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How does divergence of opinions affect the relative trading activity and information content in option and stock prior to takeover announcement?

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ABSTRACT

This paper examines whether the options/stock trading volume ratio (O/S) is higher when investors' opinions are more diverse with respect to the value of acquirer during pre-takeover announcement period and explores how divergence of opinions affects the predictive power of O/S on subsequent stock prices. We find that the coefficients of proxies for diversity of opinion are significantly positive, suggesting that more disagreements tend to have higher volumes of option trading relative to stock. Less predictive powers of O/S on subsequent stock returns are associated with larger divergence of opinion, implying that O/S contains less information about subsequent stock price movements when the divergence of opinions of acquirer firm is higher.

1. Introduction

Over the past few decades, a considerable number of studies have been conducted on the relative merits of trading in option and stock to explore where the informed trader should trade. Nevertheless, only few attempts have been made to date to examine the relative trading volume in derivatives and their underlying assets. Roll, Schwartz, and Subrahmanyam (2010) explore the determinants of the options/stock trading volume ratio (O/S). They suggest that O/S might be driven by informed trades. Choy and Wei (2012) find that around earnings announcements, stocks associated with greater dispersion of opinions tend to have a higher O/S. Moreover, option trading is mostly driven by differences of opinion instead of information asymmetry. Since the extent of informed trading during a pre-takeover announcement period should be higher than such trading during pre-earning announcement period[1], the impact of dispersion of opinions should be lower than that of information asymmetry during a pre-takeover announcement period. Therefore, we explore whether more disagreements still tend to result in higher O/S during a pre-takeover announcement period[2].

Although a great deal of effort has been made to study the relationship between divergence of opinions and stock market price (Miller, 1977; Chen, Hong, & Stein, 2002; Diether, Malloy, & Scherbina, 2002), little is known about the effect of divergence of opinions on a particular type of corporate event. For example, Berkman, Dimitrov, Jain, Koch, and Tice (2009) expect earnings announcements to reduce differences of opinions among investors; consequently, these announcements should reduce overvaluations. Moeller, Schlingemann, and Stulz (2007) document that, in mergers and acquisitions, as divergence of opinions increases related to an acquirer's equity value, acquirer return on equity offers decreases. Chatterjee, John, & Yan (2012) indicate that total takeover premium

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[1] Cao, Chen, and Griffin (2005) document that unlike preplanned earning announcements, takeover announcements are not scheduled; even the announcement's pending is not known by the public. Abnormal pre-takeover announcement trading could be initiated primarily by informed traders. The extent of informed trading during a pre-takeover announcement period should be higher than such trading during pre-earning announcement period.

[2] In our paper, there could be two kinds of disagreement, which are the disagreement about the likelihood of a takeover announcement and the disagreement about the firm value. Since takeover announcement's pending is not known by the public, the latter type of disagreement should dominate the former one.

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is higher when investors have a greater diversity of opinions on the target's value. Unlike prior studies' focus on the stock price of acquirer or target, we pay attention to trading volume. Further, the past studies on diversity of opinions for a takeover have only been conducted on stock market. The impact of diversity of opinions on the linkage between option and stock markets during a takeover has never been discussed[3]. Because both higher volumes of options and stocks should be associated with a higher diversity of opinions, the relative trading activity in options and stocks of the acquirer is uncertain. That is, we use the option/stock trading volume ratio proposed by Roll et al. (2010) to explore whether O/S is higher when investors have greater diversity of opinions on the value of acquirer[4].

Johnson and So (2012) find that O/S negatively predicts the returns of options' underlying stocks over a one-week horizon because informed traders use options more frequently for bad news[5]. Instead, Chan, Li, and Lin (2015) make a regression of acquirer absolute return on unsigned O/S because M&A event could be good news or bad news. They show that higher O/S predicts higher acquirer absolute announcement return. In particular, we explore how divergence of opinions on equity value of acquirer affects the predictive power of O/S on subsequent stock prices during pre-takeover announcement period.

Moreover, although Miller's overvaluation[6] occurs when both dispersion of opinions and short-sale constraints are relatively high, the above empirical tests have typically focused on only dispersion of opinions. These uni-dimensional approaches might reduce the power of the magnitude of the measured overvaluation. Therefore, the extant literature contains some inconclusive empirical results. Boehme, Danielsen, and Sorescu (2006) examine the two Miller dimensions using proxies for both differences in marginal costs of short selling and dispersion of opinions. They find robust evidence of Miller-style overpricing and acquire point-estimates of ex-post abnormal returns, which are significantly more negative than previously reported. Therefore, in this paper, short-sale constraints are also concerned to increase the power of the linkage between option and stock markets in takeover[7].

We find that the coefficients of the proxy of diversity of opinions are significantly positive, indicating that more disagreements tend to have higher option trading volume relative to stock trading during the pre-takeover announcement period. The predictive powers of the O/S on subsequent stock returns in higher divergence of opinions are weaker, implying that the options volume contains less information about subsequent stock price movements. In addition, the information effects of options and stocks volume from both dispersion of opinions and short-sale constraints are not stronger than those only from dispersion of opinions.

This paper contributes to the literature on divergence of opinions in two important aspects. First, the related studies focus on the effect of the divergence of opinions on stock prices in the stock market. For example, Moeller et al. (2007) explore the relation between divergence of opinions of the acquirer and its abnormal return, and Chatterjee et al. (2012) examine the effect of divergence of opinions of the target on takeover premium. Further, we extend the research to the options market. That is, we investigate whether the divergence of opinions of the acquirer could influence the decisions of informed traders to trade in the stock or option market during the pre-takeover announcement period. We believe our attempt is the first to focus on the options market in a takeover in the literature on divergence of opinions. Second, Moeller et al. (2007) and Chatterjee et al. (2012) focus on the effect of divergence of opinions on abnormal stock return around takeover announcements, whereas we are concerned with the influence on relative volume of option and stock and the information content of volume of option and stock on future stock prices.

Our paper also contributes to the literature on O/S. The related studies focus on the effect of O/S on stock's announcement abnormal return around earning and takeover announcements. Around earning announcements, Roll et al. (2010) document that post-announcement absolute returns are positively related to pre-announcement O/S. Johnson and So (2012) find that firms in the lowest decile of the O/S outperform the highest decile. Around takeover announcement, Shafer (2012) finds that the deviations in dollar O/S have some predictive power of a target firm's abnormal returns on the day prior to the acquisition announcement. Chan et al. (2015) show that higher O/S predicts higher acquirer absolute announcement return. Ge et al. (2014) find that the signed O/S measures can predict announcement returns for both earnings announcements and unscheduled corporate events. Further, we explore whether the divergence of opinions have the impact of predictive power of O/S on announcement return.

The remainder of this paper is organized as follows. Section 2 develops testable hypotheses. Section 3 describes the data and defines the variables. Section 4 presents the regression results and discussions, and Section 5 tests the robustness checks. Section 6 provides our conclusion and suggestion.

2. Hypotheses

According to Chordia, Huh, and Subrahmanyam (2007), dispersion in analysts' opinions is positively related to stock trading volume. Choy and Wei (2012) show that option trading is primarily driven by differences in opinions, indicating that greater disagreements lead to higher option trading volume. Specifically, around earning announcement, they find that more disagreements tend to create higher option trading volume relative to the stock trading volume. In addition, option trading is mostly driven by differences of opinion instead of information asymmetry. Because the extent of informed trading during a pre-takeover announcement period should be higher than that during pre-earning announcement period, the impact of dispersion of opinions should be lower than that of information asymmetry during a pre-takeover announcement period. Moreover, during the pre-announcement takeover period, informed traders prefer to trade options, and then option contains more information (Hu, 2014). Since takeover event might be good (or bad) news for investors, informed traders would long (short) call options or short (long) put options. In each case, O/S should increase. Therefore, we explore whether more disagreements still

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[3] Cao and Ou-Yang (2009) find that, during normal period, disagreements over the mean of the current- and next-period public information lead to trading in stocks during the current period but have no effect on options trading.

[4] Elkamhi, Lee, and Yao (2011) also use the ratio of options' open interest to stock trading volume (OI/S) and find that OI/S is a conditional measure of informed option trading.

[5] Ge, Lin, and Pearson (2014) use signed option volume to examine which components of option volume predict returns. They find no evidence that trades related to synthetic short positions in the underlying stocks contain more information than trades related to synthetic long positions. They argue that the role of options in providing leverage is the most important reason why options trading predict stock returns.

[6] Miller (1977) argues that, when investors with heterogeneous beliefs are subject to short-sales constraints, a stock's price reflects the valuations of optimists, but do not reflect the valuations of pessimists, because the pessimists simply sit out of the market. Conditional on a fixed stock float, the greater divergence of opinions in a stock price's valuation by optimists and pessimists is associated with the higher price of the stock in equilibrium.

[7] Lin, Liu, and Driessen (2013) find that informed traders choose to use the options market particularly because of short-sale constraints. Hao, Lee, and Piqueira (2013) show that in general short sales of the underlying stock contain more information than put options. Chen, Chen, and Chou (2014) argue that short-sale constraints relaxation allows traders to switch part of their trading demand to the stock market.

tend to result in higher O/S during a pre-takeover announcement period.

Hypothesis 1 (H_1) *(:).* When divergence of opinions of acquirer firm is greater, the magnitude of increasing acquirer's abnormal option trading volume is higher than that of stock trading volume during the pre-announcement takeover period. Therefore, the option/stock trading volume ratio (O/S) increases.

Divergence of opinions could arise due to differential interpretations of public information (Kandel & Pearson, 1995). Higher different opinions should be accompanied with more small investors. The more active trading in the small investors is not due to informed traders splitting the orders. It is mostly driven by speculation on the continuation of return momentums (Choy & Wei, 2012). Therefore, when the divergence of opinions of acquirer firm is higher, there should be less informed traders in the market. The predictive power of option/stock trading volume ratio (O/S) on future stock return is weaker.

Hypothesis 2 (H_2) *(:).* When the divergence of opinions of acquirer firm is higher, the predictive power of option/stock trading volume ratio (O/S) on future stock return is weaker.

The above hypotheses only focus on dispersion of opinions, which might reduce abnormal option trading volume and its predictive power. Following Nagel (2005) and Berkman et al. (2009), we add a proxy for short-sales constraints to explore whether the effect in hypothesis 2 is stronger than that only from dispersion of opinions.

3. Data and variable definitions

3.1. Data

The takeover sample consists of all firms that were merger or tender-offer acquirers[8] and had options listed on Chicago Board Options Exchange (CBOE) from January 1996 to December 2013[9]. Takeover announcement are identified by the Security Data Corporation (SDC) database. Following Schwert (1996), we define the announcement day[10] as an official bid is received. We define the announcement date as date 0; the period from trading −200 to −100 as the benchmark period; and the period from trading −30 to −1 as the preannouncement period. Daily stock prices, volume, dividend, and split information are acquired from the Center for Research in Security Prices (CRSP), while the intraday stock trade and quote data are obtained from the Trade and Quote (TAQ) database distributed by the New York Stock Exchange (NYSE). Intraday option prices and volume are acquired from Ivy DB Option Metrics Database.

The final sample of acquisition is selected according to the following criteria:

1. We retain those events which are classified as "acquisition of a major interest", "acquisition of a partial interest", and "acquisition of a remaining interest"[11].
2. The deal is classified by SDC as either successful, unconditional, or withdrawn.
3. The deal value is equal to or greater than $1 million.
4. The target is a US public firm or a US private firm.
5. The deal value must be at least 0.1% of the market value of the acquirer.
6. Our sample is limited to pure cash or pure equity offers.
7. Data on the acquirer and target is available from CRSP and COMPUSTAT.

Finally, 291 acquirers are examined in our sample.

To appreciate the information content of stock volume, one must divide volume into buyer- and seller-initiated one since TAQ has not classified the volume. We use the algorithm used by Lee and Ready (1991). If a transaction occurs above (under) the prevailing quote midpoint, it is regarded as a buy (sell)-initiated volume. If a transaction occurs exactly at the quote midpoint, it is signed using the previous transaction price according to the tick test (i.e., buys if the sign of the last non-zero price change is positive and vice versa).

We compute the share options/stock volume ratio (ShO/S) and the dollar options/stock volume ratio ($O/S) for each acquirer on each day. The natural logarithms of these ratios are used to reduce the influence of possible outliers. For convenience, O/S would be referred to the logged variables.

Table 1 presents some summary statistics associated with the different O/S measures. For each firm in the sample, we calculate summary statistics over the firm's time-series observations of O/S. Then cross-sectional statistics are computed using the time-series statistics. The mean and median of O/S are very close to each other and the value of O/S in shares is larger than that in dollars. The mean kurtosis is fairly small. Therefore, O/S appears well-behaved and suitable for the linear regression analysis.

Table 2 provides the change in O/S summary statistics from benchmark period to preannouncement period. The increasing mean and median of O/S (the rates of change are all positive) indicate that investors prefer to trade options during preannouncement period than during benchmark period. The explanations are as follows. Cao et al. (2005) find that, during the benchmark period, lagged stock volume are more informative of next-day return and lagged call volume imbalances are not related to returns. In the preannouncement period, call volume imbalances become significant predictors of next-day stock returns. Hao et al. (2013) find similar results in the put option market. Based on the above findings, we can conclude that informed traders prefer trade options (stocks) to stocks (options) during the preannouncement (benchmark) period. Therefore, the option/stock trading volume ratio (O/S) of acquirer should increase prior to takeover announcement.

3.2. Measure of opinion divergence

Idiosyncratic volatility of the stock, which is defined as the standard deviation of the firm's daily abnormal stock return, is the proxy for divergence of opinions. According to Diether et al. (2002), and Boehme et al. (2006), a higher idiosyncratic volatility is accompanied with a larger divergence of opinions.

[8] Although the returns for target firm stocks around the takeover announcement are typically very large and informed traders, who attempt to profit from a large change in firm value, should trade in the target stocks and options to profit from the private information, we focus on acquirers instead of targets since many targets are private firms without option trading and acquirers are important for their larger market capitalization.

[9] The sample starts in 1996 as the Option Metrics Database used is only available from 1996.

[10] We take the SDC announcement date as day 0 unless the announcement takes place after 4:00 P.M. Eastern time in which cases we assign the following trading day as day 0.

[11] The definitions are as follows: Acquisition of a major interest: the acquirer must have held less than 50% and be seeking to acquire 50% or more, but less than 100% of the target company's stock; Acquisition of a partial interest: deals in which the acquirer holds less than 50% and is seeking to acquire less than 50%, or the acquirer holds over 50% and is seeking less than 100% of the target company's stock; Acquisition of a remaining interest: deals in which the acquirer holds over 50% and is seeking to acquire 100% of the target company's stock.

Table 1
Time series summary statistics for option/stock volume ratios prior to takeover announcement
This table presents some summary statistics associated with the different O/S measures during the period from 30 to 1 day prior to announcement day. For each firm in the sample, we calculate summary statistics over the firm's time-series observations of O/S. Then cross-sectional statistics are computed using the time-series statistics. Panel A presents the time series summary statistics for dollar options/stock volume ratio, while Panel B shows the time series summary statistics for share options/stock volume ratio. Mean is the sample mean. Std is the standard deviation.

	Mean	Median	Std	Skewness	Kurtosis	Maximum	Minimum
Panel A: dollar options/stock volume ratio, Ln($O/S)							
Mean	−11.188	−11.154	1.227	−0.063	0.492	−8.858	−13.664
Median	−11.206	−11.089	1.208	−0.105	0.022	−8.630	−13.462
Std	1.597	1.590	0.477	0.701	1.604	1.361	2.511
Skewness	−0.286	−0.308	0.267	0.452	1.397	−0.713	−0.231
Kurtosis	−0.519	−0.471	−0.267	1.435	4.310	0.472	−0.469
Panel B: share options/stock volume ratio, Ln(ShO/S)							
Mean	−3.725	−3.703	1.066	−0.027	0.314	−1.700	−5.823
Median	−3.729	−3.691	1.032	−0.025	0.079	−1.507	−5.872
Std	1.458	1.440	0.451	0.654	1.485	1.265	2.169
Skewness	−0.265	−0.290	0.652	0.010	1.768	−0.424	−0.127
Kurtosis	−0.401	−0.284	0.797	1.275	7.923	0.321	−0.584

Table 2
The change of O/S summary statistics from benchmark period to preannouncement period
This table presents the change of O/S summary statistics from benchmark period to preannouncement period. We define the announcement date as date 0; the period from trading −200 to −100 as the benchmark period; and the period from trading −30 to −1 as the preannouncement period. Panel A presents the change of O/S summary statistics for dollar options/stock volume ratio, while Panel B shows the change of O/S summary statistics for share options/stock volume ratio. Mean is the sample mean. Std is the standard deviation.

	Mean	Median	Std	Skewness	Kurtosis	Maximum	Minimum
Panel A: dollar options/stock volume ratio, Ln($O/S)							
benchmark	−11.073	−11.033	1.323	0.006	0.741	−7.907	−14.345
Pre-anno	−11.154	−11.117	1.230	−0.062	0.507	−8.813	−13.646
Change (%)	0.729	0.766	−6.994	−1117.296	−31.576	11.447	−4.873
volume ratio, Ln(ShO/S)							
benchmark	−3.651	−3.633	1.138	0.019	0.558	−0.876	−6.374
Pre-anno	−3.699	−3.672	1.070	−0.037	0.328	−1.674	−5.821
Change (%)	1.295	1.078	−5.975	−294.302	−41.214	91.171	−8.670

Therefore, larger divergence of opinions suggests more disagreement over the company in question, which could result in higher option and stock trading volumes by either informed or convinced investors. If the increasing magnitude of option trading is higher than that of stock trading, higher divergence of opinions is associated with higher O/S.

3.3. Measures of short-sale constraint

Institutional ownership (INSOWN) is used as a proxy for short-sale constraint. According to Nagel (2005), institutions could be subject to short-sale constraints in two ways. First, institutional investors could usually be unable or unwilling to short for various cultural and institutional reasons. For example, Almazan, Brown, Carlson, and Chapman (2004) document that only about 30% of mutual funds are allowed by their rules to sell short and only about 3% of funds do sell short. Second, under some circumstances, short sellers could be constrained by the costs of selling short. In addition, short-sale constraints are less binding for stocks that are mostly held by lending investors. In stock markets, institutional investors always provide the mass of loan supply. Large insurance companies, passive index funds, and pension funds are the active lenders[12]. When institutional ownership is higher, the cost to sell short is lower because there is plenty of stock loan supply. Therefore, we could conclude that higher level of institutional ownership signals that short-sale constraints are less binding.

INSOWN is calculated by the fraction of the firm's shares held by institutional agents before announcement, as reported in Thomson Financial's CDA/Spectrum Institutional Holdings data. INSOWN is zero if ownership data are not available during the preannouncement period.

The relationship between institutional ownership and O/S is uncertain. Large and better-known firms usually attract institutions to invest their options. Thus, we might expect a positive relation between institutional ownership and O/S. Nevertheless, higher institutional ownership indicates less individual holdings. Because individuals might trade more often than institutions based on the mistaken belief that they have information, such activity may result in a negative relation between institutional ownership and O/S. Thus, the relationship between institutional ownership and O/S is uncertain.

3.4. Control variables

3.4.1. For O/S

Based on Roll et al. (2010), we control the following variables to examine the relation between O/S and divergence of opinions: firm size, option spreads, implied volatility, option delta and the number of analysts following the firm.

First, in the financial literature, firm size is a standard control variable. Intuitively, larger firms would have more liquid options and stock markets allowing more trading. Therefore, the effect of firm size on O/S is uncertain. The log of firm size (market capitalization) is used as an explanatory variable.

Second, option spreads are used to measure the trading costs in the option market. Higher spreads are associated with lower O/S.

[12] D'Avolio (2002) shows that the degree of institutional ownership explains 55% of cross-sectional variation in loan supply.

Table 3
Summary statistics for explanatory variables
For every variable used to explain the options/stock volume ratios, a daily cross-sectional mean is computed for each trading day and then various statistics are computed from the daily means across pre-announcement takeover period. Size is the firm's size in $millions. % Spread is 100 × (Ask − Bid)/[(Ask + Bid)/2]. Implied volatility (imvola) and delta pertain to the options traded (with put deltas being reversed in sign). Analysts is the number of analysts following for a firm. Idiosyncratic volatility (idvola) of the stock, which is defined as the standard deviation of the firm's daily abnormal stock return, is the proxy for divergence of opinions. Institutional holding (insti) is the fraction of the firm's shares held by institutions (in percent). The IV spread is the average difference of implied volatilities between call and put options on the same stock with the same maturity and strike price. The IV skew is defined as the difference between implied volatilities of out-of-the-money (OTM) put and at-of-the-money (ATM) call. Std is the standard deviation in daily means. MAD is the mean absolute deviation. The fraction greater than zero in the overall sample days is given by % >0.

	Size	Spread	Delta	imvola	Analyst	idvola	insti	IV spread	IV skew
Mean	8.653	0.548	0.042	0.474	5.992	0.003	0.202	−0.011	0.048
Median	8.537	0.501	0.037	0.449	4.000	0.002	0.193	−0.008	0.045
Std	1.798	0.263	0.079	0.171	5.422	0.003	0.118	0.028	0.039
MAD	1.425	0.205	0.062	0.130	3.975	0.002	0.097	0.018	0.027
Skewness	0.418	0.906	0.309	0.948	1.659	0.746	0.426	−0.534	0.975
Kurtosis	0.227	0.565	−0.253	0.812	2.356	4.162	−0.400	4.455	3.623
Maximum	14.257	1.351	0.244	1.006	26.00	0.019	0.558	0.114	0.205
Minimum	4.751	0.127	−0.117	0.196	1.000	0.001	0.002	−0.146	−0.063
% >0	100.0	100.0	69.281	100.0	100.0	100.0	100.0	24.658	95.349

The percentage spread is measured as the average bid-ask spread divided by the midpoint over all options for each firm in each day.

Third, higher implied volatility of option may attract more informed traders because investors would earn higher profits on their information signal in more volatile firm. Higher implied volatility is associated with higher O/S.

Fourth, a higher option delta implies more sensitivity to changes in the underlying stock price. Firms whose options have higher delta would require less option contracts to accomplish the same share equivalent position. Therefore, higher option delta should be associated with lower O/S.

Fifth, the relation between number of analyst following and O/S is uncertain. When there are more analysts following a firm, the speed of uncovering information should be faster. It indicates that the higher number of analyst following should be associated with lower O/S owing to less informed trading in options. On the contrary, if analysts provide valuable information to institutional clients, these clients might use this information in the option markets. The higher number of analyst following implies higher O/S. As a result, the relation between number of analyst following and O/S is uncertain.

3.4.2. For abnormal return

We control the following variables[13] to examine the impact of the divergence of opinions of acquirer on the abnormal return of acquirer. First, we control for the acquirer's stock liquidity. The spread is used to represent liquidity.

$$\text{Relative quoted spread} = 100 \times \frac{(P_a - P_b)}{\left((P_a + P_b)/2\right)} \qquad (1)$$

where P_a is the lowest ask price, and P_b is the highest bid price.

We compute the ratio of bid/ask spread across all quotes during the period from trading −30 to −1 to average of the average daily bid/ask spreads during the period from trading −200 to −100.

Second, we control for the level of stock misevaluation prior to the takeover announcement. The market-to-book ratio (M/B) is used as the firm-level stock misevaluation. An acquirer with higher M/B would be more overvalued.

Table 3 reports summary statistics for explanatory variables. A cross-sectional mean is computed for each pre-announcement trading day and then various statistics are computed from the daily means across all 30 pre-announcement trading day in the sample. The average firm size is 7.814 billion, and the average option relative spread is 0.514%. For the market value, option spread, and option delta, the daily means are very well behaved-the means and medians are close, and little evidence exists of skewness or excess kurtosis. The maximums and minimums indicate the extremes of the daily means across all pre-announcement trading day.

4. Regression results

4.1. Determinants of O/S

We examine the determinants of O/S. Because we are particularly interested in the cross-sectional effects of the explanatory variables on O/S, we run daily cross-sectional regressions and test the significance of the time-series means of the cross-sectional coefficients (as in Fama and MacBeth, 1973; Roll et al., 2010). To control for industry effects, we include seven industry dummies.

A cross-sectional regression analysis between O/S and divergence of opinions is implemented to determine whether the O/S of acquirer is higher when the divergence of opinions of acquirer is higher. For each pre-announcement trading day in the sample, we regress log O/S on eight explanatory variables and seven industry dummies. Panel A of Table 4 presents the time-series statistics for the cross-sectional t-statistics of the explanatory variables[14]. We document the results for share volume ratios and dollar volume ratios separately[15]. The idiosyncratic volatility is significantly positive at the 10% significance level. Thus, H_1 is accepted, implying when divergence of opinions of acquirer firm is higher, the magnitude of increasing abnormal option trading volume is higher than that of stock trading volume. Institutional ownership term, which is proxied as the short-sales constraints, is also negative and significant at the 10% significance level, indicating that a higher level of institutional holdings (a lower level of holdings by unsophisticated individual investors) is associated with a lower option trading volume. Moreover, the interaction coefficient of institutional ownership with idiosyncratic volatility is positive and insignificant, suggesting that the influence of idiosyncratic volatility on O/S is weakly positive when institutional ownership is low. Therefore, the effect of divergence of opinions on the O/S is not strongly higher after considering short-sales constraints.

The market value variable is insignificantly positive, implying that larger firms do not have significantly higher O/S. The option spread is negative and significant at the 1% significance level,

[13] Chatterjee et al. (2012) control these variables to explore the influence of the divergence of opinion of target on takeover premium.

[14] For brevity, we do not present the statistics of the industry dummies.

[15] In the following presentation, we show the weak significance level for brevity when the results for the share volume O/S ratios and dollar volume O/S ratios are significant under different levels.

Table 4
Cross-sectional regressions of O/S ratio on divergence of opinion in the pre-announcement takeover period
For each trading day in the pre-announcement takeover period, a cross-sectional regression with the log of share or dollar O/S as dependent variable is computed using eight explanatory variables. Panel A reports time-series statistics for the cross-sectional t-statistics of the explanatory variables. In Panel B, we also use the panel data methods to present the results of regression between O/S and divergence of opinions. Size is the firm's size in $millions. % Spread is 100 × (Ask − Bid)/[(Ask + Bid)/2]. Implied volatility (imvola) and delta pertain to the options traded (with put deltas being reversed in sign). Analysts is the number of analysts following for a firm. Idiosyncratic volatility (idvola) of the stock, which is defined as the standard deviation of the firm's daily abnormal stock return, is the proxy for divergence of opinions. Institutional holding (insti) is the fraction of the firm's shares held by institutions (in percent). Std is the standard deviation in daily means. MAD is the mean absolute deviation. The fraction greater than zero in the overall sample days is given by % >0. *P*-value is reported in parentheses. The dependent variable in model 1 is share options/stock volume ratio, while the dependent variable in model 2 is dollar options/stock volume ratio.

Panel A: Time-series statistics for the cross-sectional *t*-statistics

	Size	Spread	Delta	imvola	Analyst	idvola	insti	insti_idvola
Share options/stock volume ratio								
Mean	0.221	−4.982	−0.341	0.871	1.203	1.693	−1.681	0.603
% >0	51.722	0.000	27.593	82.761	100.000	3.451	6.902	75.861
Dollar options/stock volume ratio								
Mean	0.091	−4.582	−0.241	1.621	0.983	1.704	−1.691	0.592
% >0	48.283	0.000	34.481	100.000	96.554	6.901	10.342	82.761

Panel B: the panel data method

Constant	Size	Spread	Delta	imvola	Analyst	idvola	insti	insti_idvola	R^2
Share options/stock volume ratio									
−3.369	0.026	−1.498	−0.087	0.891	0.070	0.472	−2.030	1.017	0.020
(0.001)	(0.734)	(0.001)	(0.765)	(0.192)	(0.006)	(0.098)	(0.120)	(0.557)	
Dollar options/stock volume ratio									
−10.785	0.015	−1.612	−0.336	1.925	0.070	0.382	−2.495	0.412	0.024
(0.001)	(0.850)	(0.001)	(0.299)	(0.111)	(0.008)	(0.084)	(0.070)	(0.828)	

meaning that a lower spread is associated with higher O/S. This result also implies that higher liquidity of the option market is accompanied by higher option trading. The effect of the option delta on O/S is negative and insignificant. For hedge reason, a lower delta implies a higher hedge ratio and should be accompanied by a higher ratio. Nevertheless, hedge reason does not dominate option trading. Thus, the trend is not clear. The implied volatility is insignificantly positive, suggesting that stocks with higher volatility weakly attract more option trading. The number of analysts following a stock is positive and insignificant. The reason might be the coarseness of the variable, which change in value only once a year.

In Panel B, we also use the panel data methods proposed by Shafer (2012) to discuss the regression between O/S and divergence of opinions. The results are similar with those in Panel A.

4.2. Cumulative abnormal returns and option/stock volume ratios

For all of the samples, the abnormal stock returns are measured by the market model. The benchmark period data are used to estimate the parameters to generate abnormal returns during the preannouncement period. Because daily abnormal returns are correlated over time, we pre-white returns to focus on the innovation in returns by the time-series model, which is sufficient to smooth the excess return time series. All the innovations are normalized using the standard deviation during the benchmark period to ensure that the variables are comparable across firms. Thus, we define r_{it} as the standardized innovation in daily excess returns of firm *i* on day *t*.

Following Roll et al. (2010), we examine the relation between post-cumulative abnormal return (CAR) and the average O/S during the pre-announcement period to explore whether the increase in the O/S is attributable to increased trading in options by informed traders. Pre-CAR is computed from three days before the announcement day to one day before the announcement day. Post-CAR is computed from the announcement day to one day after the announcement day. If the pre-announcement O/S is the result of informed trading, it should predict the post-CAR. Because the news of announcement could be good or bad, we explore the absolute values of pre- and post-CARs[16].

The basic regression in Table 5 shows that the effect of the pre-announcement O/S on absolute post-CAR is positive and significant at the 5% significance level, implying that more pre-announcement option trading relative to stock trading is accompanied by a larger absolute post-announcement price movement. The interaction coefficient of pre-O/S with pre-CAR is negative and significant at the 1% significance level, suggesting that the influence of pre-O/S on absolute post-CAR is weak when the pre-CAR is high. A possible explanation for this phenomenon may be that when more informed traders make some profits and influence stock prices toward full information value before the announcement, post-CAR is less sensitive to the pre-O/S.

Since the relationship between the pre-announcement O/S and absolute post-CAR might be influenced by the number of analysts following the firm (Easley, O'Hara, & Srinivas, 1998), the shares held by institutions, and firm size, we add interaction terms for the analysts, institution holdings, and firm size. The results are similar with those without interaction terms. Moreover, we find that the interaction coefficients of pre-O/S with the number of analysts and with firm size are insignificant. Institution holdings have a positive and significant impact at 10% significance level, suggesting that when the firm held more by institution is more transparent, the influence of pre-O/S on absolute post-CAR is stronger. Therefore, the above results prove that some investors who trade actively in the options market prior to the tender offer announcements are informed.

Because some informed traders exist in the options market before the announcements, further, we explore the relationship between divergence of opinions and the degree of the informed trader in the next section. That is, we examine whether the O/S

[16] When the event is good (bad) news, investors may buy (sell) call options or sell (buy) put options. Although O/S would be driven up, we cannot judge whether the increasing O/S is dominated by buy-initiated or sell-initiated options. Therefore, we conjecture that, if informed investors trade options before announcement, O/S should positively predict absolute CAR.

Table 5
Cumulative abnormal returns and option/stock volume ratios
Cumulative abnormal returns (CARs) during the announcement are related to the share options/stock volume ratio (O/S) during a period immediately preceding the announcement. The basic regression relates the absolute values of CAR on days 0 through +1 relative to the announcement day (day zero), the post-CAR, to the log of O/S averaged over days −3 to −1 and to this log average O/S interacted with the absolute values of CAR on days −3 to −1, the pre-CAR. The augmented regression further interacts the latter variable with three other variables measured just prior to the earnings announcement: the number of analysts, the percentage of the firm held by institutions, and the log market capitalization (size) of the equity. *P*-values are in parentheses below the coefficients. ***, **, and * denote significant at 1%, 5%, and 10% level.

Dependent variable: absolute value of post-CAR		
Explanatory variable	Basic regression	Augmented regression
O/S	0.003** (0.032)	0.003** (0.045)
O/S*pre-CAR	−0.088*** (0.001)	−0.183** (0.012)
O/S*pre-CAR* Number of Analysts		0.004 (0.247)
O/S*pre-CAR*Institutional holdings		0.099* (0.062)
O/S*pre-CAR* Ln(Size)		−0.005 (0.163)
Adj. R^2	0.708	0.726

contains more information about subsequent stock price movements when the divergence of opinions of the acquirer firm is higher.

4.3. Time-series regressions of next-day abnormal returns

A regression analysis between O/S[17], stock order imbalances[18] and stock returns is implemented to determine whether the forecasting powers have changed when the divergence of opinions is higher. Following Shafer (2012), we use panel data methods to adjust for both a firm effect and a time effect. The time-series regression model[19] is

$$r_t = \beta_0 + \beta_1 \mathrm{OI}_{t-1} + \left(\beta_2 \mathrm{O/S}_{t-1}\right) + \gamma_1 \mathrm{DIV\ OI}_{t-1} + \left(\gamma_2 \mathrm{DIV\ O/S}_{t-1}\right) + (\mathrm{Control\ \ Variable})_i + \zeta_t \quad (2)$$

where r_t is the standardized innovation in daily excess returns on day t, OI_{t-1} is the standardized stock order imbalance on day $t-1$, $\mathrm{O/S}_{t-1}$ is the options/stock trading volume ratio on day $t-1$, DIV is the divergence of opinions on the stock value of acquirer, which is proxied by idiosyncratic volatility. The control variables include the acquirer's stock liquidity, and market-to-book ratio (M/B) of acquirer.

Table 6 presents that the coefficients of lag-one O/S are positive and significant at the 5% significant level, indicating when the lag-one O/S increases, subsequent stock returns increase. This result might be explained as follows. When informed traders acquire information on a tender offer announcement, they prefer to trade options instead of stocks (O/S increases). Takeover announcement signals good news on average, informed traders would buy call or sell put to make profit. When the long call (or short put) positions increase, option market makers need to buy stocks to hedge their long call (or short put) positions, causing the stock's price to increase from buying pressure.

In addition, the effect of stock order imbalance on next-day stock return is positive and significant at the 1% significant level, implying informed traders also trade stock. A larger stock order imbalance has a greater effect on price movement, because it can signal private information and exerts pressure on market maker's inventory, thereby prompting a change in quotes.

The results show that γ_2 is negative and significant at the 5% significant level, implying support of H_2. The higher idiosyncratic volatility is associated with higher divergence of opinions. When the divergence of opinions is higher, the impact of O/S on subsequent stock's price is weaker. This suggests that O/S contains less information about subsequent stock price movements during the pre-announcement takeover period when the divergence of opinions is higher. γ_1 is negative and significant at the 1% significant level, indicating that stock volume is contains less information about subsequent stock price movements during the pre-announcement takeover period with higher divergence of opinions.

Moreover, we also examine the effect of short-sale constraint on information content of the volume of option and stock. We sort our sample by INSOWN, which is proxied for the short-sale constraint. Deciles range from 1 to 5 with the highest (lowest) values located in the 5th (1st) deciles. Since the higher level of institutional ownership signals that short-sale constraints are less binding, decile 5 (1) represent the least (most) binding short-sale constraint. Panel B of Table 6 presents the regression results without contemporaneous order imbalance and O/S ratio[20]. The absolute values of γ_2 in decile 1 is smaller than those in decile 5, implying that the information effects of option volume from both dispersion of opinions and short sale constraint are not stronger than the effect only from dispersion of opinions, inconsistent with Nagel (2005) and Berkman et al. (2009). Although short-sale constraints might be regarded to increase the power of the linkage between option and stock markets, based on Grundy et al. (2012), tight short-sale constraint makes it difficult for option market makers to hedge their positions in the stock markets. It makes them reluctant to provide liquidity to the option market. Therefore, the impact of short-sales constraint on the predictive power of O/S on future stock return is not clear.

We also use the regression analysis between O/S, absolute value of stock order imbalances and absolute value of stock returns to examine whether the forecasting powers of O/S on stock price volatility have changed when the divergence of opinions is higher. The regression model is:

$$|r_t| = \beta_0 + \beta_1 \left|\mathrm{OI}_{t-1}\right| + \left(\beta_2 \mathrm{O/S}_{t-1}\right) + \gamma_1 \mathrm{DIV} \left|\mathrm{OI}_{t-1}\right| + \left(\gamma_2 \mathrm{DIVO/S}_{t-1}\right) + (\mathrm{Control\ \ Variable})_i + \zeta_t \quad (3)$$

The results show that β_2 is positive and significant at the 1% significant level, indicating the greater O/S contains more information about subsequent stock price volatility movements during the pre-announcement takeover period. In addition, γ_2 is negative and significant at the 5% significant level, implying that O/S contains less information about subsequent stock price volatility

[17] According to Johnson and So (2012), O/S provides a cleaner signal of private information than the put-call ratio since call volume could be good news (if informed traders buy) or bad news (if informed traders sell), and put volume is also ambiguous. Therefore, in the absence of information about the sign of each trade (buyer-initiated or seller-initiated), O/S is an indication of the sign of private information, whereas the put-call ratio is not.

[18] We include the stock order imbalance as a control to address the concern that the O/S effect may be driven only by stock trading activity.

[19] Beside Eq. (2) which contains lagged –one O/S and stock order imbalance, we also run another regression which adds contemporaneous O/S and stock order imbalance to control for potential price pressure effects. The results are similar with those without contemporaneous O/S and stock order imbalances.

[20] For brevity, we just present the results about the interaction coefficients of the divergence of opinions with lag-one stock order imbalance and with lag-one O/S.

Table 6
Time-series regressions of next-day abnormal returns

The regression results in Panel A and B are based on the following equation: $r_t = \beta_0 + \beta_1 \mathrm{OI}_{t-1} + \left(\beta_2 \mathrm{O/S}_{t-1}\right) + \gamma_1 \mathrm{DIV\ OI}_{t-1} + \left(\gamma_2 \mathrm{DIVO/S}_{t-1}\right) + (\text{Control Variable})_i + \zeta_t$ The regression results in Panel C are based on the following equation: $|r_t| = \beta_0 + \beta_1 |\mathrm{OI}_{t-1}| + \left(\beta_2 \mathrm{O/S}_{t-1}\right) + \gamma_1 \mathrm{DIV} |\mathrm{OI}_{t-1}| + \left(\gamma_2 \mathrm{DIVO/S}_{t-1}\right) + (\text{Control Variable})_i + \zeta_t$ where r_t is the standardized innovation in daily excess returns on day t, OI_{t-1} is the standardized stock order imbalance on day $t-1$, $\mathrm{O/S}_{t-1}$ is the options/stock trading volume ratio on day $t-1$, DIV is the divergence of opinions on the stock value of acquirer, which is proxied by idiosyncratic volatility. The control variables include the acquirer's stock liquidity, and market-to-book ratio (M/B) of acquirer. The O/S in models 1 and 3 is the share options/stock volume ratio (ShO/S) and the O/S in models 2 and 4 is the dollar options/stock volume ratio ($O/S). In Panel B, we sort our sample by INSOWN, which is proxied for the short-sale constraint. Deciles range from 1 to 5 with the highest (lowest) values located in the 5th (1st) deciles. Since the higher level of institutional ownership signals that short-sale constraints are less binding, decile 5 (1) represents the least (most) binding short-sale constraint. Because the coefficients are small, we multiply the coefficients by 10^4 in all the panels. *P*-value is reported in parentheses. ***, **, and * denote significant at 1%, 5%, and 10% level.

Panel A: abnormal returns

	(1)	(2)	(3)	(4)
Intercept	−23.400 (0.123)	−35.900 (0.243)	−34.400** (0.046)	−76.500** (0.036)
OI_{t-1}	61.800*** (0.002)	62.000*** (0.002)	187.500*** (0.000)	188.900*** (0.000)
$\mathrm{O/S}_{t-1}$	2.627** (0.043)	1.990** (0.043)	3.835** (0.040)	5.151** (0.013)
OI_t			−151.800*** (0.000)	−150.100*** (0.000)
$\mathrm{O/S}_t$			11.000*** (0.002)	11.100*** (0.001)
$\mathrm{DIV}^*\mathrm{OI}_{t-1}$	−3.302*** (0.001)	−3.294*** (0.001)	−2.524* (0.076)	−2.575* (0.100)
$\mathrm{DIV}^*\mathrm{O/S}_{t-1}$	−0.105** (0.042)	−0.038** (0.042)	−0.192** (0.032)	−0.056** (0.046)
MB	5.803* (0.057)	5.956** (0.049)	7.462** (0.019)	7.760** (0.014)
LIQ	−0.509 (0.634)	−0.512 (0.631)	−0.330 (0.769)	−0.315 (0.778)
Adj. R^2	0.0038	0.0039	0.0146	0.0153

Panel B: abnormal returns between different institutional ownership

	(1)		(2)	
	decile 1	decile 5	decile 1	decile 5
$\mathrm{DIV}^*\mathrm{OI}_{t-1}$	−1.091* (0.082)	−2.702* (0.054)	−0.762* (0.088)	−1.646* (0.072)
$\mathrm{DIV}^*\mathrm{O/S}_{t-1}$	−0.342* (0.064)	−0.411** (0.018)	−0.074* (0.076)	−0.112** (0.041)
Adj. R^2	0.0032	0.0035	0.0023	0.0016

Panel C: absolute abnormal returns

	(1)	(2)
Intercept	144.401*** (0.001)	252.202*** (0.001)
$\mathrm{ABS(OI}_{t-1})$	−38.303** (0.042)	−6.707* (0.074)
$\mathrm{O/S}_{t-1}$	12.102*** (0.001)	15.502*** (0.001)
$\mathrm{DIV}^*\mathrm{ABS(OI}_{t-1})$	6.746*** (0.001)	4.408*** (0.001)
$\mathrm{DIV}^*\mathrm{OS}_{t-1}$	−1.314** (0.033)	−0.189*** (0.001)
MB	13.505*** (0.001)	12.501*** (0.001)
LIQ	−1.806** (0.023)	−1.806** (0.022)
Adj. R^2	0.0781	0.089

movements during the pre-announcement takeover period when the divergence of opinions is higher.

β_1 is negative and significant at the 10% significant level, indicating the greater absolute value of stock order imbalances contains less information about subsequent stock price volatility movements during the pre-announcement takeover period. Moreover, γ_1 is positive and significant at the 1% significant level, indicating that stock volume contains less information about subsequent stock price volatility movements during the pre-announcement takeover period with higher divergence of opinions.

4.4. Cross-sectional regressions of announcement-day returns

The above analyses focus on the ability of O/S to predict next-day abnormal returns. In this section, we explore the relation between preannouncement volume and announcement abnormal returns using the following cross-sectional regression:

$$\mathrm{CAR}[0,1]_i = \beta_0 + \beta_1 \mathrm{CAR}[-3,-1]_i + \beta_2 \Delta \mathrm{OI}_i + \left(\beta_3 \Delta \mathrm{O/S}_i\right) + \gamma_1 \mathrm{DIV\,CAR}[-3,-1]_i + \gamma_2 \mathrm{DIV}\,\Delta \mathrm{OI}_i + \left(\gamma_3 \mathrm{DIV} \Delta \mathrm{O/S}_i\right) + \text{Control Variable} + \zeta_i \quad (4)$$

where CAR [0, 1] is the two-day cumulative abnormal return from day 0 to day 1, CAR [−3, −1] is the preannouncement price run-up, ΔOI is changes in stock from the benchmark period to the pre-announcement period, $\Delta \mathrm{O/S}_i$ is changes in options/stock trading volume ratio (O/S) from the benchmark period to the preannouncement period, DIV is the divergence of opinions on the stock value of acquirer, which is proxied by idiosyncratic volatility. Control variables include the acquirer's stock liquidity, and market-to-book ratio (M/B) of acquirer.

Table 7 shows the relationship between pre-announcement volume and announcement abnormal returns. We find that γ_1 is negative and significant at the 10% significant level, implying that the ability of the pre-announcement price run-up to predict the two-day cumulative abnormal return increases with higher divergence of opinions. γ_2 is insignificant, suggesting that the ability of preannouncement stock imbalance change to predict the two-day cumulative abnormal return does not increase with higher divergence of opinions. γ_3 is negative and significant at the 10% significant level, indicating that the power of pre-announcement O/S change to predict the pending two-day cumulative abnormal return decreases with higher divergence of opinions.

5. Robustness checks

This section provides the robustness checks on variations of the option measure. Following Chan et al. (2015), we use implied

Table 7
Cross-sectional regressions of announcement returns

The regression results in the table are based on the following equation: $\mathrm{CAR}[0,1]_i = \beta_0 + \beta_1 \mathrm{CAR}[-3,-1]_i + \beta_2 \Delta \mathrm{OI}_i + \beta_3 \left(\Delta \mathrm{O/S}_i\right) + \gamma_1 \mathrm{DIV\,CAR}[-3,-1]_i + \gamma_2 \mathrm{DIV}\,\Delta \mathrm{OI}_i + \gamma_3 \mathrm{DIV}\left(\Delta \mathrm{O/S}_i\right) + \text{Control Variable} + \zeta_i$ where CAR [0, 1] is the two-day cumulative abnormal return from day 0 to day 1, CAR [−3, −1] is the preannouncement price run-up, ΔOI is changes in stock from the benchmark period to the preannouncement period, $\Delta \mathrm{O/S}_i$ is changes in options/stock trading volume ratio from the benchmark period to the preannouncement period, DIV is the divergence of opinions on the stock value of acquirer, which is proxied by idiosyncratic volatility. Control variables include the acquirer's stock liquidity, market-to-book ratio (M/B) of acquirer. The O/S in model 1 is the share options/stock volume ratio (ShO/S) and the O/S in model 2 is the dollar options/stock volume ratio ($O/S). P value is reported in parentheses. ***, **, and * denote significant at 1%, 5%, and 10% level.

Explanatory variable	(1)	(2)
Intercept	−0.005 (0.787)	−0.005 (0.782)
pre-CAR	0.062* (0.076)	0.071* (0.073)
ΔOI	0.007 (0.645)	0.008 (0.616)
(ΔO/S)	0.009* (0.085)	0.070** (0.035)
DIV*pre-CAR	−0.074* (0.076)	−0.075* (0.075)
DIV*OI	0.019 (0.461)	0.022 (0.406)
DIV* (ΔO/S)	−0.024* (0.069)	−0.061* (0.051)
Adj. R^2	0.0049	0.0017

volatility (IV) spread and skew to capture the information content in the option[21]. The IV spread means the average difference of implied volatilities between call and put options on the same stock with the same maturity and strike price. The IV skew is defined as the difference between implied volatilities of out-of-the-money (OTM) put and at-of-the-money (ATM) call. We compute IV spread and IV skew for each firm i on each day t as follows.

$$\mathrm{IV\ \ Spread}_{i,t} = \mathrm{IV}_{i,t}^{\mathrm{calls}} - \mathrm{IV}_{i,t}^{\mathrm{puts}} \tag{5}$$

$$\mathrm{IV\ \ Skew}_{i,t} = \mathrm{IV}_{i,t}^{\mathrm{OTM\ \ puts}} - \mathrm{IV}_{i,t}^{\mathrm{ATM\ \ calls}} \tag{6}$$

A higher IV spread indicates that calls are more expensive compared with puts, expecting a larger buying pressure on call options. A larger IV skew means that investors demand more OTM puts, indicating a decline in the future stock price.

In Panel A (B) of Table 8, we use IV spread (IV skew) to capture the information content in the option. We replace O/S by IV spread (or IV skew) to run Eq. (2). Panel A shows that γ_2 is negative and significant at the 1% significant level, implying higher divergence of opinions is associated with weaker positive impact of IV spread on subsequent stock's price. This suggests that IV spread contains less information about subsequent stock price movements during the pre-announcement takeover period when the divergence of opinions is higher. γ_1 is negative and significant at the 5% significant level, indicating that stock volume contains less information about subsequent stock price movements during the pre-announcement takeover period with higher divergence of opinions.

Panel B presents that γ_2 is positive and significant at the 1% significant level. When the divergence of opinions is higher, the negative impact of IV skew on subsequent stock's price is weaker. This suggests that IV skew contains less information about subsequent stock price movements during the pre-announcement takeover period when the divergence of opinions is higher. γ_1 is negative and significant at the 1% significant level, indicating that stock volume contains less information about subsequent stock price movements during the pre-announcement takeover period with higher divergence of opinions. Therefore, our results are robust to different informed option trading measures.

[21] We thank for the opinions of referee.

Table 8
Robustness check on alternatives for O/S

The regression results in Panel A are based on the following equation: $r_t = \beta_0 + \beta_1 \mathrm{OI}_{t-1} + \beta_2 \mathrm{SPREAD}_{t-1} + \gamma_1 \mathrm{DIV\ OI}_{t-1} + \gamma_2 \mathrm{DIV\ SPREAD}_{t-1} + (\mathrm{Control\ \ Variable})_i + \zeta_t$ The regression results in Panel B are based on the following equation: $r_t = \beta_0 + \beta_1 \mathrm{OI}_{t-1} + \beta_2 \mathrm{SKEW}_{t-1} + \gamma_1 \mathrm{DIV\ OI}_{t-1} + \gamma_2 \mathrm{DIV\ SKEW}_{t-1} + (\mathrm{Control\ \ Variable})_i + \zeta_t$ where r_t is the standardized innovation in daily excess returns on day t, OI_{t-1} is the standardized stock order imbalance on day $t-1$, The SPREAD_{t-1} means the average difference of implied volatilities between call and put options on the same stock with the same maturity and strike price on day $t-1$. The SKEW_{t-1} is defined as the difference between implied volatilities of out-of-the-money (OTM) put and at-of-the-money (ATM) call on day $t-1$. DIV is the divergence of opinions on the stock value of acquirer, which is proxied by idiosyncratic volatility. The control variables include the acquirer's stock liquidity, and market-to-book ratio (M/B) of acquirer. Because the coefficients are small, we multiply the coefficients by 10^4 in all the panels. *P*-value is reported in parentheses. ***, **, and * denote significant at 1%, 5%, and 10% level.

	(1)	(2)
Panel A: IV Spread		
Intercept	−37.100*** (0.001)	−34.3*** (0.002)
OI_{t-1}	72.500*** (0.003)	171.5*** (0.000)
SPREAD_{t-1}	201.400* (0.061)	340.8*** (0.002)
OI_t		−105.2*** (0.005)
SPREAD_t		287.1*** (0.008)
$\mathrm{DIV^*OI}_{t-1}$	−3.001** (0.011)	−3.3707*** (0.004)
$\mathrm{DIV^*SPREAD}_{t-1}$	−20690.700*** (0.001)	−20803*** (0.001)
MB	12.200*** (0.001)	13.4*** (0.001)
LIQ	−0.518 (0.665)	−0.6536 (0.582)
Adj. R^2	0.0241	0.0337
Panel B: IV Skew		
Intercept	−88.000*** (0.001)	−80.800*** (0.004)
OI_{t-1}	125.4** (0.015)	193.800 (0.101)
Skew_{t-1}	−370.1* (0.076)	−306.700** (0.030)
OI_t		−87.100 (0.418)
OS_t		−274.100 (0.328)
$\mathrm{DIV^*OI}_{t-1}$	−6.3831** (0.011)	−6.332** (0.032)
$\mathrm{DIV^*SKEW}_{t-1}$	10588.3*** (0.001)	9949.300*** (0.001)
MB	18.3*** (0.001)	20.700*** (0.001)
LIQ	−0.4868 (0.728)	−0.103 (0.944)
Adj. R^2	0.0841	0.1017

6. Conclusion

This paper examines whether the O/S proposed by Roll et al. (2010) is higher when investors have higher diversity of opinions on the value of the acquirer during the pre-takeover announcement period. In particular, we analyze how divergence of opinions about the equity value of acquirer affects the predictive power of the volume of options and stocks on subsequent stock prices.

According to Choy and Wei (2012), around earning announcement, they find that more disagreements tend to create higher option trading volume relative to the stock trading volume. During a pre-takeover announcement period, we also find that more disagreements still tend to result in higher O/S.

Higher pre-announcement option trading relative to stock trading is associated with a larger post-announcement return, implying that some investors who trade actively in option market before tender offer announcements are informed.

The effects of the O/S on next-day stock returns are positive and significant at the 5% significant level, indicating that when the lag-one O/S increases, subsequent stock returns increase.

The lower predictive powers of the O/S on subsequent stock returns are associated with higher divergence of opinions about the equity value of acquirer. Moreover, the information effects of option and stock volume by both dispersion of opinions and short-sale constraints are not stronger than those only by dispersion of opinions.

The above findings have important implications for market regulators. The effect of the pre-announcement O/S on post-CAR is significant, implying that some investors which trade actively in the option market prior to tender offer announcements are informed. Given the evidence that some private information is obtained illegally, the efforts of regulators in monitoring the securities markets in advance of exceptional events should be reinforced.

Several possible directions for future research are suggested. Our research focuses on the effects of divergence of opinions on the O/S and the predictability of options on subsequent stock prices. Because information asymmetry also has an influence on the O/S and the predictability of options and stock prices, future research could explore whether divergence of opinions or information asymmetry has the higher impact.

In this paper, we do not discuss whether the results depend on the relative size of the target firm. An enhanced investigation on how the relative size of the target firm affects the results would be interesting. Presumably, the results are stronger when the relative size of the target is larger.

Moreover, Ge et al. (2014) use signed option volume to examine which components of option volume predict returns. Separating the volume of call and put would make it much more interesting in determining whether the volume of put has less predictive powers of O/S on subsequent stock returns than the volume of call when the divergence of opinions of acquirer firm is higher.

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