha_{R,T} + \beta_{R,T} \times \text{Net Total OI} + \gamma_{R,T} \times \text{Size} + \delta_{R,T} \times \text{Volatility} + \varepsilon_{R,T} \ (15)$$

$$\text{Raw Return} = \alpha_{R,N} + \beta_{R,N} \times \text{Net NTM OI} + \gamma_{R,N} \times \text{Size} + \delta_{R,N} \times \text{Volatility} + \varepsilon_{R,N} \ (16)$$

$$\text{Raw Return} = \alpha_{R,I} + \beta_{R,I} \times \text{Net NIM OI} + \gamma_{R,I} \times \text{Size} + \delta_{R,I} \times \text{Volatility} + \varepsilon_{R,I} \ (17)$$

$$\text{Raw Return} = \alpha_{R,O} + \beta_{R,O} \times \text{Net NOM OI} + \gamma_{R,O} \times \text{Size} + \delta_{R,O} \times \text{Volatility} + \varepsilon_{R,O} \ (18)$$

$$\text{Excess Return} = \alpha_{E,T} + \beta_{E,T} \times \mathit{Net\ Total\ OI} + \gamma_{E,T} \times \mathit{Size} + \delta_{E,T} \times \mathit{Volatility} + \varepsilon_{E,T} \ (19)$$

$$\text{Excess Return} = \alpha_{E,N} + \beta_{E,N} \times \text{Net NTM OI} + \gamma_{E,N} \times \text{Size} + \delta_{E,N} \times \text{Volatility} + \varepsilon_{E,N} \ (20)$$

$$\text{Excess Return} = \alpha_{E,I} + \beta_{E,I} \times \text{Net NIM OI} + \gamma_{E,I} \times \text{Size} + \delta_{E,I} \times \text{Volatility} + \varepsilon_{E,I} \ (21)$$

$$\text{Excess Return} = \alpha_{E,O} + \beta_{E,O} \times \text{Net NOM OI} + \gamma_{E,O} \times \text{Size} + \delta_{E,O} \times \text{Volatility} + \varepsilon_{E,O} (22)$$

$$\text{Abnormal Return} = \alpha_{A,T} + \beta_{A,T} \times \text{Net Total OI} + \gamma_{A,T} \times \text{Size} + \delta_{A,T} \times \text{Volatility} + \varepsilon_{A,T} \ (23)$$

$$\text{Abnormal Return} = \alpha_{A,N} + \beta_{A,N} \times \text{Net NTM OI} + \gamma_{A,N} \times \text{Size} + \delta_{A,N} \times \text{Volatility} + \varepsilon_{A,N} \ (24)$$

$$\text{Abnormal Return} = \alpha_{A,I} + \beta_{A,I} \times \text{Net NIM OI} + \gamma_{A,I} \times \text{Size} + \delta_{A,I} \times \text{Volatility} + \varepsilon_{A,I} \ (25)$$

$$\text{Abnormal Return} = \alpha_{A,O} + \beta_{A,O} \times \text{Net NOM OI} + \gamma_{A,O} \times \text{Size} + \delta_{A,O} \times \text{Volatility} + \varepsilon_{A,O} \ (26)$$

$$Size = \begin{cases} 1, & if \text{ market size } > \text{ mean of market size in each year} \\ 0, & if \text{ market size} < \text{ mean of market size in each year} \end{cases}$$

$$Volatility = \begin{cases} 1, & if \text{ volatility of underlying stock } > 1 \\ 0, & if \text{ volatility of underlying stock} < 1 \end{cases}$$

4. Data

Since lower-price stocks are relatively easier to influence by option writers compared with higher-price stocks, we choose 156 stocks whose prices were under $80 most of the time in 2017 from S&P 500 and NASDAQ Index, within which 124 have options (American options). We then collect 10-year (2007-2017) data of those 124 options from OptionMetrics dataset on Wharton Research Data Services (WRDS) for open interest (OI), strike price, option flag (call or put), expiration date, CUSIP, PERMNO and last trading day (LTD) before expiration as well as underlying stock data from the Center for Research in Security Prices (CRSP) dataset on Wharton Research Data Services (WRDS) for CUSIP, PERMNO, 365-day historical volatility, stock price, shares outstanding and trading volume on the LTD before expiration. The returns of underlying stocks on the LTD before expiration are calculated by using the stock price on the LTD before expiration and the day before that.

Further, the dividend payment on LTD would affect the stock price and thus the moneyness of options on LTD. To eliminate this dividend-paying effect on the returns of the LTD, we delete 3996 options whose underlying stocks happen to pay dividend on the LTD before expiration. To observe moneyness of options on the day before LTD before expiration, we merge the option data with the data of underlying stocks according to the LTD before expiration and CUSIP. Descriptive statistics of option and underlying stock data are shown in Table 2 in appendix.

We also download market excess return (market return – risk-free rate) and risk-free rate (one-month treasury bills) in the same time frame (2007-2017) from Fama-French (1993) Factors-Daily Frequency on WRDS for CAPM regression.

5. Empirical Analysis

We perform regressions of open interest and stock return on expiration date as described in section 3.4. Results of the regressions are displayed in Table 4-6, which are the main analysis of the paper. In these regression tables, we provide an analysis where the dependent variables are the raw, excess, or abnormal return, while independent variables are our proxies for sophisticated investors' incentives to push the price level of the underlying stock. The difference of these tables concerns the control variables used.

5.1 Regressions of Stock Return and Net Open Interest (Without controlling for fixed effects)

We conduct regressions (3) to (14) explained in Section 3.4 without controlling for fixed effects. As shown in Table 4, the negative coefficients between return and net OI would be consistent with our hypothesis that when there is more open interest of call options (positive net OI) on the last trading day before expiration, the return on that day should be negative because call option writers tend to push down the underlying stock price, and vice versa for open interest of put options.

In general, regression results show more significance for Net NTM OI than Net Total OI, which correspond to our assumption that NTM option writers have more incentive to influence underlying stock price on the last trading day before expiration. More specifically, within the near-the-money open interest group, coefficient significance of Net NOM OI is greater than that of Net NIM OI. This indicates a stronger tendency for near-out-of-money option writers to keep pushing the underlying stock price away from the strike price on LTD so that option buyers would not be able to exercise the options on the last day. Nevertheless, for NIM options, it is very likely that the option buyers have already exercised the options many days before since they are in-the-money; thus, there would be less incentive for NIM option writers to push the underlying stock price.

Another observation lies in the significance difference among raw, excess, or abnormal return. Regression results suggest that the significance level of raw return and excess return is larger than that of abnormal return, indicating that absolute return matters more. One possible explanation is that option writers care more about the absolute distance between underlying stock price and strike price, and absolute return is a direct measure of the increase or decrease of that distance.

5.2 Regressions of Stock Return and Net Open Interest ()

Table 5 is almost the same as Table 4 except for the fact that Table 5 includes firm and year effect. We conduct regressions (15) to (26) explained in Section 3.4 and want to test whether this relationship between stock return and net open interest will be more robust with in each year and each firm.

However, regression results show that under this circumstance, coefficients for Net NTM OI, Net NIM OI and Net NOM OI are less significant than those in previous regressions. The reduced significance suggests that the relationship is somewhat related to the specific underlying asset; nevertheless, firm and year effect increase the significance of Net Total OI and do not eliminate the significance of the abnormal return result in specification (6).

5.3 Regressions of Stock Return and Net Open Interest (Without controlling for fixed effect)

To further test the effect of other factors, after controlling the effect of year and firm, we also test the effect of size and volatility.

We created two dummy variables of size and volatility. We define volatility = 1 if volatility of underlying stock >1; volatility = 0 if volatility of underlying stock <1. We also calculate the mean of market size of all firms at the beginning of each year and define Size = 1 if market size > mean of market size and Size = 0 if market size < mean of market size.

The result shows that the size and volatility are not significantly related with the return and will not affect the relationship of the return and options.

6. Conclusion

In this paper, we provide strong evidence that option writers with larger amount of net open interest (calls minus puts) on the last trading day before expiration tend to move the underlying stock price away from strike price so that option buyers are not able to exercise the options on the last allowable day. This effect is more significant for near-the-money and near-out-of-money option writers since pushing stock price requires less cost under this circumstance, and near-out-of-money option writers are incentivized to keep the options out-of-money until expiration so that they can earn the full amount of option premium. In other words, the evidence corresponds to our hypothesis that option writers are more sophisticated than option buyers in terms of influencing underlying stock price.

On the whole, the 124 stocks we choose over a ten-year sample period (2007-2017) are representative for the option market. Our regressions of net open interest and stock return on the last trading day before expiration suggest a negative relationship between the two variables. That is, when there is more open interest of call options than that of put options, the return of underlying stock on that day tend to be negative because call option writers are in favor of lower underlying stock price.

Moreover, this paper provides empirical support to the existing literature. We explain which kind of options might have the most significant influence on the return of underlying stocks on expiration dates through analyzing the relationship between the moneyness of option and underlying assets returns.

Appendices

Table 2. Descriptive Statistics of Option and Underlying Stock Raw Data.

The table provides basic characteristics of 124 underlying stocks we choose and their options on the last trading day before expiration from 2007 to 2017. Data are obtained from OptionMetrics and CRSP. Since we include both the options that expire on the third Saturday (Friday) of each month before February 15, 2015 (on and after February 15, 2015) and the Weeklys that expire on the Fridays of each month except for the third Friday, within all 409 expiration dates, there are 11 Thursdays, 309 Fridays, and 89 Saturdays. Raw option data include all the calls and puts of the underlying stocks on all expiration dates. Underlying stock volatility is historical 365-day volatility.

	N	Mean	Standard deviation	p1	p99
Expiration date	409				
Strike price	644951	36.374	19.604	4.5	100
OI	644951	2012.364	11298.94	1	31405
Calls and puts	644951	0.493	0.5	0	1
OI of call	318027	2295.695	12477	1	36119
OI of put	326924	1736.743	10013.25	1	26755
Underlying Stock Volatility on T_{LTD}	24127	0.329	0.181	0.136	1.045
Trading Volume of underlying stock on T_{LTD}	24127	14100000	27400000	518190	126109839
Shares outstanding on T_{LTD}	24127	1470000	2230000	85619	10557351
MV (in million) on T_{LTD}	24127	39200	55900	1675.2	247000
Raw Return of underlying stock on T_{LTD}	24127	0.001	0.023	-0.056	0.068
Price on T_{LTD}	24127	33.113	18.404	3.57	91.95

Table 3. Open Interest of Various Moneyness.

Characteristics of open interest in this table is described for each underlying stock observation on each T_{LTD} except for open interest of NTM/NIM/NOM options. Characteristics of these three groups is described for each option on each T_{LTD}. Option group classification is defined in Table 1.

	N	Mean	Standard deviation	p1	p99
OI of NTM call	91190	2845.918	9806.772	2	40894
OI of NTM put	88801	1970.306	6748.236	1	27120
OI of NIM call	43089	2433.443	8508.593	1	35392
OI of NIM put	43881	1614.486	6031.642	1	22782
OI of NOM call	48474	3226.553	10839.29	2	46072
OI of NOM put	45289	2323.405	7364.13	3	31050
Sum of OI for call	24127	48219.73	144000	275	542273
Sum of OI for put	24127	38449.98	115000	158	456395
Sum of OI for NTM call	24127	10756.38	26198.2	0	127967
Sum of OI for NTM put	24127	7251.841	17372.43	0	81962
Sum of OI for NIM call	24127	4345.945	12691.93	0	55464
Sum of OI for NIM put	24127	2936.347	8947.976	0	37898
Sum of OI for NOM call	24127	6482.528	17484.53	0	83523
Sum of OI for NOM put	24127	4361.283	11673.82	0	54294
OI of call - OI of put	24127	6727.315	40072.81	-46477	135572
OI of NTM call - OI of NTM put	24127	3504.541	15682.23	-22000	66004
OI of NIM call - OI of NIM put	24127	1409.598	13342.63	-26449	46371
OI of NOM call - OI of NOM put	24127	2121.245	14304.2	-22522	52534
Net Total OI	24127	0.048	0.245	-0.57	0.878
Net NTM OI	24127	0.03	0.112	-0.214	0.451
Net NIM OI	24127	0.013	0.084	-0.195	0.312
Net NOM OI	24127	0.017	0.088	-0.187	0.326

Table 4. Regressions of Stock Return and Net Open Interest (No Fixed Effects)

The independent variables Net Total OI, Net NTM OI, Net NIM OI and Net NOM OI are defined by formula (a) (b) (c) and (d). They represent the standardized open interest amount on the last trading day before expiration and our proxies for measuring option writers' power to push underlying stock price. Positive value of Net OI means there are more calls than put on that day, while negative value means there are more puts. The dependent variable raw return is calculated using raw stock data from CRSP as described in Table 2. The dependent variable excess return and abnormal return are calculated by conducting regression of CAPM model as described in section 3.3. The *t*-statistics are adjusted for heteroskedasticity and are provided in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

	(1) Raw return	(2) Excess return	(3) Abnormal return	(4) Raw return	(5) Excess return	(6) Abnormal return	(7) Raw return	(8) Excess return	(9) Abnormal return	(10) Raw return	(11) Excess return	(12) Abnormal return
Net Total OI	-0.0003	-0.0003	-0.0003									
	(-0.7687)	(-0.7753)	(-0.7029)									
Net NTM OI				-0.0025***	-0.0025***	-0.0015**						
				(-3.1254)	(-3.1132)	(-2.2217)						
Net NIM OI							-0.0019*	-0.0019*	-0.0014			
							(-1.8142)	(-1.8048)	(-1.3563)			
Net NOM OI										-0.0022**	-0.0022**	-0.001
										(-2.0153)	(-2.0089)	(-0.9247)
Constant	0.0009***	0.0009***	0.0001	0.0009***	0.0009***	0.0002	0.0009***	0.0009***	0.0001	0.0009***	0.0009***	0.0001
	(-5.8935)	(-5.8167)	(-1.109)	(-6.0203)	(-5.9441)	(-1.3101)	(-5.9036)	(-5.8258)	(-1.1458)	(-5.9429)	(-5.8657)	(-1.1298)
Year fixed effect	No	No	No	No	No	No	No	No	No	No	No	No
Firm fixed effect	No	No	No	No	No	No	No	No	No	No	No	No
Observations	24,127	24,127	24,127	24,127	24,127	24,127	24,127	24,127	24,127	24,127	24,127	24,127
R-squared	0	0	0	0.0002	0.0002	0.0001	0.0001	0.0001	0	0.0001	0.0001	0

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5. Regressions of Stock Return and Net Open Interest (with fixed effects)

The dependent and independent variables are the same as Table 4. For regressions in this table, we include the year and firm effects. The *t*-statistics are adjusted for heteroskedasticity and are provided in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

	(1) Raw return	(2) Excess return	(3) Abnormal return	(4) Raw return	(5) Excess return	(6) Abnormal return	(7) Raw return	(8) Excess return	(9) Abnormal return	(10) Raw return	(11) Excess return	(12) Abnormal return
Net Total OI	-0.0009*	-0.0009*	-0.0004									
	(-1.8640)	(-1.8648)	(-0.9859)									
Net NTM OI				-0.0016**	-0.0016**	-0.0015**						
				(-1.9680)	(-1.9689)	(-2.2325)						
Net NIM OI							-0.001	-0.001	-0.0013			
							(-0.9392)	(-0.9400)	(-1.2294)			
Net NOM OI										-0.0015	-0.0015	-0.0011
										(-1.3370)	(-1.3373)	(-1.0017)
Constant	-0.0005	-0.0006	-0.0007	-0.0005	-0.0007	-0.0007	-0.0005	-0.0007	-0.0008	-0.0005	-0.0007	-0.0008
	(-0.4240)	(-0.5658)	(-0.9728)	(-0.4643)	(-0.6065)	(-0.9793)	(-0.4825)	(-0.6246)	(-1.0006)	(-0.4762)	(-0.6184)	(-0.9993)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,127	24,127	24,127	24,127	24,127	24,127	24,127	24,127	24,127	24,127	24,127	24,127
R-squared	0.0266	0.0264	0.0056	0.0266	0.0264	0.0045	0.0265	0.0264	0.0045	0.0265	0.0264	0.0045

Robust t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 6. Regressions of Stock Return and Net Open Interest (Size and Volatility Tested)

The dependent and independent variables are the same as Table 4. For regressions in this table, we test the size and volatility effects. The *t*-statistics are adjusted for heteroskedasticity and are provided in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

	(1) Raw return	(2) Excess return	(3) Abnormal return	(4) Raw return	(5) Excess return	(6) Abnormal return	(7) Raw return	(8) Excess return	(9) Abnormal return	(10) Raw return	(11) Excess return	(12) Abnormal return
Volatility	0.0034	0.0034	0.0049	0.0034	0.0034	0.0049	0.0034	0.0034	0.0049	0.0034	0.0034	0.0049
	(-1.1006)	(-1.0991)	(-1.6273)	(-1.1063)	(-1.1048)	(-1.6275)	(-1.1119)	(-1.1104)	(-1.6331)	(-1.105)	(-1.1035)	(-1.6273)
Size	0.0001	0.0001	0.0003	0.0001	0.0001	0.0003	0.0001	0.0001	0.0003	0.0001	0.0001	0.0003
	(-0.1039)	(-0.1013)	(-0.4951)	(-0.1471)	(-0.1446)	(-0.5463)	(-0.1199)	(-0.1173)	(-0.5202)	(-0.1219)	(-0.1193)	(-0.5115)
Net Total OI	-0.0009*	-0.0009*	-0.0004									
	(-1.8205)	(-1.8213)	(-0.9105)									
Net NTM OI				-0.0016*	-0.0016*	-0.0015**						
				(-1.9513)	(-1.9521)	(-2.2248)						
Net NIM OI							-0.001	-0.001	-0.0013			
							(-0.9578)	(-0.9584)	(-1.2698)			
Net NOM OI										-0.0015	-0.0015	-0.0011
										(-1.3007)	(-1.3011)	(-0.9542)
Constant	-0.0038	-0.004	-0.0057*	-0.0039	-0.0041	-0.0057*	-0.0039	-0.0041	-0.0058*	-0.0039	-0.0041	-0.0058*
	(-1.1846)	(-1.2300)	(-1.8428)	(-1.2065)	(-1.2520)	(-1.8477)	(-1.2157)	(-1.2612)	(-1.8569)	(-1.2073)	(-1.2528)	(-1.8502)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,127	24,127	24,127	24,127	24,127	24,127	24,127	24,127	24,127	24,127	24,127	24,127
R-squared	0.0268	0.0266	0.0051	0.0268	0.0266	0.0051	0.0267	0.0266	0.0051	0.0267	0.0266	0.0051

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

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