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Option volume and stock returns: evidence from single stock options on the Korea Exchange

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Abstract
Informed traders may prefer the options market to the stock market for reasons including the leverage effect, transaction costs, restrictions on short sale. Many studies try to predict future returns of stocks using informed traders' behavior in the options market. In this study, we examine whether the trading volume ratios of single stock options have the predictive power for future returns of the underlying stock. By analyzing the stock price responses to the "preliminary announcement of performance" of 36 underlying stocks on the Korea Exchange from November 2014 to March 2021 and the trading volume of options written on those stocks, we investigate the relation between the option ratios, which are the call option volume to put option volume ratio (C/P ratio) and the option volume to stock volume ratio (O/S ratio), and the future returns of the underlying stock. We also examine which ratio is better in predicting the future returns. The authors found that both option ratios showed the statistically significant predictability about future returns of the underlying stock and that the return predictability of the O/S ratio is more robust than that of the C/P ratio. This study shows that indicators generated in the options market can be used to predict future underlying stock returns. Further, the findings of this study contributed to a dearth of literature pertaining to single stock options. The results suggest that the single stock options market is efficient and influences the price discovery in the stock market.

Keywords Single stock option, Option to stock ratio, Call option to put option ratio, Return predictability
Paper type Research paper

1. Introduction
Informed traders might be induced to trade options rather than stocks since the option market is known to provide more opportunities of leverage (Black, 1975). Information asymmetry is greater in the options market than in the stock market (Cao and Wei, 2010), and this drives informed traders to deal in options. The existence of informed traders in the options market is supported by evidence that the trading volume of options increases around the announcement of favorable or unfavorable news. The call option trading volume of takeover targets increases just before the announcement date (Cao *et al.*, 2005). The net trading volume of put option increases a few days prior to negative earnings announcements (Hao *et al.*, 2013).

If informed traders are active in the options market, then the future return of a stock may be predicted by the trading volume of options, which have the corresponding stock as their underlying asset. Two of the widely used measures referenced in the literature are the ratio of trading volume of call option to that of put option (C/P ratio, hereafter) and the ratio of trading volume of both call and put options to that of an underlying stock (O/S ratio, hereafter).

JEL Classification — G12, G13, G14

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The former is interpreted as the indicator of investor sentiment as well as the bet for or against the stock price increase (Dennis and Mayhew, 2002). Regarding the latter, Roll *et al.* (2010) show that private information increases the O/S ratio, explaining the predictability of the O/S ratio and its connection to future stock returns. Further, Johnson and So (2012) show that the trades based on information raise the O/S ratio. Comparing the two measures, Blau *et al.* (2014) show that the O/S ratio has the better predictability than the C/P ratio for weekly and monthly returns, while the C/P ratio is better for daily returns.

By analyzing 36 stocks and the options derived from those stocks, which are listed on the Korea Exchange, from November 2014 to March 2021, we examine the relation between option ratios and future returns of stocks. The main findings of this paper are as follows. First, the O/S ratio shows statistically significant predictability for future returns of an underlying asset. Second, the C/P ratio also showed statistically significant predictability for future returns of the underlying asset. Third, the regression coefficient of the O/S ratio remains statistically significant but that of the C/P ratio loses its statistical significance when the relation between the ratios and the future stock return is estimated with the regression model that include both ratios. The result is consistent with that of Blau *et al.* (2014), where the O/S ratio shows the more robust return predictability than the C/P ratio.

This study tests whether the relative size of trading volume of options provides information about the future returns of an underlying asset. The results of this study show that the market of single stock options facilitates price discovery in the stock market, which results in enhancing the capital market efficiency. The remaining parts of this paper are as follows. Section 2 reviews the previous literature. Section 3 explains the data and the methodology. Section 4 discusses the findings, Section 5 provides the results from the robustness check, and Section 6 provides the summary of the findings and discusses the limitation of this study.

2. Literature

There are many studies about the informed traders' choice between the stock market and the derivatives market and which of these markets show better predictability about future returns of stocks. In general, the literature presented below argues that the options market predicts future return of stocks better than the stock market. According to Easley *et al.* (1998), the volume of particular option trades has predictive power for future stock prices when the option leverage effect is high, the stock liquidity is small or there are many informed traders using options. Chakravarty *et al.* (2004) analyzed 60 stocks that are listed on NYSE and have the options trading on CBOE, from 1988 to 1992. They found the evidence of significant price discovery in the options market. In addition, the options market becomes more informative when option trading volume is high relative to stock trading volume. Pan and Poteshman (2006) analyzed the aggregated trading volume of options across different exercise prices and maturities and the volume of stocks, using the sample of single stock options and index options listed on CBOE from January 1990 to December 2001. They showed that trading volume of stock options contains information about the future price of stocks and that the result is not from the pressure on prices but from trades based on information. In the same vein, analyzing the KOSPI200 options market from January 2007 to January 2011, Choi (2011) shows that option trading volume has strong predictability for the direction of the index. Choi (2011) also shows that information contained in the option volume transfers to the spot market very quickly. According to Hu (2014), options market makers also trade in the stock market through their delta hedging practice. As a result, option trading volume has the statistically significant predictability about the future price of stocks even when the past stock price and the past returns of options are controlled for.

Prices and trading volumes are used as an important indicator in predicting the future price in the stock market. The representative measures using trading volume are call to put volume ratio (C/P ratio) and option to stock volume ratio (O/S ratio).

Research findings pertaining to the C/P ratio are as follows. Investigating the flow of information between the stock market and the options market, Chen *et al.* (2005) show that informed traders trade in both markets and some of them prefer out-of-money options because of higher liquidity, low premium and high delta-to-premium ratio. The result suggests the C/P ratio as an indicator of the price direction in the stock market. Kim (2007), analyzing all trades of KOSPI200 option in the exchange from January 2000 to July 2006 in order to reflect the sentiment of all types of market participants, shows that the C/P ratio leads the stock index. The paper explains that the result reflects the feature of the KOSPI200 options market, which is quite occupied by individual investors. Analyzing S&P500 constituents and related options from May 2005 to December 2012, Houlihan and Creamer (2019) show that C/S ratio is interpreted as the indicator of the investment sentiment and has the predictability for the future price.

Research about the O/S ratio are as follows. Roll *et al.* (2010) analyze the O/S ratio around earnings announcements suggesting that private information increases option trading volume compared to stock volume. According to Johnson and So (2012), the lowest decile of the O/S ratio shows a higher return than the highest decile by 0.34% per week (19.3% annually). Ge *et al.* (2016) shows that leverage embedded in options is an important channel through which the option trading volume predicts the stock return. Kim *et al.* (2016) show that the relation between the O/S ratio and future stock returns is stronger during the period when Baker and Wurgler's Investor Sentiment Index is high. Examining the behavior of asymmetric information proxies, Kacperczyk and Pagnotta (2019) show that trading volume in the options market contains more information than that in the stock market. According to Blau *et al.* (2014), the predictability of the O/S/ratio was higher at weekly and monthly levels, respectively, while that of P/C ratio [1] was higher at daily level.

3. Data and methodology

3.1 Data

Listed firms should disclose important information that may affect stock prices. The disclosure requirement is imposed to ensure investors and other stakeholders properly informed, encouraging fair pricing in the market. When a listed firm provides institutional investors with undisclosed and material information, the firm should disclose it in advance complying with the Principle of Fair Disclosure. Plans for future business or management, prospect for sales or income, and performance outlook before disclosure are examples of material information that are subject to the Principle of Fair Disclosure. Regarding the Fair Disclosure case that is related to performance as an event, we investigate whether information in the options market predicts future returns in the stock market.

Detail process of developing our research sample is as follows. First, we select the events that provide the market with new information. In this study, the events are the disclosures of "Preliminary Announcements of Performance" from November 2011 to March 2021 for 36 stocks that are the underlying assets of single stock options listed on the Korea Exchange. The entire sample of our research consists of 738 stock-day observations. Second, we calculate the price responses to the event as CAR (0,T), which is the cumulative abnormal return for the period of T days from day 0 (announcement date). Abnormal return is calculated by subtracting the return of the market composite index from the return of a stock [2]. Price responses are measured for short term (T+1 ~ T+5) and medium term (T+10 ~ T+20). It represents future underlying stock returns. Third, we test whether the future returns can be predicted by the O/S ratios and the C/P ratios on the announcement date and which ratio is superior to the other in predicting the future underlying stock returns. The O/S ratio is the log of option trading volume to stock trading volume. In our study, two types of C/P ratios are used. The C/P 1 ratio is the log of call option trading volume to put option trading volume and the C/P 2 ratio is the log of open interest of call option to that of put option.

Table 1 shows the descriptive statistics of the price responses to "Preliminary Announcement of Performance" and the option ratios on the announcement date. Information followed by the positive (negative) abnormal return is considered as "good (bad) news." When conflicting information, for example, the sales increase and the net income decrease, is simultaneously released, the stock price response can be a proper indicator to determine whether the information is "good news" or "bad news." The mean of price responses is less than 1% in every window, implying that the effect of "good news" and "bad news" on stock prices offset each other. For example, the maximum and minimum values of CAR (0, 20) are 51.79% and −51.90%, respectively, which is quite symmetric.

3.2 Methodology

The purpose of this study is to find whether the C/P ratio and the O/S ratio can predict the future returns of the corresponding underlying asset, and to compare the predictive power of the two ratios. For a single underlying asset, multiple options are listed with different exercise prices and different expiration dates. They are traded at the money, out of the money, or in the money depending on investors' preference over leverage and the option characteristics. In this study, the option trading volume for a single underlying stock includes the volume of all options for the stock regardless the exercise price or the time to maturity, as in Pan and Poteshman (2006). Otherwise, trading volume will be split into several options following investors' preference.

C/P ratios are calculated as in Equations (1) and (2). The C/P 1 ratio is calculated by dividing the trading volume of call options with that of put options, and the C/P 2 ratio is calculated by dividing the open interest of call options with that of put options. The trading volumes and the open interest of the options issued for an underlying stock are summed

Nobs = 738	CAR (0,1)	CAR (0,3)	CAR (0,5)	CAR (0,10)	CAR (0,20)	*O/S*	*C/P 1*	*C/P 2*
Mean	0.11	0.15	0.11	0.20	0.57	−3.01	2.47	1.44
Std. dev	3.09	4.34	5.38	6.96	10.03	1.08	7.14	1.63
Max	16.85	19.22	33.86	39.31	51.79	−0.85	107.5	19.33
99%	9.52	12.52	14.31	20.23	30.28	−1.31	38.5	8.59
95%	4.87	7.20	9.22	11.76	17.51	−1.62	6.79	3.56
90%	3.55	5.50	6.315	8.39	12.26	−1.77	3.25	2.46
75%	1.76	2.88	3.06	4.15	5.66	−2.19	1.80	1.51
Median	0.17	−0.17	−0.41	−0.235	−0.36	−2.8	1.11	1.03
25%	−1.69	−2.88	−3.41	−4.37	−5.745	−3.67	0.77	0.755
10%	−3.4	−5.05	−6.185	−7.74	−10.77	−4.64	0.46	0.48
5%	−4.79	−6.15	−7.67	−9.76	−12.94	−5.00	0.29	0.31
1%	−7.02	−9.4	−10.82	−13.61	−18.55	−5.79	0.07	0.15
Min	−11.98	−14.08	−14.64	−26.96	−51.90	−7.05	0.01	0.01

Note(s): This table shows the descriptive statistics of the future underlying stock return and the option ratios. The research sample consists of 738 stock-day observations. Future returns are represented by CAR (0,T), which is calculated by cumulating the daily abnormal returns for T days from day 0 (announcement date). Abnormal return is calculated by subtracting the return of the market composite index from the return of a stock. *O/S* represents the O/S ratio, which is calculated as the log of option trading volume to stock trading volume. *C/P 1* represents the C/P 1 ratio, which is calculated as the log of call option trading volume to put option trading volume and *C/P 2* represents the C/P 2 ratio, which is calculated as the log of open interest of call option to that of put option

Table 1.
Descriptive statistics (in percentage)

across different exercise prices and maturities.

$$C/P\ 1\,\text{ratio} = \frac{\sum_{xc}\sum_{mc} Call\ Volume_{xc,mc}}{\sum_{xp}\sum_{mp} Put\ Volume_{xp,mp}} \tag{1}$$

$$C/P\ 2\,\text{ratio} = \frac{\sum_{xc}\sum_{mc} Call\ OpenInt_{xc,mc}}{\sum_{xp}\sum_{mp} Put\ OpenInt_{xp,mp}} \tag{2}$$

Here,

Call Volume: Trading volume of call options

Put Volume: Trading volume of put options

Call OpenInt: Open interest of call options

Put OpenInt: Open interest of put options

xc: Exercise price of call option, *mc*: Maturity of call option

xp: Exercise price of put option, *mp*: Maturity of put option

The O/S ratio is calculated by dividing the sum of trading volume of call options and put options across all exercise prices and all maturities with the trading volume of the underlying stock, as in Johnson and So (2012). We do not differentiate option types in calculating the O/S ratio since new information is followed by an increase in the trading volume of both call options and put options at the same time. Favorable information leads to an increase in trading volume caused by call options purchase and put options sale, while unfavorable information leads to an increase in trading volume caused by call options sale and put options purchase.

$$O/S\ ratio = \frac{\sum_{xc}\sum_{mc} Call\ Volume_{xc,mc} + \sum_{xp}\sum_{mp} Put\ Volume_{xp,mp}}{Stock\ Volume} \tag{3}$$

Here,

Call Volume: Trading volume of call options

Put Volume: Trading volume of put options

Stock Volume: Trading volume of the underlying stock

xc: Exercise price of call option, m*c*: Maturity of call option

xp: Exercise price of put option, m*p*: Maturity of put option

To examine the return predictability of option trading volume, we regress stock returns on the C/P ratios and the O/S ratio. Control variables that may affect stock returns are also included in regression models. Predictive power for future returns is measured with cumulative abnormal return (CAR) for specified periods starting from the event date [3]. CAR (0,1), CAR (0,3), and CAR (0,5) represent the predictability of short-term return, while CAR (0,10) and CAR (0,20) represent the predictability of medium-term return. We did not test the predictability of long-term return, considering that the speed of information transfer tends to be fast between the options market and the stock market

$$CAR_{i,t}(0,\ T) = \alpha_0 + \beta_1 C/P\ ratio_{i,t} + \beta_2 Return_{i,t} + \beta_3 Volatility_{i,t} + \beta_4 Short_{i,t} + \beta_5 Spread_{i,t} + \varepsilon_{i,t} \tag{4}$$

$$CAR_{i,t}(0,\ T) = \alpha_0 + \beta_1 O/S\ ratio_{i,t} + \beta_2 Return_{i,t} + \beta_3 Volatility_{i,t} + \beta_4 Short_{i,t} + \beta_5 Spread_{i,t} + \varepsilon_{i,t} \quad (5)$$

Here,

$Return$: $\frac{\text{Closing price on the event date} - \text{Closing price on the previous day}}{\text{Closing price on the previous day}}$

$Volatility$: $\frac{\text{Highest price} - \text{Lowest price}}{\text{Average of the two prices}}$

$Short$: $\frac{\text{Trading amount of short sale}}{\text{Total trading amount}}$

$Spread$: $\frac{\text{Best quoted sale price} - \text{Best quoted purchase price}}{\text{Average of the two prices}}$

4. Empirical results

This section presents the result that estimates the predictability of option volume measures for the future returns of the underlying asset. Table 2 shows the correlation among option ratios, future returns of the underlying stock, and the control variables. According to Panel A, the O/S ratio shows the statistically negative correlation with the future returns of most windows, which are CAR (0,3) through CAR (0,20), except for CAR (0,1). On the contrary, the C/P 1 ratio does not show a statistically significant correlation with the future returns of any window while the C/P 2 ratio shows a statistically negative correlation with the future returns only in the windows of (0,1) and (0,3). In Panel B, the O/S ratio shows a statistically positive correlation with the price level and the spread while the ratio shows a statistically negative correlation with the trading volume of underlying stock and the turnover. The C/P 2 ratio shows a statistically negative correlation with the current return. Since the correlation between only two variables does not control for the effect of other variables, we will present the results from multivariate analyses in the next section.

In Table 3, the entire research sample is sorted into five equal groups based on the level of option ratios. The table shows the future underlying stock returns in each quintile [4]. L and H represent the low and the high levels of the option ratios, respectively. Panel A shows the results for the O/S ratio. Panel B and Panel C show the results for the C/P 1 ratio and the C/P 2 ratio, respectively. The last row of each panel shows the statistical difference in the CARs between the decile with the lowest option ratio and that with the highest option ratio.

In Panel A, CAR (0,5) and CAR (0,10) tend to decline monotonously as the O/S ratio of each quintile moves from L to H. The strategy of buying stocks in L and simultaneously selling them in H generates statistically positive returns, which is shown not only in CAR (0,3) but in the CARs of longer windows through CAR (0,20). In Panel B, the monotonous change in future returns does not appear as the C/P ratio 1 of each quintile moves from L to H. The strategy of buying stocks in L and simultaneously selling them in H generates statistically significant returns only for the window from day 0 to day 3. In Panel C, no monotonous change in future returns is observed as the C/P ratio 2 of each quintile moves from L to H. The strategy of buying the stocks in L and simultaneously selling them in H generates statistically significant returns of 0.80% in CAR (0,1) and 1.25% in CAR (0,3).

According to Johnson and So (2012), a group with the lowest O/S ratio shows higher performance by 0.34% point in terms of weekly returns. Since Panel A of Table 3 shows that the CAR (0,5) of a group with the lowest the O/S ratio is higher by 1.95% points than that of a group with the highest the O/S ratio, the difference is larger in the Korean stock market. As far as only option ratios are concerned, the C/P 2 ratio has superior predictability for short-term returns, while the O/S ratio is superior to the others in predicting medium-term returns. According to Blau *et al.* (2014), the C/P ratio has better return predictability at daily level,

Table 2.
Correlations

Panel A. Option ratios and future returns	*C/P 1*	*C/P 2*	CAR (0,1)	CAR (0,3)	CAR (0,5)	CAR (0,10)	CAR (0,20)
O/S	−0.1611 (<0.0001)	−0.2231 (<0.0001)	−0.0195 (0.6143)	−0.0665 (0.0796)	−0.1030 (0.0067)	−0.1656 (<0.0001)	−0.2064 (<0.0001)
C/P 1		0.1226 (0.0019)	0.0014 (0.9733)	−0.0315 (0.4286)	−0.0134 (0.7371)	0.0294 (0.4628)	−0.0043 (0.9149)
C/P 2			−0.0844 (0.0251)	−0.0780 (0.0349)	−0.0463 (0.2125)	−0.0124 (0.7385)	0.0301 (0.4185)

Panel B. Option ratios and stock trading characteristics	*Price*	*Return*	*TrdWon*	*Turnover*	*Volatility*	*Short*	*Spread*
O/S	0.1358 (0.0011)	0.0085 (0.8390)	−0.0940 (0.0243)	−0.1085 (0.0093)	−0.0476 (0.2548)	0.0679 (0.1042)	0.1610 (<0.0001)
C/P 1	0.0363 (0.4008)	−0.0064 (0.8818)	0.0297 (0.4918)	0.0440 (0.3083)	0.0210 (0.6278)	0.0429 (0.3206)	−0.0235 (0.5771)
C/P 2	−0.0300 (0.4653)	−0.0907 (0.0270)	−0.0211 (0.6075)	0.0390 (0.3419)	0.0583 (0.1556)	0.0189 (0.6448)	−0.0117 (0.7697)

Note(s): This table shows the correlations between variables. Future returns are represented by CAR (0,T), which is calculated by cumulating the daily abnormal returns for the period of T days from day 0 (announcement date). Abnormal return is calculated by subtracting the return of the market composite index from the return of a stock. *O/S* represents the O/S ratio, which is calculated as the log of option trading volume to stock trading volume. *C/P 1* represents the C/P 1 ratio, which is calculated as the log of call option trading volume to put option trading volume and *C/P 2* represents the C/P 2 ratio, which is calculated as the log of open interest of call option to that of put option. *Price* is the closing price on the announcement date, *Return* is the daily return of the underlying stock, *TrdWon* is calculated as the log of the stock trading amount, *Turnover* is calculated by dividing the stock trading volume with the number of shares outstanding, *Volatility* is calculated by dividing the difference between the highest price and the lowest price with the average of the two prices, *Short* is calculated by dividing the short sale amount with the total trading amount, *Spread* is calculated by dividing the difference between the best quoted sale price and the best quoted purchase price with the average of the two prices. The p-values of the correlation coefficients are within the parentheses

		CAR (0,1)	CAR (0,3)	CAR (0,5)	CAR (0,10)	CAR (0,20)
Panel A. Quintiles by the O/S ratio	1 (L)	0.22	0.70	1.13	2.37	4.63
	2	−0.02	−0.02	0.46	1.11	1.82
	3	0.27	0.34	−0.06	−0.49	−0.94
	4	0.30	−0.06	−0.37	−0.63	−1.58
	5 (H)	−0.36	−0.47	−0.82	−1.26	−1.38
	L–H (*t*-value)	0.57 (1.60)	1.17** (2.23)	1.95*** (2.99)	3.62*** (4.31)	6.01*** (4.53)
Panel B. Quintiles by the C/P 1 ratio	1 (L)	0.24	0.72	0.47	0.89	1.60
	2	0.05	−0.32	−0.67	−1.11	−1.15
	3	0.23	0.12	−0.15	−0.67	−1.04
	4	0.20	0.32	0.84	0.97	1.26
	5 (H)	−0.13	−0.34	−0.14	0.53	0.96
	L–H (*t*-value)	0.37 (1.02)	1.05* (1.92)	0.60 (0.88)	0.35 (0.41)	0.64 (0.48)
Panel C. Quintiles by the C/P 2 ratio	1 (L)	0.67	0.92	0.39	−0.22	0.12
	2	0.03	0.17	0.10	0.23	0.27
	3	−0.26	−0.63	−0.51	−0.33	−0.49
	4	0.29	0.59	0.96	1.30	1.90
	5 (H)	−0.13	−0.33	−0.37	0.09	1.07
	L–H (*t*-value)	0.80** (2.11)	1.25** (2.42)	0.76 (1.25)	−0.31 (−0.42)	−0.95 (−0.82)

Note(s): This table shows the future underlying stock returns in each quintile sorted by option ratios. L and H represent the low and the high levels of option ratios, respectively. Future returns are represented by CAR (0,T), which is calculated by cumulating the daily abnormal returns for the period of T days from day 0 (announcement date). Abnormal return is calculated by subtracting the return of the market composite index from the return of a stock. The O/S ratio is calculated as the log of option trading volume to stock trading volume, the C/P 1 ratio is calculated as the log of call option trading volume to put option trading volume, and the C/P 2 ratio is calculated as the log of open interest of call option to that of put option. The *t*-values are within the parentheses. ***, ** and * represent the statistical significance at the levels of 1%, 5%, 10%, respectively

Table 3. Future returns (in percentage) and option ratios

while the O/S ratio is better at weekly and monthly levels, respectively. Table 3 shows that the C/P ratios have better predictability for future returns of 1-day and 3-day windows compared to those of longer windows, while the O/S ratio is better for the windows of 5 days and longer. Thus, our results are consistent with those from prior research.

Table 4 shows the result of regressing future underlying stock returns on the option ratios. In Panel A, the O/S ratio does not have statistically significant regression coefficient across the models with the CARs of different windows. Panel B, which is the result from the regression models that include the C/P ratio 1, also shows that the C/P ratio 1 has no statistically significant predictability for future returns. Only in Panel C, which reports the regression result with the C/P 2 ratio, the option ratio is negatively related to future returns for the windows of 1 day, 3 days and 5 days, respectively, with a statistical significance.

One of the interpretations about Table 4 is that the C/P 2 ratio has better predictability on the future returns of the underlying asset than the O/S ratio does. However, it is also possible that events of conflicting information are mixed in the research sample, which results in offsetting their effect on future returns with each other. Thus, in Table 5 we estimate the relation between option ratios and future returns using the sub-samples of favorable information ("good news" hereafter) and unfavorable information ("bad news" hereafter), respectively.

Table 5 shows the result of regressing future underlying stock returns on the option ratios for the events of "good news" and those of "bad news," separately. Observations belong the sub-sample of "good news" if CAR (0,T) is positive and belong to the sub-sample of "bad news," if CAR (0,T) is negative.

Table 4.
Regressions for the entire sample

	CAR (0,1)	CAR (0,3)	CAR (0,5)	CAR (0,10)	CAR (0,20)
Panel A. Effect of the O/S ratio					
O/S	−0.0374 (−0.39)	0.1393 (1.03)	0.1633 (1.05)	0.0179 (0.09)	0.2775 (0.99)
Return	5.6467 (1.05)	−0.8171 (−0.11)	0.0453 (0.01)	3.9253 (0.34)	−17.7782 (−1.14)
Volatility	4.0478 (0.58)	15.6497 (1.59)	16.3385 (1.44)	9.3941 (0.62)	3.3433 (0.16)
Short	−2.7950 (−1.42)	−2.4222 (−0.88)	−0.0407 (−0.01)	0.5491 (0.13)	−0.1618 (−0.03)
Spread	0.0500 (0.05)	−0.2209 (−0.15)	−1.8182 (−1.09)	−3.2500 (−1.45)	−0.8310 (−0.28)
Adjusted R^2	0.0020	0.0030	0.0003	0.0018	0.0032
Panel B. Effect of the C/P 1 ratio					
C/P 1	0.0070 (0.38)	−0.0238 (−0.90)	−0.0245 (−0.80)	0.0016 (0.04)	−0.0593 (−1.07)
Return	5.7298 (1.06)	−2.5349 (−0.33)	−1.2744 (−0.14)	4.4026 (0.37)	−20.2665 (−1.27)
Volatility	4.4942 (0.70)	12.3466 (1.35)	11.7606 (1.11)	6.7665 (0.47)	−4.9444 (−0.26)
Short	−3.1719 (−1.63)	−3.2957 (−1.20)	−0.6544 (−0.21)	0.7939 (0.18)	−0.8583 (−0.15)
Spread	0.4757 (0.50)	−0.5605 (−0.42)	−2.3892 (−1.53)	−3.1798 (−1.51)	−1.7457 (−0.62)
Adjusted R^2	0.0003	0.0034	0.0016	0.0029	0.0038
Panel C. Effect of the C/P 2 ratio					
C/P 2	-0.2194^{*} (−1.93)	-0.3419^{**} (−2.16)	-0.3933^{**} (−2.13)	−0.1039 (−0.42)	0.2803 (0.84)
Return	6.2679 (1.20)	−1.3497 (−0.19)	−2.9938 (−0.35)	0.5856 (0.05)	−15.8842 (−1.03)
Volatility	8.2179 (1.26)	16.3955 (1.80)	16.9194 (1.59)	7.8188 (0.55)	−7.2194 (−0.37)
Short	−1.6124 (−0.84)	−2.0549 (−0.77)	0.1396 (0.04)	1.0343 (0.25)	−0.8097 (−0.14)
Spread	0.5699 (0.60)	−0.2388 (−0.18)	−1.8771 (−1.22)	−3.0209 (−1.45)	−3.0375 (−1.09)
Adjusted R^2	0.0043	0.0036	0.0083	−0.0009	0.0011

Note(s): This table shows the results from regressing future underlying stock returns on the option ratios. The dependent variables are CARs (0,T), which is calculated by cumulating the daily abnormal returns for the period of T days from day 0 (announcement date). Abnormal return is calculated by subtracting the return of the market composite index from the return of a stock. *O/S* represents the O/S ratio, which is calculated as the log of option trading volume to stock trading volume. *C/P 1* represents the C/P 1 ratio, which is calculated as the log of call option trading volume to put option trading volume and *C/P 2* represents the C/P 2 ratio, which is calculated as the log of open interest of call option to that of put option. *Return* is the daily return of an underlying stock, *Volatility* is calculated by dividing the difference between the highest price and the lowest price of an underlying stock with the average of the two prices, *Short* is calculated by dividing the amount of short sale with the amount of total trading of an underlying stock, *Spread* is calculated by dividing the difference between the best quoted sale price and the best quoted purchase price with the average of the two prices. The intercept and the control variables are not shown for the readability. The *t*-values are within the parentheses. ** and * represent the statistical significance at the levels of 5% and 10%, respectively

Table 5. Regressions for the sub-samples by informative feature

	CAR (0,1)	CAR (0,3)	CAR (0,5)	CAR (0,10)	CAR (0,20)
Panel A. Response to "good news"					
O/S	−0.3752*** (−4.21)	−0.4314*** (−3.99)	−0.5339*** (−3.92)	−0.3369* (−1.70)	−0.4874** (−2.02)
Return	−0.6895 (−0.14)	1.1683 (0.20)	−4.4938 (−0.64)	6.6455 (0.57)	−26.7455** (−2.04)
Volatility	0.1923*** (2.93)	0.2925*** (3.87)	0.3165*** (3.43)	0.4167*** (2.73)	0.2711 (1.57)
Short	1.1935 (0.67)	1.8178 (0.78)	6.8269** (2.25)	4.5286 (1.11)	8.2230* (1.66)
Spread	1.3731 (1.44)	3.6269*** (3.06)	2.8034* (1.87)	8.4494*** (4.09)	13.7430*** (5.41)
Adjusted R^2	0.5197	0.6262	0.6228	0.5482	0.6019
Panel B. Response to "bad news"					
O/S	0.3059*** (3.60)	0.4188*** (3.82)	0.3669*** (3.01)	0.5665*** (3.17)	0.7508*** (3.19)
Return	1.8629 (0.40)	8.8356 (1.50)	2.3674 (0.34)	11.6423 (1.28)	−2.8071 (−0.22)
Volatility	−0.1076* (−1.75)	−0.1696** (−2.11)	−0.3701*** (−4.00)	−0.1021 (−0.86)	−0.3682** (−2.19)
Short	−5.9584*** (−3.33)	−3.9351* (−1.89)	−4.0097* (−1.75)	−8.5083** (−2.34)	−11.7023** (−2.44)
Spread	−2.2735** (−2.53)	−5.2784*** (−4.96)	−4.4986*** (−3.70)	−9.6208*** (−5.26)	−10.3075*** (−4.20)
Adjusted R^2	0.5971	0.6577	0.6342	0.5919	0.5922
Panel C. Response to "good news"					
C/P 1	−0.0052 (−0.33)	−0.0261 (−1.26)	−0.0059 (−0.20)	−0.0215 (−0.61)	0.2416 (1.34)
Return	0.3423 (0.06)	1.7183 (0.27)	−3.8343 (−0.51)	7.8845 (0.64)	−6.0293 (−1.88)
Volatility	0.2835*** (4.39)	0.4018*** (5.40)	0.4569*** (4.95)	0.5790*** (4.12)	0.3774** (2.24)
Short	3.1071* (1.72)	3.7962 (1.57)	9.1123*** (2.83)	5.7671 (1.36)	9.3629* (1.84)
Spread	3.1220*** (3.36)	5.7614*** (5.11)	5.1015*** (3.59)	9.3880*** (4.63)	15.3304*** (6.09)
Adjusted R^2	0.4820	0.6017	0.5934	0.5363	0.5899
Panel D. Response to "bad news"					
C/P 1	0.0133 (0.59)	−0.0486* (−1.93)	−0.0292 (−1.20)	−0.0410 (−0.91)	0.0289 (0.78)
Return	0.3227 (0.07)	12.4791** (2.06)	3.1798 (0.45)	11.6910 (1.22)	−6.5147 (−0.48)
Volatility	−0.2060*** (−3.70)	−0.3194*** (−4.37)	−0.5037*** (−5.91)	−0.2251* (−1.92)	−0.5904*** (−3.64)
Short	−7.4516*** (−4.24)	−5.4233** (−2.60)	−5.7819** (−2.54)	−11.4355*** (−3.12)	−15.6917*** (−3.19)
Spread	−3.4091*** (−4.15)	−6.5797*** (−6.70)	−5.6669*** (−4.95)	−12.2230*** (−7.33)	−13.5928*** (−5.91)
Adjusted R^2	0.5962	0.6519	0.6334	0.5731	0.5704

(*continued*)

Table 5.

	CAR (0,1)	CAR (0,3)	CAR (0,5)	CAR (0,10)	CAR (0,20)
Panel E. Response to "good news"					
C/P 2	0.3902*** (2.81)	0.2318 (1.48)	0.2355 (1.21)	0.2392 (1.06)	0.5958** (2.07)
Return	2.1231 (0.43)	3.5204 (0.59)	−2.5006 (−0.36)	7.6142 (0.67)	−19.0130 (−1.43)
Volatility	0.2330*** (3.63)	0.3766*** (5.15)	0.4179*** (4.67)	0.4963*** (3.69)	0.3982** (2.43)
Short	2.1155 (1.20)	2.4997 (1.07)	8.3565*** (2.74)	5.2424 (1.31)	8.8174* (1.75)
Spread	2.4095*** (2.73)	5.1924*** (4.76)	4.8893*** (3.47)	9.3448*** (4.89)	14.1188*** (5.93)
Adjusted R^2	0.5042	0.6042	0.6029	0.5509	0.5990
Panel F. Response to "bad news"					
C/P 2	−0.2146*** (−2.98)	−0.1803* (−1.85)	−0.2713** (−2.44)	−0.4329** (−2.04)	−0.2174 (−0.92)
Return	1.1603 (0.25)	10.0951* (1.72)	−3.6091 (−0.51)	7.0107 (0.76)	−8.1761 (−0.63)
Volatility	−0.1794*** (−3.18)	−0.2931*** (−3.98)	−0.4743*** (−5.47)	−0.1999 (−1.70)	−0.5661*** (−3.54)
Short	−6.7346*** (−3.82)	−5.1420** (−2.51)	−4.8307** (−2.10)	−10.1055*** (−2.81)	−14.5533*** (−3.07)
Spread	−2.9612*** (−3.50)	−6.6325*** (−6.66)	−5.2774*** (−4.55)	−11.5180*** (−6.78)	−13.1072*** (−5.68)
Adjusted R^2	0.5920	0.6484	0.6189	0.5811	0.5748

Note(s): This table shows the result from regressing future underlying stock returns on option ratios for the sub-samples grouped by the feature of information. Observations belong the sub-sample of "good news" if CAR (0,T) is positive, while they belong to the sub-sample of "bad news" if CAR (0,T) is negative. The dependent variables are CARs (0,T), which is calculated by cumulating the daily abnormal returns for the period of T days from day 0 (announcement date). Abnormal return is calculated by subtracting the return of the market composite index from the return of a stock. *O/S* represents the O/S ratio, which is calculated as the log of option trading volume to stock trading volume. *C/P 1* represents the C/P 1 ratio, which is calculated as the log of call option trading volume to put option trading volume and *C/P 2* represents the C/P 2 ratio, which is calculated as the log of open interest of call option to that of put option. *Return* is the daily return of an underlying stock, *Volatility* is calculated by dividing the difference between the highest price and the lowest price of an underlying stock with the average of the two prices, *Short* is calculated by dividing the amount of short sale with the amount of total trading of an underlying stock, *Spread* is calculated by dividing the difference between the best quoted sale price and the best quoted purchase price with the average of the two prices. The intercept and the control variables are not shown for the readability. The *t*-values are within the parentheses. ***, **, * represent the statistical significance at the levels of 1%, 5%, 10%, respectively

In Panel A, the O/S ratio is negatively related to future returns in the sub-sample of “good news” events. Although not presented in the table, the trading volume of put options decreases in the sub-sample of “good news” when both of the trading volume of call options and that of put options are included in regression models, but the statistical significance of the result is weak. In Panel B, the O/S ratio is positively related to future returns in the sub-sample of “bad news” events. The relation is statistically significant in the models where the effect of short sale is controlled for. Thus, it is considered that the O/S ratio contains information about future returns since the ratio reflects the trading volume of call options, which the investors with “good news” are interested in, that of put options, which the investors with “bad news” are interested in, and that of the underlying asset. When there is “good news” in the market, the decrease of the O/S ratio predicts the increase of returns in the future, while when there is “bad news” in the market, the increase of O/S/Ratio predicts the increase of returns in the future.

Panel C and Panel D show the results of regressing future returns on the C/P 1 ratio for the sub-samples of “good news” and “bad news,” respectively, but most of the results are not statistically significant. The regressions in Table 5 are carried out for separate samples since the insignificant results of Table 4 might have come from the events of conflicting information. However, none of the regression results in this table shows statistically significant result except for one in the sub-sample of “bad news.”

Table 4 showed the statistically significant relation between the C/P 2 ratio and future returns of the underlying stock. In Table 5, Panel E shows that the C/P 2 ratio is positively related to the future returns of CAR (0,1) and CAR (0,20) with a statistical significance. In Panel F, the C/P ratio is negatively related to future returns and the results are statistically significant for the future returns of most windows. It suggests that future underlying stock returns increase as the ratio of the open interest of call options to that of put options increases in the sub-sample of “good news,” which leads to a jump in the future return. On the contrary, in the sub-sample of “bad news,” which leads to a large drop in the future return, the future return decreases as the ratio of open interest of call options to that of put options increases. The results of Table 5 show that the open interest of options are more useful than the option trading volume in predicting the future returns of an underlying asset.

Table 6 shows the result from regressing future underlying stock returns on the option ratios for the sub-samples grouped by the future returns for each window. The dependent variables are CARs (0,T), which are the cumulative abnormal returns for the window from day 0 (event date) until day T. To do this, the entire sample is sorted into quintiles for the CAR of each window. Then, we regress CAR (0,T) on the option ratio of each panel and the control variables. The same process is repeated for all windows of future returns in the table. For example, in the row of CAR (0,1) in Panel A, the columns from Low through High show the regression coefficients of CAR (0,1), which result from the model with the O/S ratio for the corresponding sub-samples of CAR (0,1).

Panel A shows that the O/S ratio tends to be positively related to the future returns among the stocks with unfavorable information, which belong to the lower quintiles, while it tends to be negatively related to the future returns among the stocks with favorable information, which belong to the upper quintiles. The relation between the O/S ratio and the future returns remains consistent across the future returns of different windows from 1-day through 20-day. The absolute values of regression coefficients in subsample “Low” are larger than those in subsample “2”. The absolute values of regression coefficients in subsample “High” are also larger than those in subsample “4”. Assuming that the impact of information is proportionate to the absolute size of future returns, the result suggests that the change in the absolute value of future return to one-unit increase of the O/S ratio increases as the materiality of information increases. It proves that one can predict future underlying stock returns using the O/S ratio, which contains the information reflected through trading of call options and put options by informed traders.

Table 6. Regressions for the sub-samples by future stock returns

	1 (Low)	2	3	4	5 (High)
Panel A. Effect of the O/S ratio					
CAR (0,1)	0.6283*** (4.63)	0.2311*** (5.41)	0.0078 (0.40)	−0.2973*** (−6.57)	−0.7534*** (−4.87)
CAR (0,3)	0.6507*** (3.74)	0.4042*** (6.84)	0.0110 (0.24)	−0.4487*** (−7.89)	−0.9425*** (−5.42)
CAR (0,5)	0.8038*** (4.39)	0.4217*** (5.41)	0.0423 (0.89)	−0.4108*** (−5.89)	−1.1859*** (−5.46)
CAR (0,10)	1.3433*** (4.29)	0.8469*** (9.60)	0.0187 (0.30)	−0.6099*** (−6.44)	−1.2329*** (−3.24)
CAR (0,20)	1.7767*** (4.12)	1.0600*** (8.76)	0.0197 (0.43)	−0.8137*** (−7.01)	−1.4581*** (−2.77)
Panel B. Effect of the C/P 1 ratio					
CAR (0,1)	0.0816 (1.22)	−0.0810 (−0.44)	−0.0002 (−0.01)	0.0322* (1.82)	0.0238 (0.29)
CAR (0,3)	−0.0522* (−1.84)	−0.0155 (−1.10)	0.0087 (0.82)	0.0140 (0.41)	0.2839** (2.20)
CAR (0,5)	−0.0390 (−0.99)	−0.0350*** (−2.59)	−0.0301 (−1.52)	0.0049 (0.24)	0.2909* (1.77)
CAR (0,10)	0.1010 (0.74)	−0.0498* (−1.83)	−0.0148 (−0.70)	−0.0007 (−0.13)	0.2825 (1.07)
CAR (0,20)	0.1309 (1.00)	−0.0176 (−1.30)	−0.0178 (−1.41)	0.2830 (1.20)	0.4923 (1.21)
Panel C. Effect of the C/P 2 ratio					
CAR (0,1)	−0.1651* (−1.74)	−0.1424*** (−3.05)	−0.0378 (−1.02)	0.2809*** (2.98)	0.7591*** (3.14)
CAR (0,3)	0.0133 (0.08)	−0.1718*** (−3.67)	0.1236* (1.71)	0.4505*** (4.77)	1.6118*** (4.63)
CAR (0,5)	−0.1813 (−1.38)	−0.3047** (−2.95)	−0.0849 (−1.24)	0.2432*** (2.67)	1.6244*** (3.86)
CAR (0,10)	−0.7043** (−2.16)	−0.3655*** (−2.82)	0.1268 (1.14)	0.3047*** (2.77)	0.6545 (1.47)
CAR (0,20)	−0.6240 (−1.04)	−0.3770*** (−3.26)	−0.1016 (−1.02)	0.7243*** (4.69)	0.5610 (1.13)

Note(s): This table shows the result from regressing future underlying stock returns on the option ratios for quintiles sorted by each period of future returns. 1(Low), 2, 3, 4 and 5 (High) represent a quintile with the lowest CAR through the highest CAR, respectively. The dependent variables are CARs (0,T), which is calculated by cumulating the daily abnormal returns for the period of T days from day 0 (announcement date). Abnormal return is calculated by subtracting the return of the market composite index from the return of a stock. *O/S* represents the O/S ratio, which is calculated as the log of option trading volume to stock trading volume. *C/P 1* represents the C/P 1 ratio, which is calculated as the log of call option trading volume to put option trading volume and *C/P 2* represents the C/P 2 ratio, which is calculated as the log of open interest of call option to that of put option. The intercept and the control variables are not shown for the readability. The *t*-values are within the parentheses. ***, **, * represent the statistical significance at the levels of 1%, 5%, 10%, respectively

Panel B shows the results for C/P 1 ratio from the same regressions with those in Panel A. In the highest quintile of future returns, the ratio is positively related to CAR (0,3) and CAR (0,5) with a statistical significance. In the lowest quintile of future returns, there is a statistically significant and negative relation between CAR (0,3) and C/P 1 ratio. However, the relation is not consistent across the different windows of future return.

Panel C shows the results for C/P 2 ratio from the same regressions with those in Panel A. Unlike the C/P 1 ratio, the C/P 2 ratio tends to be negatively related to the future returns among the stocks with unfavorable information, which belong to the lower quintiles. The C/P 2 ratio tends to be positively related to the future returns among the stocks with favorable information, which belong to the upper quintiles. Although the predictability of the C/P 2 ratio and the O/S ratio suggest the opposite directions about the future returns, both of them are statistically significant.

The results from Table 4 through Table 6 show that both the O/S ratio and the C/P ratios, which are based on the trading volume in the options market, have the predictive power for future underlying stock returns. In Table 7 through Table 9, we investigate which ratio is better at predicting future returns by estimating the relation between the future returns and the option ratios with the regression models that include two ratios at the same time.

Table 7 shows the results from regressing future returns on the O/S ratio and the C/P 1 ratio to compare the return predictability of the two ratios. The intercept and the control variables are not shown in the table for the readability. Panel A shows the same result as that of Table 6. The O/S ratio tends to be positively related to the future returns among the stocks with unfavorable information, while it tends to be negatively related to the future returns among the stocks with favorable information. The C/P 1 ratio shows the statistically significant regression coefficient only in the lowest quintile of the future return.

In Table 6, the C/P 1 ratio was related to CAR (0,3) and CAR (0,5) with a statistical significance among the stocks that belong to the highest quintile of the future returns, but in Table 7, the ratio loses its statistical significance in the regression model that include both the O/S ratio and C/P 1 ratio. The C/P 1 ratio was also related to CAR (0,5) and CAR (0,10) with a statistical significance among the stocks that belong to the quintile "2" in Table 6, but its statistical significance disappears in Table 7. The results in Table 7 suggest that the O/S ratio, which reflects the trading volume of call options, put options, and an underlying asset, is a more effective indicator than the C/P 1 ratio, which reflects the trading volume of only call options and put options, to acknowledge the trading by informed investors in the options market.

Table 8 shows the results from regressing future returns on the O/S ratio and the C/P 2 ratio at the same time. The two option ratios showed the statistically significant relation to future returns in Table 6. In Table 6, the O/S ratio and the C/P 2 ratio tend to be positively and negatively related to future returns among the stocks with unfavorable information, respectively. The ratios also tend to be negatively and positively related to future returns among the stocks with favorable information, respectively. In Table 8, the O/S ratio shows the consistent results to those in Table 6, while the regression coefficients of the C/P 2 ratio are not statistically significant anymore. The result suggests that the O/S ratio has the better predictability for the future underlying stock return since it reflects the trading volume of not only options but an underlying asset. Our result is consistent with that of Blau *et al.* (2014), which show that the O/S ratio has the stronger predictive power for the future returns of an underlying asset.

Table 9 shows the results from regressing future returns on the C/P 1 ratio and the C/P 2 ratio at the same time to compare the predictability of future returns between the two option ratios. The C/P 1 ratio reflects the trading volume during the day, while the C/P 2 reflects the volume that remains unsettled at the end of the day. The former represents the investors' decision promptly but may fail to do so when the liquidity is low. The latter has a shortfall in

Table 7.
Regressions with the models including both the O/S ratio and the C/P 1 ratio

	1 (Low)	2	3	4	5 (High)
Panel A. Effects of the O/S ratio and the C/P 1 ratio on CAR (0,1)					
O/S ratio	0.7899*** (4.90)	0.3166*** (6.37)	−0.0143 (−0.31)	−0.3368*** (−6.45)	−1.0681*** (−5.28)
C/P 1 ratio	0.1271** (2.12)	0.0188 (1.36)	−0.0002 (−0.06)	0.0149 (1.05)	−0.0003 (−0.04)
Panel B. Effects of the O/S ratio and the C/P 1 ratio on CAR (0,3)					
O/S ratio	0.5712** (2.64)	0.5007*** (6.79)	−0.0143 (−0.13)	−0.5958*** (−8.75)	−1.1967*** (−5.42)
C/P 1 ratio	−0.0286 (−0.94)	0.0146 (0.79)	0.0085 (0.80)	−0.0279 (−1.49)	0.0727 (0.58)
Panel C. Effects of the O/S ratio and the C/P 1 ratio on CAR (0,5)					
O/S ratio	0.9322*** (4.32)	0.4468*** (4.71)	0.0120 (0.24)	−0.4710*** (−5.75)	−1.6739*** (−5.86)
C/P 1 ratio	−0.0048 (−0.08)	−0.0223 (−1.11)	−0.0197* (−1.70)	−0.0037 (−0.21)	0.0501 (0.43)
Panel D. Effects of the O/S ratio and the C/P 1 ratio on CAR (0,10)					
O/S ratio	1.8509*** (5.17)	0.9015*** (8.47)	0.0610 (0.78)	−0.8446*** (−7.49)	−1.6157*** (−3.21)
C/P 1 ratio	0.1519 (1.22)	−0.0140 (−0.30)	−0.0108 (−0.49)	−0.0696 (−1.26)	0.0626 (0.22)
Panel E. Effects of the O/S ratio and the C/P 1 ratio on CAR (0,20)					
O/S ratio	3.1868*** (5.77)	1.1507*** (8.99)	0.1114 (0.99)	−0.9405*** (−6.46)	−1.9225*** (−2.88)
C/P 1 ratio	0.2245* (1.89)	−0.0105 (−0.35)	−0.0205 (−1.08)	0.1039 (1.23)	0.0692 (0.18)

Note(s): This table shows the result from regressing future underlying stock returns on the option ratios for quintiles sorted by each period of future returns. 1(Low), 2, 3, 4 and 5 (High) represent the quintile with the lowest CAR through the highest CAR, respectively. The dependent variables are CARs (0,T), which is calculated by cumulating the daily abnormal returns for the period of T days from day 0 (announcement date). The abnormal return is calculated by subtracting the return of the market composite index from the return of a stock. Both the O/S ratio and the C/P 1 ratio are included in each regression model. *O/S* represents the O/S ratio, which is calculated as the log of option trading volume to stock trading volume and *C/P 1* represents the C/P 1 ratio, which is calculated as the log of call option trading volume to put option trading volume. The intercept and the control variables are not shown for the readability. The *t*-values are within the parentheses. ***, **, * represent the statistical significance at the levels of 1%, 5%, 10%, respectively

Table 8. Regressions with the models including both the O/S ratio and the C/P 2 ratio

	1 (Low)	2	3	4	5 (High)
Panel A. Effects of the O/S ratio and the C/P 2 ratio on CAR (0,1)					
O/S ratio	0.6491*** (4.27)	0.2134*** (4.48)	0.0022 (0.09)	−0.2814*** (−5.37)	−0.6767*** (−3.54)
C/P 2 ratio	0.0340 (0.32)	−0.0306 (−0.61)	−0.0309 (−0.64)	0.1007 (0.92)	0.2247 (0.65)
Panel B. Effects of the O/S ratio and the C/P 2 ratio on CAR (0,3)					
O/S ratio	0.7333*** (4.00)	0.3849*** (5.79)	0.0536 (0.78)	−0.4338*** (−6.12)	−0.6926*** (−3.40)
C/P 2 ratio	0.2425 (1.39)	−0.0264 (−0.65)	0.1307 (1.31)	0.0607 (0.62)	0.8786** (2.24)
Panel C. Effects of the O/S ratio and the C/P 2 ratio on CAR (0,5)					
O/S ratio	0.8595*** (4.35)	0.3910*** (4.40)	0.0247 (0.31)	−0.3938*** (−4.93)	−1.0424*** (−3.73)
C/P 2 ratio	0.0955 (0.81)	−0.0739 (−0.53)	−0.0809 (−1.03)	0.0618 (0.58)	0.4185 (0.81)
Panel D. Effects of the O/S ratio and the C/P 2 ratio on CAR (0,10)					
O/S ratio	1.2956*** (3.97)	0.8792*** (9.01)	0.0407 (0.58)	−0.6199*** (−5.52)	−1.2425*** (−2.82)
C/P 2 ratio	−0.1709 (−0.47)	0.1409 (1.07)	0.1017 (0.73)	−0.0108 (−0.09)	−0.0209 (−0.03)
Panel E. Effects of the O/S ratio and the C/P 2 ratio on CAR (0,20)					
O/S ratio	1.7848*** (4.02)	1.0522*** (7.89)	−0.0319 (−0.27)	−0.7036*** (−5.32)	−1.5710*** (−2.64)
C/P 2 ratio	0.0319 (0.05)	−0.0309 (−0.23)	−0.1406 (−1.04)	0.3015* (1.81)	−0.2708 (−0.42)

Note(s): This table shows the result from regressing future underlying stock returns on the option ratios for quintiles sorted by each period of future returns. 1(Low), 2, 3, 4 and 5 (High) represent a quintile with the lowest CAR through the highest CAR, respectively. The dependent variables are CARs (0,T), which is calculated by cumulating the daily abnormal returns for the period of T days from day 0 (announcement date). Abnormal return is calculated by subtracting the return of the market composite index from the return of a stock. Both the O/S ratio and the C/P 2 ratio are included in each regression model. *O/S* represents the O/S ratio, which is calculated as the log of option trading volume to stock trading volume and *C/P 2* represents the C/P 2 ratio, which is calculated as the log of open interest of call option to that of put option. The intercept and the control variables are not shown for the readability. The *t*-values are within the parentheses. ***, **, * represent the statistical significance at the levels of 1%, 5%, 10%, respectively

representing the trading information promptly because the investors' decision remains hidden until accumulated orders exceed the amount that is available for trading. Nevertheless, it can be a good alternative when the stock market liquidity is low.

In Table 6, the C/P 2 ratio tends to be negatively related to future returns among the stocks with unfavorable information. The ratio also tends to be positively related to future returns among the stocks with favorable information. The result of the C/P 1 ratio was less consistent than that of the C/P 2 ratio in Table 6. In Panel A of Table 9, the result for CAR (0,1) is consistent with that in Table 6, but the results for the future returns of other windows are different from those in Table 6. For example, both the C/P 1 ratio and the C/P 2 ratio are

	1 (Low)	2	3	4	5 (High)
Panel A. Effects of the C/P 1 ratio and the C/P 2 ratio on CAR (0,1)					
C/P 1	0.1219* (1.81)	0.0027 (0.33)	0.0000 (0.02)	0.0243** (2.34)	0.0515 (0.53)
C/P 2	−0.2082** (−2.04)	−0.2609** (−2.63)	−0.0234 (−0.41)	0.3633** (2.40)	1.0556*** (2.75)
Panel B. Effects of the C/P 1 ratio and the C/P 2 ratio on CAR (0,3)					
C/P 1	−0.0523* (−1.83)	−0.0010 (−0.26)	0.0079 (0.70)	−0.0024 (−0.16)	0.0414 (0.33)
C/P 2	0.0514 (0.28)	−0.1534** (−2.47)	0.1123 (1.21)	0.7120*** (4.47)	1.7019*** (3.83)
Panel C. Effects of the C/P 1 ratio and the C/P 2 ratio on CAR (0,5)					
C/P 1	−0.0381 (−0.91)	−0.0262** (−2.03)	−0.0355* (−1.69)	0.0113 (0.56)	0.1027 (0.70)
C/P 2	−0.0716 (−0.49)	−0.4728*** (−2.87)	0.0345 (0.26)	0.4654*** (3.05)	1.6805*** (2.97)
Panel D. Effects of the C/P 1 ratio and the C/P 2 ratio on CAR (0,10)					
C/P 1	0.2100 (1.45)	−0.0639** (−2.00)	−0.0148 (−0.71)	−0.0005 (−0.18)	0.2409 (0.89)
C/P 2	−0.9805** (−2.17)	−0.2405 (−1.43)	0.0408 (0.31)	0.3745*** (2.70)	1.1907 (1.43)
Panel E. Effects of the C/P 1 ratio and the C/P 2 ratio on CAR (0,20)					
C/P 1	0.1813 (1.29)	−0.0151 (−1.13)	−0.0208 (−1.13)	0.1726* (1.73)	0.3654 (0.90)
C/P 2	−0.8929 (−1.29)	−0.3727*** (−2.93)	−0.1624 (−0.90)	0.5435*** (2.78)	1.0009 (1.09)

Note(s): This table shows the result from regressing future underlying stock returns on the option ratios for quintiles sorted by each period of future returns. 1(Low), 2, 3, 4 and 5 (High) represent a quintile with the lowest CAR through the highest CAR, respectively. The dependent variables are CARs (0,T), which is calculated by cumulating the daily abnormal returns for the period of T days from day 0 (announcement date). Abnormal return is calculated by subtracting the return of the market composite index from the return of a stock. Both the C/P 1 ratio and the C/P 2 ratio are included in each regression model. The intercept and the control variables are not shown for the readability. *C/P 1* represents the C/P 1 ratio, which is calculated as the log of call option trading volume to put option trading volume and *C/P 2* represents the C/P 2 ratio, which is calculated as the log of open interest of call option to that of put option. The intercept and the control variables are not shown for the readability. The *t*-values are within the parentheses. ***, **, * represent the statistical significance at the levels of 1%, 5%, 10%, respectively

Table 9.
Regressions with the models including both the C/P 1 ratio and the C/P 2 ratio

related to CAR (0,10) with a statistical significance in Table 6, but the regression coefficient of the C/P 2 ratio is not statistically significant in Panel D of Table 9 while that of the C/P 1 ratio still remains statistically significant. The results of Table 9 suggest that no C/P ratio is dominant in predicting the future returns of the underlying stock. The predictability is relative to each other between the trading volume and the open interest of options, depending on the time period and the level of future returns.

5. Robustness

Table 10 shows whether the results of this study hold when the effects of the past returns and the past volatility of underlying assets are controlled for in the regression model [5]. Panel A and Panel B show the results from regressing CAR (0,1) of an underlying stock on the O/S ratio with the models which include CAR (−10,−1) and CAR (−20,−1), respectively. Panel C and Panel D show the results from regressing CAR (0,1) of the underlying stock on the O/S ratio with the models which include Vol (−10,−1) and Vol (−20,−1), respectively. Vol (−10,−1) and Vol (−20,−1) are calculated by averaging *Volatility* from day $t-10$ to day $t-1$ and from day $t-20$ to day $t-1$, respectively. Panel E shows only the regression coefficients of CAR (0,20) in the results from the models used in Panel A, Panel B, Panel C, and Panel D, respectively.

According to the results from robustness test, the return predictability of option ratios remains consistent when the relation between the option ratios and the future returns are estimated with the regression models that include the past return or the past volatility of an

Table 10. Robustness test

	1 (Low)	2	3	4	5 (High)
Panel A. Effect of the O/S ratio on CAR (0,1)					
O/S	0.6211*** (4.55)	0.2107*** (5.17)	0.0075 (0.34)	−0.2564*** (−5.89)	−0.7338*** (−4.94)
Return	9.2223 (1.35)	1.8147 (0.84)	1.9164 (1.19)	−1.1007 (−0.49)	2.7816 (0.35)
Volatility	−10.7505 (−1.14)	−4.3856 (−1.54)	1.4777 (0.79)	5.4443* (1.71)	26.7123*** (2.73)
Short	−6.5876** (−2.38)	−2.4838*** (−3.22)	0.5995 (1.14)	0.6291 (0.67)	2.3568 (0.86)
CAR (−10,−1)	−0.8934 (−0.32)	0.0645 (0.08)	−1.5605** (−2.47)	0.0797 (0.09)	−4.0242 (−1.01)
Adjusted R^2	0.8178	0.8426	0.0657	0.8389	0.7736
Panel B. Effect of the O/S ratio on CAR (0,1)					
O/S	0.5819*** (4.34)	0.2111*** (5.19)	0.0028 (0.13)	−0.2528*** (−5.81)	−0.7376*** (−4.95)
Return	8.7844 (1.32)	1.9114 (0.88)	1.6975 (1.05)	−1.1517 (−0.51)	3.8142 (0.47)
Volatility	−10.2873 (−1.11)	−4.4068 (−1.56)	1.7605 (0.93)	5.4592* (1.73)	26.2916*** (2.69)
Short	−7.2567*** (−2.66)	−2.4622*** (−3.19)	0.6032 (1.14)	0.6180 (0.66)	2.3697 (0.87)
CAR (−20,−1)	4.6303** (2.10)	0.2359 (0.41)	−0.9514** (−2.32)	0.3134 (0.49)	−1.3986 (−0.85)
Adjusted R^2	0.8249	0.8428	0.0596	0.8393	0.7730
Panel C. Effect of the O/S ratio on CAR (0,1)					
O/S	0.6278*** (4.43)	0.2152*** (5.23)	−0.0002 (−0.01)	−0.2566*** (−5.76)	−0.6349*** (−4.58)
Return	9.3547 (1.37)	1.7218 (0.80)	1.4298 (0.88)	−1.0892 (−0.47)	5.6598 (0.76)
Volatility	−10.9528 (−1.15)	−4.8474* (−1.67)	2.0163 (1.04)	5.4051 (1.57)	7.2144 (0.72)
Short	−6.9560** (−2.35)	−2.5459*** (−3.29)	0.7766 (1.45)	0.6141 (0.64)	0.9622 (0.38)
Vol (−10,−1)	1.3431 (0.28)	0.7592 (0.67)	−1.1862 (−1.48)	0.0727 (0.05)	25.7654*** (4.34)
Adjusted R^2	0.8178	0.8433	0.0312	0.8389	0.8062
Panel D. Effect of the O/S ratio on CAR (0,1)					
O/S	0.5801*** (4.11)	0.2096*** (4.96)	0.0020 (0.08)	−0.2492*** (−5.61)	−0.6752*** (−4.47)
Return	9.1197 (1.34)	1.7829 (0.83)	1.4182 (0.86)	−0.8176 (−0.36)	1.7126 (0.21)
Volatility	−8.2442 (−0.84)	−4.3568 (−1.52)	1.7582 (0.89)	4.8844 (1.48)	22.5076** (2.25)
Short	−5.6866* (−1.92)	−2.4839*** (−3.22)	0.7542 (1.39)	0.4849 (0.50)	2.1330 (0.79)
Vol (−20,−1)	−3.6611 (−0.90)	−0.0824 (−0.10)	−0.3108 (−0.46)	0.5901 (0.63)	4.2252 (1.46)
Adjusted R^2	0.8190	0.8426	0.0128	0.8395	0.7760

(*continued*)

Table 10.

	1 (Low)	2	3	4	5 (High)
Panel E. Effect of the O/S ratio on CAR (0,20)					
O/S	1.8192*** (4.57)	1.1079*** (9.39)	0.2284*** (2.91)	−0.4111*** (−4.28)	−0.8516*** (−2.29)
Adjusted R^2	0.8523	0.9249	0.5568	0.82010	0.8223
O/S	0.9187*** (4.88)	0.9027*** (7.30)	0.1902*** (2.51)	−0.3418*** (−4.02)	−0.2080* (−1.73)
Adjusted R^2	0.9688	0.9312	0.5968	0.8593	0.9007
O/S	1.4935*** (3.84)	0.9932*** (8.53)	0.2444*** (3.00)	−0.4341*** (−4.37)	−0.5741* (−1.66)
Adjusted R^2	0.8638	0.9318	0.5527	0.8193	0.8306
O/S	0.8132*** (3.50)	0.9118*** (7.60)	0.2363*** (2.70)	−0.3164*** (−2.98)	0.0401 (−1.13)
Adjusted R^2	0.9535	0.9333	0.5502	0.8262	0.8858

Note(s): This table shows the result from regressing future underlying stock returns on the option ratios for quintiles sorted by each period of future returns. 1(Low), 2, 3, 4 and 5 (High) represent a quintile with the lowest CAR through the highest CAR, respectively. The dependent variables of Panel A through Panel D are CAR (0,1), which is the cumulative abnormal return for the window from day 0 to day 1. The dependent variable of Panel E is CAR (0,20), which is the cumulative abnormal return for the window from day 0 to day 20. The abnormal return is calculated by subtracting the return of the market composite index from the return of a stock. *O/S* represents the O/S ratio, which is calculated as the log of option trading volume to stock trading volume, *Return* is the daily return of an underlying stock, *Volatility* is calculated by dividing the difference between the highest price and the lowest price of an underlying stock with the average of the two prices, *Short* is calculated by dividing the amount of short sale with the amount of total trading of an underlying stock, CAR (−10,−1) and CAR (−20,−1) are the cumulative abnormal returns for the period from day $t-10$ to day $t-1$ and for the period from day $t-20$ to day $t-1$, respectively, Vol (−10,−1) and Vol (−20,−1) are calculated by averaging *Volatility* from day $t-10$ to day $t-1$ and from day $t-20$ to day $t-1$, respectively. In Panel E, the intercept and the control variables are not shown for the readability. The *t*-values are within the parentheses. ***, **, * represent the statistical significance at the levels of 1%, 5%, 10%, respectively underlying asset. It proves that the results of our study are not from the effect of the past returns or the past volatility but they suggest the predictive power of the option ratios for future underlying stock return.

6. Concluding remarks

Prior research shows that informed traders prefer the options market to the stock market for several reasons. It implies that information about stocks may be released in the options market. Using the single stock options listed on the Korea Exchange, we test whether two well-known option trading volume ratios can have the predictability for the future returns of an underlying asset, and whether there is a superior indicator if both ratios have the statistically significant return predictability.

Main findings of this paper are as follows. First, the O/S ratio, which reflects the option trading volume to the stock trading volume, has the predictive power for future underlying stock return. Second, the C/P ratio, which is the trading volume of call options to that of put options, also predicts the future returns of an underlying stock. Third, the effect of the O/S ratio is relatively stronger in predicting the future returns than that of the C/P ratio is. This result is consistent with Blau *et al.* (2014).

Our study provides evidence that information achieved in the options market has the predictive power for future returns of the underlying asset, based on the notion of informed traders' preference over the options market to the stock market. In particular, we analyze the options of single stocks, which are little studied in prior research. The results of our study suggest that the single stock options market is efficient and influences the price discovery process of the stock market.

The volume indicators used in this study are calculated by aggregating both the sale volume and the purchase volume. It leads to a limitation in this study since the indicators do not deal with the net trading volume, which is calculated by subtracting the sale volume from the purchase volume. We expect that further research with net trading volume measures will generate meaningful results.

Notes

1. Put-call ratio or call-put ratio is used depending on the research. Our study does not differentiate them since the economic interpretation does not change.
2. The KOSPI (Korea Composite Stock Price Index) is used as the market composite index for most observations and the KOSDAQ composite index is used for only one stock, which is listed on KOSDAQ.
3. We calculate the CARs for the periods starting on the announcement date as this study aims to analyze option ratios' predictive power for future returns using the events of preliminary earnings announcement. We are grateful for the anonymous reviewer for this valuable comment.
4. Future returns are represented by CAR (0,T), which is the cumulative abnormal return for the period of T days from day 0 (the announcement date). Abnormal returns are calculated by subtracting the return of KOSPI for the stocks listed on the KOSPI market and that of KOSDAQ for the stocks listed on the KOSDAQ market, respectively, from the return of each stock.
5. We are grateful to the anonymous reviewer for this valuable comment. Using the recommended models, we carried out regressions for *O/S*, *C/P 1*, and *C/P 2*, respectively. Since the results repeatedly show those in the previous tables, we only present the table with *O/S*.

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