Informational Content of Option Trading on Acquirer Announcement Return[*]

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Abstract

This paper examines the informational content of option trading in merger and acquisition (M&A) events. We find that pre-M&A announcement option trading contains information on acquirer announcement returns. Using 5,099 M&A events from 1996 to 2010, we show that implied volatility (IV) spread predicts positively on the announcement return, while implied volatility (IV) skew predicts negatively on the announcement return. The result is stronger if the option liquidity is high and stock liquidity is relatively low. We also find some supporting evidence in post-M&A long-run performance for acquirers, using calendar-time portfolio regression, post-M&A one-year buy-and-hold abnormal returns, and cumulative abnormal returns around post-M&A quarterly earnings announcement days. We show that higher IV spread and lower IV skew are associated with better long-run abnormal performance. Moreover, we use the relative trading volume of options to stock (O/S) as an alternative proxy for informed option trading activity, and show that higher O/S predicts higher acquirer absolute announcement return. A pre-event price run-up mitigates the predictive power of O/S. Our main result remains consistent among a smaller sample of target firms.

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I. Introduction

Previous literature has documented that informed investors trade in options market to capitalize on their private information. Easley, O'Hara, and Srinivas (1998) argue that informed traders would prefer options market when implicit leverage in options is high and options are relatively liquid compared with stocks. One stream of the empirical studies adopts several informed trading measures in options market to predict future stock returns. Pan and Poteshman (2006) find that stocks with low put-call ratios outperform those with high put-call ratios on the next day and over the next week. Cremers and Weinbaum (2010) document that the deviation from put-call parity contains information about firm's stock return in the following week. Xing, Zhang, and Zhao (2010) show that stocks with higher implied volatility (IV) skew experience lower future returns, and the predictability of IV skew persists for at least half a year. Johnson and So (2011) find that the ratio of options to stock trading volume (O/S) is negatively related to stock returns in the next month.

Another stream of research focuses on the relationship between pre-event informed option trading and the content and market reaction of corporate news. For example, Roll, Schwartz, and Subrahmanyam (2010) find a positive prediction of O/S on the absolute return around earnings announcement. Chan, Li, and Lin (2012) find a strong correlation between pre-split informed option trading measures (O/S, IV spread, and IV skew) and split announcement returns, which supports the signaling hypothesis. Driessen, Lin, and Lu (2012) show that standardized unexpected earnings, analyst recommendation changes, and analyst forecast changes can be predicted by IV spread and IV skew. However, little attention has been paid to whether option trading activities contain information on the most important corporate event, i.e., merger and acquisition (M&A).[1]

We fill this literature gap by testing the following main hypothesis: does option trading contain information on M&A acquirer announcement return? Specifically, we adopt two option measures, i.e. IV spread in Cremers and Weinbaum (2010) and IV skew in Xing, Zhang, and Zhao (2010), to test their predictability on acquirer announcement return. We subsequently provide more supporting evidence by answering two additional questions. Does the relative liquidity of option

[1] One exception is Cao, Chen, and Griffin (2005) who adopt option volume imbalance to predict M&A target announcement return.

to stock affect the predictability of our informed option trading measures? Do the informed option trading measures predict long-run equity performance? We focus on acquirers because many targets are private firms without stock and options trading, and acquirers are of more importance due to their larger market capitalization.

Empirically, our sample covers M&A events from the Securities Data Company (SDC) Platinum database for the period of 1996 to 2010. For each acquirer, we obtain its daily options data from OptionMetrics to construct our proxies for informed option trading. The IV spread measures the average difference of implied volatilities between call and put options on the same security with the same strike price and maturity. Intuitively, a larger IV spread means that calls are more expensive compared with puts, indicating a higher buying pressure on call options.[2] On the other hand, the IV skew measures the difference between implied volatilities of out-of-the-money (OTM) put and at-the-money (ATM) call. A higher IV skew indicates that investors demand more OTM puts, expecting a drop in the future stock price.[3]

Using the two informed option trading measures one day before M&A announcement, we find that a higher IV spread predicts a higher acquirer cumulative abnormal return (CAR), while a higher IV skew predicts a lower acquirer CAR. IV spread is positive and strongly significant by itself. The coefficient for IV spread is 8.90 with a t-statistic of 3.66 when controlling firm and deal characteristics. On the other hand, IV skew carries a negative and significant coefficient by itself. The coefficient for IV skew is -9.88 with a t-statistic of -2.24 when adding control variables. Both results are consistent with our hypothesis.

We then conduct additional tests to support the main findings. First, we show that the predictive power of option measures is stronger if the acquirer's option liquidity (measured by bid-ask spread) is relatively high and stock liquidity (measured by Amihud (2002) illiquidity ratio, ILLIQ) is relatively low. The option predictability is weaker if the acquirer has low option liquidity but relatively high stock liquidity. These results are in line with the model in Easley, O'Hara, and Srinivas (1998).

[2] For implied volatility spread, see among others, Bali and Hovakimian (2009), Chan, Li, and Lin (2012), Driessen, Lin, and Lu (2012), Jin, Livnat, and Zhang (2012).

[3] For implied volatility skew (or smirk), see among others, Bester, Martinez, and Rosu (2011), Bollen and Whaley (2004), Buskirk (2011), Chan, Li, and Lin (2012), Driessen, Lin, and Lu (2012), Jin, Livnat, and Zhang (2012).

Second, we show that pre-event informed option trading measures are also related to acquirer long-run performance. We first sort our sample into quartiles based on IV spread or IV skew. Adopting calendar-time portfolio regression (Fama, 1998; Ikenberry and Ramnath, 2002), we find that acquirers in the bottom IV skew quartile exhibit higher abnormal returns in one-year horizon, compared with those in the top IV skew quartile. The return spread is large and significant. We also discover similar patterns for IV spread sorting, although the return spread is not significant. When using post-M&A buy-and-hold abnormal return (BHAR) and quarterly earnings announcement CAR as alternative indicators of long-run performance, the evidence is consistent with calendar-time portfolio approach. In sum, pre-event IV spread (IV skew) has a positive (negative) prediction on acquirer long-term performance.

Third, we adopt O/S, based on unsigned volume, as an additional measure of informed trading. According to Roll, Schwartz, and Subrahmanyam (2010), O/S is expected to be positively correlated with absolute value of event announcement return.[4] We find that higher pre-event O/S indicates a higher absolute acquirer CAR, with a coefficient of 0.25 and t-statistic of 5.62. We also conjecture that if informed investors trade on their private information before announcements, pre-event prices will partially incorporate the information. As a result, the announcement returns will be smaller in magnitude. Our findings show that a pre-event price run-up reduces the predictive power of O/S on absolute acquirer CAR.

Finally, our main results are robust to several alternatives of constructing informed option trading measures, such as using deciles of IV spread or IV skew, changes of IV spread or IV skew compared with previous week or compared with previous month as the main explanatory variables. Excluding events with small deal value or small market capitalization does not affect our results. Moreover, we find consistent results of IV spread and IV skew in predicting target announcement CAR. However, due to a smaller number of optioned target firms, the analysis of IV spread lacks statistical power.

Our paper is most related to Cao, Chen, and Griffin (2005), who employ call and put option volume imbalances to predict CARs of target firms. Our paper differs from and yet complements their research in three key aspects. First, we investigate the informational content of option trading on acquirer announcement return (5,099 events), while they study a smaller sample of

[4] For O/S, see among others, Chan, Li, and Lin (2012), Johnson and So (2011).

target announcement return (78 events). Second, we cover an updated M&A sample from 1996 to 2010, while their M&A events occur between 1986 and 1994. Last, to capture the private information held by informed option traders, we incorporate two newly-developed proxies for demand pressure based on daily implied volatility, while they construct signed volume imbalance using Lee and Ready (1991) algorithm based on intraday trade and quote data.

The rest of the paper is organized as follows. Section II describes M&A sample and the two main option measures we use. Section III presents the main hypothesis and results in sorting and cross-sectional regressions. In Section IV, we provide supporting evidence by considering liquidity role of option and stock, the long-run performance, the predictability of O/S, and other alternative constructions of option trading measures as robustness check. Then we test our main hypothesis on target firms in Section V. Section VI concludes the paper.

II. Data

A. M&A sample

Our M&A sample covers the period of January 1996 to December 2010, obtained from Securities Data Company (SDC) platinum database. For each acquiring firm, we obtain daily options data from OptionMetrics. We require the acquirer to be listed in NYSE or AMEX or NASDAQ, with daily stock trading record in CRSP and yearly accounting information in COMPUSTAT. In order to examine the predictability of pre-event informed option trading, we only keep those firms which already have daily options trading data before they announce the M&A events. We retain those events which are classified as "merger" or "acquisition of a majority interest", because they are most relevant to our study and contain relatively more transactions. We then exclude the events if the same acquirer announces to merge with or acquire several different target firms on the same day, because the acquirer announcement return will be affected by several events simultaneously.

[Table 1 about here]

Panel A of Table 1 shows the summary statistics for M&A acquirers. Our final sample consists of 5,099 events and 1,754 acquiring firms. The event number differs from firm number because some acquirers conduct several M&A activities during the sample period. Consistent with

previous literature (e.g. Moeller, Schlingemann, and Stulz, 2004; Moeller, Schlingemann, and Stulz, 2005), there are relatively more events occurred in late 1990s.

In Panel B, we list the summary statistics for acquirer CARs by year. CAR is calculated by cumulating the abnormal returns from day *t* to *t+1*, where day *t* is the announcement date, or the first trading day after announcement if the announcement date is a non-trading day. We use CRSP value-weighted market return as the benchmark when calculating daily abnormal return. The mean of the acquirer CAR is -0.07%, and its standard deviation is 6.06%. Consistent with prior studies (e.g. Harford, Jenter, and Li, 2011), the mean CAR for acquirer is slightly negative and close to zero.

If we classify M&A events by the primary payment method, it can be shown that the mean announcement return for events with cash-only payment is much higher than that for events with equity shares payment. This is consistent with previous researches such as Loughran and Vijh (1997) and Netter, Stegemoller, and Wintoki (2011). It supports the market timing story that acquiring firms make use of overvalued equity to purchase hard assets, and as a result, their stock returns decrease later (Savor and Lu, 2009).

B. Implied volatility spread

To examine the informational content of option trading, we make use of two option measures newly adopted in recent literature. The first one is IV spread, which is regarded as a proxy for price pressure in options market. To measure deviations from put-call parity, IV spread is constructed as the average difference in implied volatilities between call and put options for the same security with the same strike price and the same maturity. In particular, we compute IV spread for each firm *i* on each day *t* as follows.

$$IV\ Spread_{i,t} = IV_{i,t}^{calls} - IV_{i,t}^{puts} = \sum_{j=1}^{N_{i,t}} w_{j,t}^{i} (IV_{j,t}^{i,call} - IV_{j,t}^{i,put}) \quad (1)$$

[Table 2 about here]

The detailed construction procedure is included in Appendix. Table 2 Panel A summarizes the IV spread by year. In general, IV spread is negative, with a sample mean of -0.0099 and a

standard deviation of 0.0635. As a directional measure of informed option trading activity, IV spread can predict both positive and negative future abnormal returns. Intuitively, if call options are more expensive than put options, the implied volatilities of calls will be higher than those of puts, leading to a positive IV spread. A larger (especially increasing) IV spread means that investors demand more call options, expecting a positive abnormal return on that stock, which cannot be explained by short sale constraints[5]. On the contrary, a smaller (especially decreasing) IV spread is associated with a negative future abnormal return. Therefore, if option investors hold private information on an M&A event, we would expect that pre-event IV spread is positively related to the announcement return.

C. Implied volatility skew

The other option measure we adopt is IV skew, which is used as a proxy for negative price pressure in the options market. We calculate daily IV skew for firm *i* on day *t*, as the implied volatility difference between out-of-the-money (OTM) put and at-the-money (ATM) call.

$$IV\ Skew_{i,t} = IV_{i,t}^{OTMput} - IV_{i,t}^{ATMcall} \tag{2}$$

The construction details are described in Appendix. As shown in Panel B of Table 2, IV skew is generally positive, with a sample mean of 0.0427 and a standard deviation of 0.0536. IV skew is also a directional measure on informed option trading. If investors hold negative information, they tend to buy put options, especially the OTM puts, either to hedge against future price drop or to speculate on the potential return on longing put options. If more investors are willing to buy OTM puts, the prices and implied volatilities of OTM puts will be pushed up, and IV skew will increase. Therefore, a higher demand for OTM put options indicates that investors hold negative news on the firm's future stock returns. ATM call is used as the benchmark since it is the most liquid option which should reflect investors' consensus about the uncertainty of the firm. The rationale of IV skew is consistent with the implied volatility functions measured by delta in Bollen and Whaley (2004). In M&A events, we expect a negative relationship between pre-announcement IV skew and the announcement return.

[5] See Cremers and Weinbaum (2010).

III. Main hypothesis and results

This section discusses our main hypothesis that option trading prior to an M&A event contains information on acquirer announcement return. As mentioned in the previous section, we use two directional measures of informed option trading, i.e. IV spread and IV skew, to test whether they can predict acquirer announcement CAR.

A. Acquirer announcement CARs sorted by IV spread and IV skew

To show the relationship between announcement returns and informed option trading measures, we sort the sample into quintiles based on pre-announcement IV spread and IV skew respectively. We expect that the acquirer announcement return will increase with the value of IV spread and decrease with the value of IV skew.

[Table 3 about here]

Table 3 shows the mean and t-statistics of acquirer CARs for each quintile of IV spread or IV skew. CARs are cumulated from day *t* to *t+1* where day *t* is the announcement date, or the first trading day after announcement if that day is a non-trading day. We use day *t-1* value of IV spread and IV skew, because the informational advantage of informed traders should be largest right before corporate events, as argued by Skinner (1997). Quintile 1 contains acquirers with the lowest 20% of IV spread or IV skew and quintile 5 contains those with the highest 20%.

In terms of IV spread sorting, mean CAR is negative for all but the highest quintile. Consistent with expectation, CAR is generally increasing with IV spread. The high-minus-low column shows the difference between quintile 5 and quintile 1. It is significant and positive, with a mean of 0.90% and a t-statistic of 2.74. We also discover that CAR is decreasing with IV skew in a monotonic pattern. Except quintile 1, each quintile has a negative mean CAR, which is especially significant in the highest IV skew quintile. The decrease of CAR is dramatic between quintile 1 and 2, and between quintile 4 and 5. High-minus-low difference equals -1.37% which is significant with a t statistic of -2.42.

From the single sorting result, we obtain preliminary supporting evidence for our main hypothesis. Acquirer announcement return is positively correlated with IV spread and negatively

correlated with IV skew. In the next subsection, we present cross-sectional regression results to further support and confirm our hypothesis.

B. Higher IV spread or lower IV skew is associated with higher acquirer announcement CAR

We argue that a high IV spread reflects investors' expectation on future price increase, while a high IV skew reflects investors' expectation on a downward price change. We have discovered the monotonic relationship between acquirer announcement CAR and pre-event option measures from the sorting results. In this subsection, we formalize the test by running cross-sectional regressions of acquirer announcement returns on informed option trading measures and other control variables. The main regression is

$$\begin{aligned} CAR_{i,[t,t+1]} = {} & \beta_{0,i} + \beta_{1,i}\ IV\ Spread_{i,t-1}\ (or\ IV\ Skew_{i,t-1}) \\ & + \gamma_{1,i}\ \mathrm{Pre}-month\ \mathrm{Return}_{i,[t-22,t-1]} + \gamma_{2,i}\ \mathrm{Pre}-year\ \mathrm{Return}_{i,[t-252,t-23]} \\ & + \gamma_{3,i}\ Successful_{i,t} + \gamma_{4,i}\ Takeover_{i,t} + \gamma_{5,i}\ Hostile_{i,t} + \gamma_{6,i}\ Rumor_{i.t} + \gamma_{7,i}\ Cash_{i.t} \\ & + \gamma_{8,i}\ Size_{i,t} + \gamma_{9,i}\ B/M_{i,t} + \gamma_{10,i}\ Year\ Fixed\ Effect + \gamma_{11,i}\ Industry\ Fixed\ Effect + \varepsilon_i \end{aligned} \quad (3)$$

where $CAR_{i,\,[t,\,t+1]}$ is the cumulative abnormal return from day *t* to *t+1* for each acquiring firm *i*, expressed in percentage. The independent variables of interest are *IV spread* and *IV skew* on day *t-1* for each firm *i*. Duo to the correlation between IV spread and IV skew, we include them in separate regressions. Control variables are then added to the main regression.

With pre-month return and pre-year return, we take into account the price run-up one year prior to each M&A event. Specifically, *pre-month return* is calculated as the buy-and-hold return compounded from day *t-22* to *t-1*, and *pre-year return* is the buy-and-hold return compounded from day *t-252* to *t-23*.

We also consider event-related characteristics which may affect announcement returns of acquirers. Similar to Cao, Chen, and Griffin (2005), we add five event-related dummies. *Successful* equals 1 if the merger or acquisition is successfully completed, i.e. the status is "C" as indicated in SDC, and 0 otherwise. *Takeover* equals 1 if the event is classified as an "acquisition of a majority interest" instead of a "merger" in SDC, and 0 otherwise. *Hostile* equals 1 if the event's "attitude" is identified as "hostile" in SDC, and 0 otherwise. *Rumor* equals 1 if there is pre-event rumor, i.e. the section of "deal began as a rumor" is "yes", and 0 otherwise. *Cash*

equals 1 if the primary payment is cash, i.e. the "% of cash" is greater than or equal to 50, and 0 otherwise.

We then control for firm characteristics. *Size* is the natural logarithm of market capitalization on the event day t. Book value is calculated as book value per share multiplied by total shares outstanding, where we use the most recent fiscal year end data prior to each event. *B/M* is natural logarithm of the ratio of book value to market capitalization. We also include year and industry fixed effects.

[Table 4 about here]

As shown in Table 4 Panel A, pre-event IV spread has a significantly positive prediction on acquirer announcement CAR. To control for heteroskedasticity, we report t-statistics calculated using White's (1980) heteroskedasticity robust standard errors for all regressions. When IV spread is the only explanatory variable, it has a positive and significant coefficient of 8.99 with a t-statistic of 3.69. In column (2) to (5), we gradually add controls for previous returns, event-related characteristics, and firm characteristics. This does not affect the predictability of IV spread on acquirer announcement return. When we include all control variables as well as year and industry fixed effects, IV spread still has a coefficient of 8.90 and a t-statistic of 3.66. When IV spread increases by one standard deviation, the acquirer announcement CAR will increase by about 0.57%. The takeaway is that higher IV spread is a proxy for positive information held by option traders, thus it predicts a higher acquirer announcement CAR, and vice versa.

Similarly, we test the predictability of IV skew on acquirer announcement return, and the regression results are presented in Panel B of Table 4. A higher IV skew is a proxy for a higher buying pressure on OTM put options. It indicates that investors are expecting a negative return on the stock. As shown in Panel B column (1), IV skew itself carries a coefficient of -11.96 with a t-statistic of -3.06. Adding all control variables does not affect the negative relationship between IV skew and acquirer CAR (β_1 = -8.88, t-statistic = -2.24). One standard deviation increase of IV skew will lead to a decrease of the acquirer announcement CAR by about 0.48%.

To sum up, our main hypothesis is well supported by cross-sectional regressions. Option traders do hold private information and trade on it before the announcement of an M&A event. The IV spread is positively associated with the acquirer announcement return, while the IV skew is

negatively associated with it. The predictability remains significant when we control for other factors that may affect event window returns.

IV. Additional tests and robustness check

In this section, we extend our main hypothesis in three aspects, i.e. the role of option and stock liquidity, long-run performance, and the predictability of O/S. We then provide evidence using different variations of IV spread and IV skew as robustness check.

A. The role of liquidity

This subsection discusses the role of relative liquidity of option to stock for an M&A acquirer. Easley, O'Hara, and Srinivas (1998) argue that there will be more informed trading in options market if options are relatively more liquid than stock, and less informed option trading if stock is relatively more liquid. A natural extension is to examine whether the predictability of IV spread and IV skew on acquirer announcement return will be affected by the relative liquidity of option to stock. We expect that the predictive power will be strengthened if option liquidity is relatively high and stock liquidity is relatively low, and vice versa.

We measure option liquidity by bid-ask spread. For each option on each day, we calculate the difference between best offer and best bid price, and then divide it by the average of the two. It is a proxy for the cost paid by option traders. The higher the bid-ask spread, the lower the liquidity of option. We take the average bid-ask spread across all non-zero trading volume options for each firm *i* on each day, and then use the average from day *t-5* to *t-1* as a proxy for the acquirer's option liquidity before each M&A event.

To measure stock liquidity, we adopt Amihud (2002) illiquidity ratio (ILLIQ), which is calculated as the daily ratio of the absolute stock return to its dollar trading volume, averaged over day *t-5* to *t-1* for each M&A acquirer. A higher ILLIQ means lower stock liquidity in pre-event five days.

For each announcement on day *t*, we calculate option liquidity for all of the firms in the market with non-zero option trading volume during day *t-5* to *t-1*. After that, we sort all these firms into

quartiles based on option liquidity and identify which quartile the acquirer belongs to. Quartile 1 has the lowest option liquidity (highest bid-ask spread), and quartile 4 has the highest option liquidity (lowest bid-ask spread). We then sort events in each option liquidity group based on acquirer's stock liquidity, where quartile 1 has the lowest stock liquidity (highest Amihud ILLIQ) and quartile 4 has the highest stock liquidity (lowest Amihud ILLIQ). Similar to the approach used in Cremers and Weinbaum (2010), we create two dummy variables based on the above liquidity measures. The dummy *High Option Low Stock Liq* equals 1 for acquirer stocks that are both in the highest 25% of option liquidity and in the lowest 25% of stock liquidity, and 0 otherwise. *Low Option High Stock Liq* equals 1 for acquirer stocks that are both in the lowest 25% of option liquidity and in the highest 25% of stock liquidity, and 0 otherwise. These dummy variables are interacted with each of our informed option trading measures. The regressions are as follows,

$$\begin{aligned} CAR_{i,[t,t+1]} = {} & \beta_{0,i} + \beta_{1,i}\ IV\ Spread_{i,t-1} \\ & + \beta_{2,i}\ IV\ Spread_{i,t-1} * High\ Option\ Low\ Stock\ Liq_i \\ & + \beta_{3,i}\ IV\ Spread_{i,t-1} * Low\ Option\ High\ Stock\ Liq_i + \gamma_i\ Control\ Variables_i + \varepsilon_i \end{aligned} \quad (4a)$$

$$\begin{aligned} CAR_{i,[t,t+1]} = {} & \beta_{0,i} + \beta_{1,i}\ IV\ Skew_{i,t-1} \\ & + \beta_{2,i}\ IV\ Skew_{i,t-1} * High\ Option\ Low\ Stock\ Liq_i \\ & + \beta_{3,i}\ IV\ Skew_{i,t-1} * Low\ Option\ High\ Stock\ Liq_i + \gamma_i\ Control\ Variables_i + \varepsilon_i \end{aligned} \quad (4b)$$

where $CAR_{i,\,[t,\,t+1]}$ refers to the cumulative abnormal return for acquiring firm *i* from day *t* to *t+1*, *IV spread* and *IV skew* are day *t-1* measures for informed option trading, *High Option Low Stock Liq* and *Low Option High Stock Liq* are dummy variables defined as in the previous paragraph. We use the interaction terms of informed trading measures with liquidity dummies to gauge the return predictability for acquirers with different relative liquidity of option to stock. All control variables are the same as in regression equation (3).

[Table 5 about here]

As shown in the first three columns of Table 5, IV spread still has a positive prediction on acquirer announcement return. Consistent with expectation, the coefficient on *IV spread * High Option Low Stock Liq* is positive (β_2 = 1.49 in column (3)), indicating that IV spread has a stronger predictive power when option liquidity is relatively high and stock liquidity is relatively

low. On the other hand, the coefficient on *IV spread * Low Option High Stock Liq* is negative and significant (β_3 = -16.62 in column (3)). It means that the predictive power will be much smaller if option liquidity is low while stock liquidity is relatively high.

The last three columns of Table 5 present the results for IV skew which still shows a significantly negative prediction on acquirer CAR. The coefficient on *IV skew * High Option Low Stock Liq* is negative and significant (β_2 = -18.92 in column (6)), while the coefficient on *IV skew * Low Option High Stock Liq* is positive (β_3 = 19.45 in column (6)). It supports our argument that high option liquidity, relative to stock liquidity, strengthens the predictive power of IV skew, and vice versa.

Concur with the results in Easley, O'Hara, and Srinivas (1998) and Cremers and Weinbaum (2010), we find that liquidity plays a significant role when investors choose which market to trade in. When option has a high liquidity, informed investors may trade more actively in option to take advantage of its high leverage and low cost. As a result, option trading will contain more information about the M&A events, and our option measures will have stronger predictive power on M&A announcement returns. Conversely, if option is less liquid, informed traders may invest more in stock market. There will be less information revealed in pre-M&A option trading and less predictability of our option measures on announcement returns.

B. Long-run performance

We have shown the predictability of informed option trading on acquirer short-term CAR around M&A announcement. One may wonder that whether pre-M&A informed option trading is also related to acquirer's long-run performance. If informed investors hold vital information about the value creation through the M&A events, one would expect that the pre-M&A informed option trading predicts firm long-run performance. In other words, firms with higher IV spread or lower IV skew are expected to generate higher long-run abnormal returns, and firms with lower IV spread or higher IV skew are expected to generate lower long-run abnormal returns.

Following Fama (1998) and Ikenberry and Ramnath (2002), we first measure long-run abnormal return by calendar-time portfolio regression which exhibits better statistical properties and mitigates the cross-sectional correlations. We sort all acquirers into quartiles based on their pre-

announcement IV spread and IV skew respectively. Within each quartile, we add acquirers into portfolio in the next month after they announce M&A events, and hold them for 12 months. The portfolio is rebalanced in each month. Monthly portfolio return is calculated based on equal-weighted investment strategy to take advantage of its better diversification and lower idiosyncratic noise. We also vary the holding period from one year to five years.

For each of the calendar-time portfolios, we measure abnormal returns using Carhart (1997) 4-factor model, which takes the form

$$R_{p,t} - R_{rf,t} = \alpha + \beta_1 (R_{mkt,t} - R_{rf,t}) + \beta_2 R_{SMB,t} + \beta_3 R_{HML,t} + \beta_4 R_{PR1YR,t} + \varepsilon_t \quad (5)$$

where $R_{p,t}$ is monthly portfolio return, $R_{rf,t}$ is risk-free rate, $R_{mkt,t}$ - $R_{rf,t}$ is market premium, $R_{SMB,t}$ is the small-minus-big market capitalization factor, $R_{HML,t}$ is the high-minus-low book-to-market factor, and $R_{PR1YR,t}$ is the momentum factor. α measures long-run abnormal performance. Since the M&A events are not uniformly distributed in time, we adopt weighted least squares (WLS), where the weights are the number of acquirers in the portfolio in each month. This approach ensures that each acquirer has the same impact in the analysis. We apply Newey-West (1987) standard errors to adjust for heteroskedasticity and autocorrelation.

[Table 6 about here]

Panel A of Table 6 shows the one-year to five-year abnormal returns for each IV spread and IV skew quartile. The last column presents the return spread between Quartile 4 and Quartile 1. Consistent with our expectation, acquirers with higher IV spread (lower IV skew) performs better than those with lower IV spread (higher IV skew) in the long-run. In one-year horizon, the top IV spread quartile firms earn 0.08% per month on average, while the bottom IV spread quartile firms lose 0.20% per month on average. There is a return spread of 0.28% per month. Similarly, the bottom IV skew quartile firms earn 0.47% per month, while the top IV skew quartile firms lose 0.36% per month. The one-year abnormal return spread amounts to -0.83% per month, which is economically and statistically significant. The high-minus-low difference is largest for one-year abnormal returns and it decreases gradually with time. The results suggest that option traders hold some information on firm performance beyond one year, and informed option trading measures can also predict acquirer long-run returns.

We also adopt buy-and-hold abnormal return (BHAR) as another measure for long-run abnormal performance. For each M&A acquirer *i*, we calculate buy-and hold return by compounding post-announcement daily returns, and use value-weighted market buy-and-hold return as the benchmark. We focus on BHARs for post-M&A announcement one year.[6] To mitigate the effect of extreme values, deciles of BHARs are regressed on day *t-1* IV spread and IV skew and control variables. As shown in Panel B of Table 6, there is some predictability of our informed option trading measures on BHAR. The coefficient on IV spread is positive and significant by itself and with all controls (β = 1.62, t-statistic = 1.96 in column (1), β = 1.42, t-statistic = 1.81 in column (3)). A higher IV spread positively predicts BHAR in one-year horizon after the M&A announcement. On the other hand, the coefficient on IV skew is negative, which is also consistent with our conjecture, although insignificant.

We then examine whether our informed option trading measures have predictive power on post-M&A earnings announcement CAR. For each M&A event, we calculate CAR (-1, 1) around each of the four quarterly earnings announcements after M&A announcement. Following Danis and Sarin (2001), we regress earnings announcement CARs on day *t-1* IV spread and IV skew. Besides size and B/M ratio, we also control for *change in earnings* which is the difference of earnings between quarter *t* and quarter *t-1*, as a percentage of the acquirer's market capitalization prior to M&A announcement. Panel C shows a positive predictability of IV spread (β = 3.17, t-statistic = 2.09 in column (3)) and a negative predictability of IV skew (β = -10.21, t-statistic = -2.80 in column (6)).

Overall, we find some supporting evidence on the predictability of IV spread and IV skew on acquirer long-run performance. We adopt calendar-time portfolio regression, and also analyze BHAR as well as earnings announcement CAR. Generally, a higher IV spread (or a lower IV skew) is associated with a better acquirer long-run performance and a higher IV skew (or a lower IV spread) is associated with a worse long-run performance.

C. The predictability of O/S

[6] We also analyzed BHAR for post-MA& announcement two to five years, and the regression results are similar. For longer holding period, both IV Spread and IV Skew show slightly more significant predictability on BHAR.

In previous analyses, we adopt IV spread and IV skew as proxies for demand pressure in option trading. In this subsection, we consider the relative trading volume of options to stock (O/S), which is an unsigned volume-based option measure.[7]

If investors hold private information on M&A events, they are likely to trade in both stock market and options market prior to announcements. Due to the advantage of leverage and liquidity of options, option trading volume should increase more than stock trading volume. As a result, the ratio of O/S should increase. When the M&A event is a piece of good (bad) news, investors may actively buy (sell) call options or sell (buy) put options. In each case, O/S will be driven up, since we take into account both call and put option trading without separating whether it is a buy or a sell. We thus conjecture that, if investors trade in options market to capitalize on their private information before M&A announcement, pre-event O/S should positively predict absolute CAR for acquirer. We conduct cross-sectional regressions as follows,

$$\left|CAR_{i,[t,t+1]}\right| = \beta_{0,i} + \beta_{1,i}\ Ln(Sh\ O/S)_{i,t-1} + \gamma_i\ Control\ Variables_i + \varepsilon_i \qquad (6a)$$

$$\left|CAR_{i,[t,t+1]}\right| = \beta_{0,i} + \beta_{1,i}\ Ln(Sh\ O/S)_{i,t-1} + \beta_{2,i}\ Ln(Sh\ O/S)_{i,t-1} * \left|CAR_{i,[t-3,t-1]}\right| + \gamma_i\ Control\ Variables_i + \varepsilon_i \qquad (6b)$$

where the dependent variable is the absolute value of CAR for acquirer *i* from day *t* to *t+1*, and *Ln (Sh O/S)* is our proxy for informed option trading for day *t-1*. We construct share volume O/S (Sh O/S) according to Roll, Schwartz, and Subrahmanyam (2010).[8] To reduce the influence of possible outliers, we take the natural logarithm of Sh O/S. In regression equation (6b), O/S is interacted with the absolute value of acquirer CAR from day *t-3* to *t-1*. All controls are defined as in equation (3).

[Table 7 about here]

In Table 7, the absolute value of acquirer announcement CAR is regressed on Ln (Sh O/S). The first two columns show a positive and significant relationship between pre-event O/S and acquirer announcement return. With all control variables as well as year and industry fixed effects, O/S has a positive coefficient of 0.25 with a large t-statistic of 5.62. A higher pre-

[7] For other volume based measures, also see Spyrou, Tsekrekos, and Siougle (2011).

[8] For each firm, daily share option volume is calculated as the total contracts traded in each option multiplied by 100, then aggregated across all options traded on that stock. (Each contract is for 100 shares of stock.) Share volume O/S (Sh O/S) is the ratio of share option volume to stock trading volume on that day.

announcement trading volume of options relative to stock is associated with a larger absolute announcement return for acquirer.

In the last two columns, O/S is interacted with the absolute CAR for pre-event three days. This term takes into account the effect of pre-event price run-up. Our argument is that, the informed trading could induce larger pre-event absolute CAR, so that private information will be partially incorporated into acquirer's stock price before announcement. In that case, O/S is expected to be less informative on acquirer announcement return. The coefficient for this interaction term should be negative, as confirmed by the results in Table 7 (β_2 = -0.04, t-statistic = -3.42 in column (4)). This is consistent with the findings in Roll, Schwartz, and Subrahmanyam (2010), which instead studies the predictability of O/S on earnings announcements.

We also compute dollar volume O/S ($ O/S) as the informed trading proxy.[9] The regressions show similar results as using share volume O/S. Besides, we try deciles of Sh O/S and deciles of $ O/S, and find that O/S deciles are in general positively associated with acquirer's absolute CAR around announcement.[10]

D. Robustness check

This subsection provides several robustness tests on variations of our option measures. The predictability remains significant when we make use of deciles of IV spread and IV skew, and changes compared with previous week as well as previous month.

[Table 8 about here]

To mitigate the impact of extreme values of our informed option trading measures, we try to adopt ranks instead of the raw value of IV spread and IV skew in regressions. As shown in the first two columns of Table 8, deciles of IV spread and IV skew have consistent and significant prediction on acquirer announcement return. A higher decile of IV spread indicates a higher acquirer announcement CAR (β = 0.11, t-statistic = 3.04), while a higher decile of IV skew

[9] Dollar option volume is calculated by multiplying the total number of contracts traded in each option by the average of best bid and best offer price, then multiplied by 100. Dollar stock volume equals stock price multiplied by stock trading volume. Dollar volume O/S ($ O/S) is then calculated as the ratio of dollar option volume to dollar stock volume.

[10] See, Johnson and So (2011) for deciles of O/S as informed option trading measure.

indicates a lower acquirer announcement CAR (β = -0.12, t-statistic = -1.95). Other variations, such as quintiles and quartiles, give similar results.

In column (3) and (4), we adopt change in IV spread and IV skew for the previous week, i.e. the difference between day *t-1* and the average from day *t-6* to day *t-2*. Similarly, in column (5) and (6), we adopt change in IV spread and IV skew for the previous month, i.e. the difference between day *t-1* and the average from day *t-23* to day *t-2*. Intuitively, a large and positive change of IV spread indicates that informed investors are buying increasingly more calls than puts when the M&A announcement is approaching. It indicates that investors may hold positive information about the event. On the contrary, if IV skew increases gradually before the M&A announcement, it is likely that investors are trading on negative information, thus they purchase more OTM puts than ATM calls. Using changes of IV spread and IV skew give consistent and significant results as shown in Table 4.

Besides, we also conduct robustness tests by excluding M&A events with deal value below $10 million (about 5% of total observations) or below $100 million (about 32% of total observations), and the predictability remains significant. We also mitigate the effect of small firms by dropping acquirers with market capitalization below $400 million (about 10% of total observation), and our results still hold.

To sum up, the results in Section III and IV indicate that some informed investors are trading actively in options market prior to announcements, in anticipation of the M&A events. Both the signed (IV spread and IV skew) and unsigned (O/S) informed option trading measures have significant predictive power on acquirer announcement return. The predictability is affected by the relative liquidity of options to stock. Moreover, the informed option trading measures are also related to acquirer long-run abnormal performance. Our results are robust to different alternative constructions of informed option trading measures.

V. Evidence from target firms

In previous sections, we have documented that option trading contains information on M&A acquirer CAR. To make the study more comprehensive, we also consider a smaller sample of target firms, and find some supporting evidence for our main hypothesis.

We follow the same sample selection procedure as that for acquirers, and obtain 2,372 M&A observations (1,990 target firms) during January 1996 to December 2010. The summary statistics are shown in Table Appendix 1. Most target firms have positive announcement returns. The mean return is 16.62%, which is much higher than that of acquirers. Investors regard the M&A events as good news for target firms and are expecting positive returns after the mergers or acquisitions. In addition, events with cash-only payment have a higher mean return than those with shares payment method. The difference is about 10%.

Table Appendix 2 reports summary statistics of IV spread and IV skew for targets. Different from acquirers, targets have a slightly positive mean for IV spread, suggesting that call option is more expensive than put option for the matching pair. It indicates a higher demand for call options due to investors' expectation that target firms will have positive returns in near future.

To examine the general pattern of target CARs with respect to our informed option trading measures, we repeat the analysis in Table 3 by sorting the sample into quintiles based on pre-event IV spread and IV skew (Table Appendix 3). Each quintile has a significantly positive mean return from day *t* to *t+1*. In general, it is consistent with the finding in acquirers that target CAR increases with IV spread and decreases with IV skew.

[Table 9 about here]

Our hypothesis is that option traders hold private information on M&A events. Target announcement return can be positively predicted by IV spread and negatively predicted by IV skew. We rerun our main regression in equation (3), using target CAR from day *t* to *t+1* as dependent variable, and target IV spread and IV skew on day *t-1* as independent variables separately. All control variables follow the same definitions as before, except that we use target information for pre-month and pre-year return and firm characteristics. Table 9 shows the cross-sectional regression results. IV spread has a positive prediction by itself (β_1 = 4.66) and with all controls (β_1 = 2.42). IV skew has a negative and significant prediction by itself (β_1 = -18.88) and with all controls (β_1 = -15.16). In general, we find some supporting evidence in target firms, which is consistent with Cao, Chen, and Griffin (2005).

VI. Conclusion

It has been documented that option trading contains information on future stock returns. Some literature has studied time-series and cross-sectional predictions of option trading. Others employ option measures in corporate event studies such as earnings announcements and stock splits. However, little is known about the informational content of option trading prior to M&A events. Our paper, to our knowledge, is the first one to study the predictability of option trading on M&A acquirer announcement return.

Investors tend to capitalize on their private information, and trade actively to take advantage of the high liquidity and leverage of options. We thus hypothesize that pre-event option trading contains information on M&A acquirer announcement return. We adopt two newly-developed proxies for informed option trading. A larger IV spread indicates a higher demand for calls and a positive expectation on future stock returns. We find that IV spread positively predicts M&A acquirer announcement return. On the other hand, a larger IV skew is a proxy for a higher buying pressure on OTM put relative to ATM call, indicating that investors are expecting a negative return in future. Thus IV skew should negatively predict M&A acquirer announcement return, as confirmed by our main results.

We further support our main hypothesis by considering the following three aspects. First, we find that predictability of option measures is higher if option has a relatively higher liquidity and stock has a relatively lower liquidity prior to M&A announcement. On the other hand, if option is less liquid, while stock is relatively more liquid, the predictability will be lower. Second, we provide evidence that pre-announcement informed option trading is also related to acquirer long-run equity performance. Adopting calendar-time portfolio regression, we find that acquirers with higher pre-announcement IV spread and lower pre-announcement IV skew exhibit higher abnormal returns in one-year to five-year horizon following M&A announcements. Beside, IV spread and IV skew also predict post-M&A BHAR and quarterly earnings announcement CAR. Third, we adopt a volume-based proxy for informed option trading, and find that a higher O/S is associated with a higher absolute announcement return for acquirer. If information has been partially incorporated into pre-event stock prices, the announcement absolute CAR will be smaller, and the predictive power of O/S will decrease. It suggests that at least some investors

have correctly predicted the direction of price changes around M&A announcements. Moreover, our main results are robust using other variations of IV spread and IV skew, such as the ranks, change from previous week, and change from previous month. The results are not dominated by events with small deal values or firms with small market capitalizations.

To sum up, the M&A acquirer announcement return can be predicted by pre-event informed option trading measures. The predictive power is strengthened if option is relatively more liquid than stock. Informed option trading can also predict acquirer long-run performance. Our main results hold for a smaller sample of target firms that IV spread and IV skew show some predictability on target announcement return.

Appendix: Construction of implied volatility spread and implied volatility skew

A. Implied volatility spread

We employ implied volatility (IV) spread documented in Cremers and Weinbaum (2010) as one of our proxies for informed option trading activity. To measure deviations from put-call parity, IV spread is constructed as the average difference in implied volatilities between call and put options for the same security with the same strike price and the same maturity. In particular, we compute the IV spread for each firm *i* on each day *t* as

$$IV\ Spread_{i,t} = IV_{i,t}^{calls} - IV_{i,t}^{puts} = \sum_{j=1}^{N_{i,t}} w_{j,t}^{i} (IV_{j,t}^{i,call} - IV_{j,t}^{i,put}) \quad (1)$$

where *j* refers to pairs of call and put options with the same strike price and the same maturity, $N_{i,t}$ is the total number of valid pairs for each stock *i* on day *t*, and $w_{j,t}^{i}$ is the weight where we use the average open interest of call and put in each pair. $IV_{j,t}^{i}$ represents the Black-Scholes (1973) implied volatility for each call and put option. We exclude those options with zero open interest or zero best bid price. We only keep short-term options with time-to-maturity less than 60 days, because an option with its maturity longer than two months is less liquid. If investors have private information on M&A events, they are more likely to trade on short-term options so as to realize profit immediately. Short-term options are thus expected to reflect more on the information embedded in pre-event option trading.

B. Implied volatility skew

The other option measure we adopt is implied volatility (IV) skew. According to Xing, Zhang, and Zhao (2010), we calculate IV skew for firm *i* on day *t*, as the implied volatility difference between out-of-the-money (OTM) put and at-the-money (ATM) call,

$$IV\ Skew_{i,t} = IV_{i,t}^{OTMput} - IV_{i,t}^{ATMcall} \quad (2)$$

Where $IV_{i,t}$ represents the Black-Scholes (1973) implied volatility for OTM put and ATM call option. To ensure option liquidity, we also use short-term options with time-to-expiration between 10 to 60 days. We require stock volume and option volume to be positive to eliminate

those non-trading cases. We further restrict stock price to be greater than $5, option open interest to be positive, implied volatility of options to be between 3% and 200%, and option's average bid and ask price to be higher than $0.125.

We define moneyness as the ratio of strike price to stock price. OTM puts are defined as put options with moneyness between 0.80 and 0.95, while ATM calls are defined as call options with moneyness between 0.95 and 1.05. If there are multiple OTM puts and ATM calls, we select one OTM put with moneyness closest to 0.95 and one ATM call with moneyness closest to 1. In several occasions, there are put options with the same moneyness which is closest to 0.95. We keep the one with the highest open interest, or if open interests are the same, we keep the one with the highest stock trading volume. We follow the same selection criteria for ATM calls. In this approach, we come up with one skew measure for each firm *i* on each day *t*.

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Table 1. Summary Statistics for M&A Events - Acquirers

This table presents summary statistics for acquirers in M&A events. Panel A shows the number of events and the number of acquirers in each year. The details of cumulative abnormal returns (CARs) from day *t* to *t+1* are listed in Panel B. The last row of each panel contains data for the whole sample period. *NOBS* represents the number of observations.

Panel A. M&A Events by Year

Year	Number of M&A Events	Number of Firms
1996	373	266
1997	418	295
1998	487	343
1999	475	330
2000	446	312
2001	280	212
2002	238	199
2003	247	209
2004	290	238
2005	293	250
2006	312	255
2007	356	296
2008	327	251
2009	248	202
2010	309	251
1996-2010	**5,099**	**1,754**

Panel B. CAR Summary Statistics by Year

Year	NOBS	MEAN	STD	MIN	Q1	MEDIAN	Q3	MAX
1996	373	0.24%	5.26%	-28.24%	-2.17%	0.19%	2.65%	23.92%
1997	418	-0.12%	5.22%	-45.17%	-1.90%	-0.20%	1.86%	18.94%
1998	487	-0.75%	6.50%	-31.02%	-3.28%	-0.73%	1.82%	52.37%
1999	475	0.08%	6.54%	-42.62%	-2.90%	-0.02%	3.09%	32.05%
2000	446	-0.56%	8.31%	-40.13%	-3.93%	-0.52%	3.60%	41.78%
2001	280	-0.29%	7.16%	-27.27%	-3.26%	-0.20%	2.53%	53.70%
2002	238	0.11%	5.44%	-36.36%	-2.32%	0.20%	2.74%	16.37%
2003	247	-1.12%	5.80%	-40.42%	-2.61%	-0.53%	1.13%	16.55%
2004	290	-0.46%	5.51%	-21.68%	-2.06%	0.02%	1.62%	23.95%
2005	293	0.28%	4.23%	-18.83%	-1.24%	0.17%	1.65%	20.35%
2006	312	0.12%	4.71%	-20.01%	-1.73%	-0.07%	1.95%	27.88%
2007	356	0.49%	4.67%	-27.48%	-1.18%	0.37%	1.96%	30.15%
2008	327	-0.07%	6.03%	-23.94%	-2.64%	-0.15%	2.33%	38.37%
2009	248	1.04%	8.09%	-15.77%	-1.69%	0.30%	2.20%	54.89%
2010	309	0.37%	4.61%	-15.41%	-1.13%	0.25%	1.85%	27.67%
1996-2010	**5,099**	**-0.07%**	**6.06%**	**-45.17%**	**-2.41%**	**-0.06%**	**2.20%**	**54.89%**

Table 2. Summary Statistics for Option Measures

This table shows the summary statistics for the two option measures we adopt, i.e. implied volatility (IV) spread and implied volatility (IV) skew. The details for each year are presented in Panel A and B, with the statistics for the whole sample period in the last row of each panel. *NOBS* represents the number of observations.

Panel A. IV spread Summary Statistics by Year

Year	NOBS	MEAN	STD	MIN	Q1	MEDIAN	Q3	MAX
1996	272	-0.0051	0.0676	-0.2649	-0.0387	-0.0110	0.0260	0.3643
1997	350	-0.0079	0.0758	-0.5098	-0.0424	-0.0154	0.0244	0.4691
1998	406	-0.0159	0.0901	-0.4270	-0.0478	-0.0165	0.0123	1.2647
1999	407	-0.0126	0.0689	-0.3129	-0.0359	-0.0108	0.0144	0.3019
2000	371	-0.0193	0.0954	-1.0661	-0.0400	-0.0152	0.0145	0.2969
2001	234	-0.0152	0.0455	-0.2713	-0.0327	-0.0146	0.0015	0.1781
2002	201	-0.0112	0.0469	-0.2247	-0.0276	-0.0074	0.0068	0.1736
2003	189	-0.0087	0.0317	-0.1849	-0.0217	-0.0067	0.0032	0.0850
2004	229	-0.0055	0.0267	-0.1332	-0.0193	-0.0054	0.0060	0.0833
2005	236	-0.0068	0.0337	-0.2865	-0.0196	-0.0053	0.0061	0.1855
2006	271	-0.0060	0.0318	-0.1665	-0.0154	-0.0044	0.0068	0.2008
2007	319	-0.0080	0.0366	-0.2258	-0.0186	-0.0058	0.0073	0.2603
2008	285	-0.0043	0.0710	-0.6025	-0.0235	-0.0024	0.0190	0.5404
2009	206	-0.0065	0.0484	-0.2363	-0.0221	-0.0044	0.0107	0.1700
2010	216	-0.0077	0.0630	-0.7431	-0.0180	-0.0009	0.0136	0.1330
1996-2010	**4,192**	**-0.0099**	**0.0635**	**-1.0661**	**-0.0283**	**-0.0077**	**0.0107**	**1.2647**

Panel B. IV skew Summary Statistics by Year

Year	NOBS	MEAN	STD	MIN	Q1	MEDIAN	Q3	MAX
1996	67	0.0292	0.0560	-0.1154	0.0020	0.0281	0.0491	0.2437
1997	82	0.0379	0.0562	-0.1497	0.0025	0.0297	0.0675	0.2103
1998	111	0.0380	0.0567	-0.0937	0.0027	0.0282	0.0651	0.3976
1999	148	0.0226	0.0453	-0.1484	0.0005	0.0237	0.0442	0.2812
2000	170	0.0435	0.1004	-0.1251	0.0069	0.0250	0.0568	1.0071
2001	104	0.0594	0.0489	-0.0520	0.0296	0.0520	0.0747	0.2805
2002	69	0.0723	0.0522	0.0023	0.0376	0.0662	0.0867	0.2726
2003	73	0.0548	0.0287	-0.0088	0.0340	0.0508	0.0679	0.1420
2004	74	0.0425	0.0238	-0.0139	0.0238	0.0387	0.0563	0.1165
2005	69	0.0442	0.0350	-0.0221	0.0179	0.0373	0.0604	0.1602
2006	87	0.0314	0.0339	-0.1264	0.0159	0.0261	0.0465	0.1630
2007	136	0.0378	0.0309	-0.0277	0.0190	0.0337	0.0530	0.1862
2008	136	0.0503	0.0536	-0.1483	0.0225	0.0422	0.0619	0.3167
2009	113	0.0476	0.0298	-0.0813	0.0294	0.0439	0.0628	0.1382
2010	104	0.0426	0.0268	-0.1035	0.0299	0.0402	0.0534	0.1197
1996-2010	**1,543**	**0.0427**	**0.0536**	**-0.1497**	**0.0182**	**0.0366**	**0.0598**	**1.0071**

Table 3. Acquirer CAR Sorted by IV spread and IV skew

This table shows the single sorting results of acquirer $CAR_{i, [t, t+1]}$ on implied volatility (IV) spread and implied volatility (IV) skew for day *t-1*. The mean and t-statistics are reported for each quintile. The difference between the highest (Quintile 5) and the lowest (Quintile 1) IV spread or IV skew group is also computed in the last column.

	IV spread Quintiles					
	1 (Low)	**2**	**3**	**4**	**5 (High)**	**High-Low**
Acquirer CAR	-0.70%	-0.48%	-0.03%	-0.20%	0.20%	0.90%
t-statistics	(-2.98)	(-2.53)	(-0.18)	(-1.22)	(0.87)	(2.74)
	IV skew Quintiles					
	1 (Low)	**2**	**3**	**4**	**5 (High)**	**High-Low**
Acquirer CAR	0.45%	-0.04%	-0.34%	-0.44%	-0.92%	-1.37%
t-statistics	(0.99)	(-0.13)	(-1.42)	(-1.48)	(-2.70)	(-2.42)

Table 4. Cross-Sectional Regressions of Acquirer Announcement Return on IV spread and IV skew

This table presents the cross-sectional regression results of acquirer announcement return on implied volatility (IV) spread and skew, as well as other control variables. The dependent variable is the *cumulative abnormal return (CAR)* from day *t* to *t+1*, where day *t* is the announcement date. The CRSP value-weighted market return has been used as the benchmark when calculating the abnormal returns. In Panel A, the independent variables include day *t-1* IV spread, which is calculated according to Cremers and Weinbaum (2010). Panel B instead uses day *t-1* IV skew, which is calculated according to Xing, Zhang, and Zhao (2010). *Pre-month Return* and *Pre-year Return* are buy-and-hold compounding returns for pre-event one month and pre-event two to twelve months respectively. Similar to Cao, Chen, and Griffin (2005), we add five event-related dummies. *Successful* equals 1 if the merger or acquisition is successfully completed and 0 otherwise. *Takeover* equals 1 if the event is identified as an "acquisition of majority interest" instead of a "merger" in SDC and 0 otherwise. *Hostile* equals 1 if the event is identified as "hostile" in SDC and 0 otherwise. *Rumor* equals 1 if there is pre-event rumor and 0 otherwise. *Cash* equals 1 if the primary payment is cash and 0 otherwise. *Size* and *B/M ratio* are included as firm characteristic controls, where both are in natural logarithm. CARs are in percentage. T-statistics are computed using White's (1980) heteroskedasticity robust standard errors, and *, **, and *** indicate significance at 10%, 5%, and 1% level respectively.

Panel A. IV spread

	Dependent Variable: $CAR_{i,[t,t+1]}$				
	(1)	(2)	(3)	(4)	(5)
IV spread	8.99***	9.31***	9.44***	9.31***	8.90***
	(3.69)	(3.75)	(3.80)	(3.76)	(3.66)
Pre-month Return		1.64*	1.77**	1.50*	1.58*
		(1.83)	(1.97)	(1.66)	(1.74)
Pre-year Return		0.20	0.24	0.12	0.15
		(1.29)	(1.45)	(0.81)	(0.91)
Successful			0.06	0.01	0.06
			(0.26)	(0.02)	(0.23)
Takeover			0.89***	1.04***	1.05***
			(4.46)	(5.27)	(5.22)
Hostile			-1.25	-1.14	-1.03
			(-1.61)	(-1.46)	(-1.32)
Rumor			0.34	0.58*	0.49
			(0.98)	(1.67)	(1.40)
Cash			0.72***	0.79***	0.67***
			(3.83)	(4.22)	(3.48)
Size				-0.10*	-0.13**
				(-1.81)	(-2.21)
B/M				-0.37***	-0.48***
				(-3.11)	(-3.85)
Year and Industry Control					Yes
Intercept	-0.15*	-0.25**	-0.70***	-0.27	-0.08
	(-1.69)	(-2.57)	(-2.78)	(-0.50)	(-0.10)
N	4,192	4,170	4,170	4,170	4,170
Adj. R-sq	0.01	0.01	0.02	0.02	0.02

Panel B. IV skew

	Dependent Variable: $CAR_{i,[t,t+1]}$				
	(1)	(2)	(3)	(4)	(5)
IV skew	-11.96***	-11.44***	-11.25***	-10.18***	-8.88**
	(-3.06)	(-2.93)	(-2.90)	(-2.63)	(-2.24)
Pre-month Return		0.94	1.06	0.73	0.93
		(0.65)	(0.74)	(0.50)	(0.64)
Pre-year Return		0.11	0.16	0.02	0.09
		(0.54)	(0.76)	(0.09)	(0.39)
Successful			-0.10	-0.18	-0.06
			(-0.29)	(-0.50)	(-0.17)
Takeover			1.25***	1.46***	1.49***
			(3.62)	(4.23)	(4.20)
Hostile			-3.09**	-2.96**	-3.05**
			(-2.17)	(-2.08)	(-2.13)
Rumor			0.26	0.43	0.39
			(0.60)	(1.02)	(0.89)
Cash			0.32	0.41	0.32
			(1.01)	(1.29)	(0.99)
Size				-0.06	-0.03
				(-0.48)	(-0.26)
B/M				-0.45**	-0.57***
				(-2.42)	(-2.77)
Year and Industry Control					Yes
Intercept	0.25	0.14	-0.10	-0.22	13.58***
	(1.07)	(0.58)	(-0.24)	(-0.17)	(12.90)
N	1,543	1,538	1,538	1,538	1,538
Adj. R-sq	0.01	0.01	0.02	0.02	0.03

Table 5. Relative Liquidity of Option and Stock

This table presents the cross-sectional regression results of acquirer *CAR* $_{i, [t, t+1]}$ on day *t-1* implied volatility (IV) spread and implied volatility (IV) skew, and their interactions with option and stock liquidity measures. We use bid-ask spread (best offer minus best bid, divided by the average of bid and ask) to measure the illiquidity of an option. We use Amihud (2002) illiquidity ratio (ILLIQ) to measure stock illiquidity. All the liquidity proxies are computed as the average for pre-event five days. For each event, we first sort the option liquidity into quartiles for all firms in the market with non-zero option trading in *t-1* to *t-5*, and get the respective quartile for the acquirer. Then, within each quartile of option liquidity, we sort the stock liquidity for all acquirers during *t-1* to *t-5* and get the quartile for each acquirer. The *High Option Low Stock Liq* equals 1 for stocks that are in the top 25% of option liquidity and the bottom 25% of stock liquidity. The *Low Option High Stock Liq* equals 1 for stocks in the bottom 25% of option liquidity and the top 25% of stock liquidity. All other control variables are the same as in Table 4. Columns (1) to (3) are for IV spread and (4) to (6) are for IV skew. CARs are in percentage. T-statistics are computed using White's (1980) heteroskedasticity robust standard errors, and *, **, and *** indicate significance at 10%, 5%, and 1% level respectively.

	Dependent Variable: CAR $_{i, [t, t+1]}$					
	IV spread			**IV skew**		
	(1)	(2)	(3)	(4)	(5)	(6)
IV spread or IV skew	9.25***	9.52***	9.17***	-11.14***	-9.31**	-7.96*
	(3.45)	(3.49)	(3.43)	(-2.71)	(-2.30)	(-1.93)
IV spread or IV skew*	1.51	2.33	1.49	-18.47	-18.61*	-18.92*
High Option Low Stock Liq	(0.23)	(0.36)	(0.23)	(-1.62)	(-1.71)	(-1.72)
IV spread or IV skew*	-16.06**	-16.10**	-16.62**	21.19	17.68	19.45
Low Option High Stock Liq	(-2.56)	(-2.50)	(-2.53)	(0.76)	(0.71)	(0.69)
Pre-month Return		1.55*	1.63*		0.76	0.95
		(1.71)	(1.79)		(0.53)	(0.65)
Pre-year Return		0.12	0.15		0.02	0.09
		(0.80)	(0.91)		(0.09)	(0.37)
Successful		0.04	0.10		-0.20	-0.08
		(0.15)	(0.38)		(-0.55)	(-0.22)
Takeover		1.05***	1.06***		1.42***	1.45***
		(5.28)	(5.25)		(4.14)	(4.12)
Hostile		-1.12	-1.02		-2.90**	-3.01**
		(-1.44)	(-1.30)		(-2.08)	(-2.14)
Rumor		0.60*	0.52		0.44	0.41
		(1.73)	(1.47)		(1.04)	(0.94)
Cash		0.79***	0.67***		0.39	0.30
		(4.23)	(3.52)		(1.23)	(0.92)
Size		-0.11*	-0.13**		-0.07	-0.05
		(-1.85)	(-2.25)		(-0.59)	(-0.42)
B/M		-0.37***	-0.49***		-0.46**	-0.59***
		(-3.12)	(-3.90)		(-2.50)	(-2.85)
Year and Industry Control			Yes			Yes
Intercept	-0.15*	-0.27	-0.10	0.23	-0.10	13.97***
	(-1.68)	(-0.50)	(-0.12)	(0.95)	(-0.08)	(12.99)
N	4,173	4,151	4,151	1,543	1,538	1,538
Adj. R-sq	0.01	0.02	0.02	0.01	0.02	0.03

Table 6. Acquirer Long-run Performance

This table shows several analyses on acquirer long-run performance. Panel A presents long-run abnormal returns sorted on implied volatility (IV) spread and skew. Following Fama (1998) and Ikenberry and Ramnath (2002), we measure long-run abnormal return as α in calendar-time portfolio regression. We first sort all acquirers into quartiles according to day *t-1* IV spread and IV skew respectively. Within each quartile, we then form monthly portfolio by adding the acquirer's stock if the M&A event is announced in the previous month, and holding it for one year. The portfolio is rebalanced monthly, and equal-weighted portfolio return is calculated. Monthly portfolio excess returns (using monthly risk-free rate as benchmark) are then regressed on Carhart (1997) four factors, and we obtain α as the one-tear horizon abnormal return. (Equation (5)) We then vary the holding period from one year to five years, and report the results in respective rows as follows. The last column shows the difference between the top and bottom quartile. All returns are in percentage, and t-statistics are calculated using Newey-West (1987) standard errors. In Panel B, we regress post-M&A announcement buy-and-hold abnormal returns (BHARs) on informed option measures. The buy-and-hold value-weighted market return is used as the benchmark. We focus on holding period of one year. Deciles of BHARs are regressed on day *t-1* IV spread (column (1) to (3)) and IV skew (column (4) to (6)). All other control variables are defined as in Table 4. Panel C shows the regression for $CAR_{i,[t-1,\ t+1]}$ around earning announcements after M&A announcement. Following Danis and Sarin (2001), we pool post-four quarters' earnings announcement CARs, and regress on day *t-1* IV spread (column (1) to (3)) and IV skew (column (4) to (6)). *Change in earnings* is the difference of earnings between quarter *t* and quarter *t-1*, as a percentage of the acquirer's market capitalization prior to M&A announcement. We include three quarter dummies where *Q1 dummy* equals 1 if the earnings announcement occurs in post-M&A one quarter, and 0 otherwise. *Q2 and Q3 dummy* follow similar definition. In Panel B and Panel C, t-statistics are computed using White's (1980) heteroskedasticity robust standard errors, and *, **, and *** indicate significance at 10%, 5%, and 1% level respectively.

Panel A: Acquirer Long-run Performance Sorted on IV spread and IV skew

	IV spread Quartiles									
	1 (Low)		**2**		**3**		**4 (High)**		**High-Low**	
1 year	-0.20	(-1.02)	-0.02	(-0.16)	0.13	(0.81)	0.08	(0.43)	0.28	(1.05)
2 year	-0.02	(-0.13)	0.17	(1.53)	0.36	(2.71)	0.24	(1.38)	0.26	(1.03)
3 year	0.15	(0.77)	0.29	(2.35)	0.35	(2.79)	0.37	(2.09)	0.22	(0.87)
4 year	0.26	(1.38)	0.35	(2.74)	0.32	(2.70)	0.45	(2.56)	0.19	(0.76)
5 year	0.27	(1.50)	0.31	(2.65)	0.32	(2.66)	0.46	(2.61)	0.19	(0.77)
	IV skew Quartiles									
	1 (Low)		**2**		**3**		**4 (High)**		**High-Low**	
1 year	0.47	(1.54)	0.31	(1.16)	-0.11	(-0.55)	-0.36	(-1.38)	-0.83	(-2.07)
2 year	0.47	(1.56)	0.38	(1.72)	0.08	(0.44)	0.02	(0.10)	-0.45	(-1.20)
3 year	0.64	(2.01)	0.45	(2.02)	0.11	(0.63)	0.14	(0.70)	-0.50	(-1.31)
4 year	0.66	(2.11)	0.49	(2.19)	0.20	(1.09)	0.22	(1.11)	-0.44	(-1.18)
5 year	0.65	(2.18)	0.42	(1.85)	0.24	(1.31)	0.19	(1.02)	-0.46	(-1.32)

Panel B. Post-announcement 1 year BHAR

	Dependent Variable: BHAR Deciles					
	(1)	(2)	(3)	(4)	(5)	(6)
IV spread	1.62**	1.54*	1.42*			
	(1.96)	(1.89)	(1.81)			
IV skew				-0.90	-1.68	-0.70
				(-0.56)	(-1.14)	(-0.48)
Pre-month Return		0.46	0.49		0.94*	0.76
		(1.33)	(1.38)		(1.66)	(1.36)
Pre-year Return		-0.16***	-0.18***		-0.21***	-0.15**
		(-3.77)	(-3.91)		(-3.43)	(-2.29)
Successful		-0.05	-0.03		-0.07	0.00
		(-0.39)	(-0.23)		(-0.37)	(0.01)
Takeover		0.04	0.04		0.13	0.09
		(0.32)	(0.31)		(0.62)	(0.46)
Hostile		-0.54	-0.48		-0.12	-0.29
		(-1.48)	(-1.36)		(-0.20)	(-0.50)
Rumor		0.07	-0.01		0.16	0.17
		(0.40)	(-0.07)		(0.66)	(0.69)
Cash		0.34***	0.20**		0.31**	0.17
		(3.54)	(2.08)		(2.05)	(1.03)
Size		0.18***	0.15***		0.19***	0.16***
		(6.74)	(5.14)		(3.87)	(3.12)
B/M		0.24***	0.16***		0.17**	0.06
		(4.63)	(2.88)		(1.97)	(0.62)
Year and Industry Control			Yes			Yes
Intercept	4.45***	3.17***	3.61***	4.44***	2.89***	0.63
	(98.90)	(12.17)	(3.78)	(43.83)	(5.46)	(1.25)
N	4,192	4,170	4,170	1,543	1,538	1,538
Adj. R-sq	0.00	0.03	0.04	-0.00	0.03	0.06

Panel C: Post-M&A Earnings Announcement CAR

	Dependent Variable: Earnings Announcement CAR $_{i, [t-1, t+1]}$					
	(1)	(2)	(3)	(4)	(5)	(6)
IV spread	2.97*	2.94*	3.17**			
	(1.96)	(1.94)	(2.09)			
IV skew				-9.34**	-9.62***	-10.21***
				(-2.58)	(-2.64)	(-2.80)
Size		0.03	0.03		-0.12	-0.11
		(0.68)	(0.66)		(-1.47)	(-1.31)
B/M		0.08	0.06		0.02	-0.02
		(0.82)	(0.58)		(0.13)	(-0.10)
Change in Earnings			6.45***			1.62
			(4.36)			(0.34)
Q1 Dummy	-0.37*	-0.36*	-0.30	-0.53	-0.53	-0.46
	(-1.84)	(-1.79)	(-1.49)	(-1.52)	(-1.51)	(-1.31)
Q2 Dummy	0.07	0.07	0.12	-0.19	-0.19	-0.12
	(0.32)	(0.36)	(0.59)	(-0.54)	(-0.53)	(-0.32)
Q3 Dummy	-0.12	-0.11	-0.05	-0.77**	-0.77**	-0.70*
	(-0.55)	(-0.50)	(-0.24)	(-2.07)	(-2.07)	(-1.88)
Intercept	0.47***	0.31	0.24	1.22***	2.45***	2.21***
	(3.04)	(0.79)	(0.61)	(4.10)	(2.88)	(2.61)
N	15,497	15,497	15,465	5,718	5,718	5,709
Adj. R-sq	0.00	0.00	0.00	0.00	0.00	0.00

Table 7. Cross-Sectional Regressions of Acquirer Announcement Return on O/S

This table shows cross-sectional regression results of absolute value of $CAR_{i,[t,t+1]}$ on day *t-1* O/S, and other control variables. We construct share volume O/S (Sh O/S) according to Roll, Schwartz, and Subrahmanyam (2010). Daily share option volume is calculated as the total contracts traded in each option multiplied by 100, then aggregated across all options traded on that stock. (Each contract is for 100 shares of stock.) Sh O/S equals share option volume divided by stock trading volume on that day. Natural logarithm of Sh O/S is used in the following regressions. In regression (3) to (4), *Ln (Sh O/S)* is interacted with absolute CAR for pre-event three days. All other control variables are the same as in Table 4. All CARs are in percentage. T-statistics are calculated using White's (1980) heteroskedasticity robust standard errors, and *, **, and *** indicate significance at 10%, 5%, and 1% level respectively.

	Dependent Variable: Absolute CAR $_{i,[t,t+1]}$			
	(1)	(2)	(3)	(4)
Ln (Sh O/S)	0.23***	0.25***	0.34***	0.33***
	(5.21)	(5.62)	(6.84)	(6.64)
Ln (Sh O/S)* Absolute CAR $_{i,[t-3,t-1]}$			-0.05***	-0.04***
			(-4.42)	(-3.42)
Pre-month Return	-1.61*	-1.55*	-1.37*	-1.38*
	(-1.93)	(-1.91)	(-1.73)	(-1.76)
Pre-year Return	0.26*	0.19	0.23*	0.18
	(1.85)	(1.45)	(1.76)	(1.39)
Successful	0.01	0.06	0.03	0.09
	(0.06)	(0.34)	(0.19)	(0.47)
Takeover	-0.83***	-0.88***	-0.83***	-0.88***
	(-5.08)	(-5.37)	(-5.13)	(-5.40)
Hostile	1.38**	1.36**	1.44**	1.41**
	(2.38)	(2.32)	(2.49)	(2.40)
Rumor	0.42	0.39	0.43	0.38
	(1.59)	(1.46)	(1.63)	(1.41)
Cash	-0.51***	-0.42***	-0.43***	-0.38***
	(-3.49)	(-2.84)	(-2.97)	(-2.61)
Size	-0.79***	-0.78***	-0.71***	-0.71***
	(-16.50)	(-15.56)	(-14.59)	(-14.10)
B/M	-0.52***	-0.36***	-0.45***	-0.33***
	(-5.25)	(-3.55)	(-4.56)	(-3.25)
Year and Industry Control		Yes		Yes
Intercept	10.78***	7.44***	9.95***	7.40***
	(21.28)	(11.71)	(19.49)	(11.00)
N	4,274	4,274	4,274	4,274
Adj. R-sq	0.09	0.12	0.11	0.13

Table 8. Robustness Check on Alternative Measures for IV spread and IV skew

This table shows the acquirer announcement $CAR_{i,[t,t+1]}$ regressed on alternative measures for implied volatility (IV) spread and implied volatility (IV) skew. In column (1) and (2), we use deciles of IV spread and IV skew as independent variables. In column (3) and (4), *Change in IV spread (or IV skew)_Week* represents the difference between IV spread (IV skew) on day *t-1* and the average of previous week, i.e. day *t-6* to day *t-2*. In the last two columns, *Change in IV spread (or IV skew)_Month* represents the difference between IV spread (IV skew) on day *t-1* and the average of previous month, i.e. day *t-23* to day *t-2*. All control variables follow the same definitions as in Table 4. CARs are in percentage. T-statistics are computed using White's (1980) heteroskedasticity robust standard errors, and *, **, and *** indicate significance at 10%, 5%, and 1% level respectively.

	Dependent Variable: $CAR_{i,[t,t+1]}$					
	(1)	(2)	(3)	(4)	(5)	(6)
IV spread Deciles	0.11***					
	(3.04)					
IV skew Deciles		-0.12*				
		(-1.95)				
Change in IV spread_Week			8.31***			
			(3.04)			
Change in IV skew_Week				-11.79***		
				(-2.73)		
Change in IV spread_Month					11.04***	
					(4.30)	
Change in IV skew_Month						-14.08***
						(-3.34)
Pre-month Return	1.49	1.04	1.47	1.15	1.49*	1.06
	(1.64)	(0.71)	(1.61)	(0.76)	(1.66)	(0.72)
Pre-year Return	0.15	0.10	0.15	0.15	0.14	0.13
	(0.91)	(0.40)	(0.89)	(0.59)	(0.84)	(0.50)
Successful	0.03	-0.04	0.04	-0.19	0.05	-0.16
	(0.14)	(-0.10)	(0.14)	(-0.48)	(0.20)	(-0.44)
Takeover	1.03***	1.51***	1.01***	1.39***	1.02***	1.40***
	(5.10)	(4.25)	(5.00)	(3.89)	(5.12)	(3.95)
Hostile	-1.04	-3.13**	-1.05	-3.06*	-1.04	-2.96**
	(-1.33)	(-2.20)	(-1.36)	(-1.93)	(-1.32)	(-2.04)
Rumor	0.50	0.41	0.52	0.43	0.53	0.40
	(1.41)	(0.95)	(1.49)	(0.98)	(1.50)	(0.93)
Cash	0.68***	0.33	0.67***	0.37	0.66***	0.34
	(3.55)	(1.02)	(3.50)	(1.09)	(3.46)	(1.06)
Size	-0.13**	-0.02	-0.12**	0.01	-0.12**	-0.00
	(-2.19)	(-0.13)	(-1.98)	(0.08)	(-2.02)	(-0.03)
B/M	-0.52***	-0.63***	-0.49***	-0.56**	-0.49***	-0.52**
	(-4.08)	(-2.93)	(-3.93)	(-2.53)	(-3.93)	(-2.49)
Year and Industry Control	Yes	Yes	Yes	Yes	Yes	Yes
Intercept	-0.76	13.47***	-0.13	0.10	-0.22	13.07***
	(-0.87)	(12.69)	(-0.15)	(0.06)	(-0.26)	(12.81)
N	4,170	1,538	4,140	1,442	4,157	1,506
Adj. R-sq	0.02	0.02	0.02	0.03	0.03	0.03

Table 9. Cross-Sectional Regressions of Target Announcement Return on IV spread and IV skew

This table presents the cross-sectional regression results of target $CAR_{i,[t,t+1]}$ on day *t-1* implied volatility (IV) spread and implied volatility (IV) skew, with other control variables. We rerun all regressions in Table 4, using data for target firms. Panel A contains regressions on IV spread, and Panel B contains regressions on IV skew. CARs are in percentage. T-statistics are calculated using White's (1980) heteroskedasticity robust standard errors, and *, **, and *** indicate significance at 10%, 5%, and 1% level respectively.

Panel A. IV spread

	Dependent Variable: $CAR_{i,[t,t+1]}$				
	(1)	(2)	(3)	(4)	(5)
IV spread	4.66	4.20	1.32	1.43	2.42
	(1.17)	(1.05)	(0.39)	(0.40)	(0.68)
Pre-month Return		-10.31***	-13.17***	-15.90***	-16.86***
		(-3.47)	(-4.66)	(-5.67)	(-5.91)
Pre-year Return		-1.24**	-1.24**	-2.10***	-2.07***
		(-2.30)	(-2.51)	(-3.57)	(-3.70)
Successful			4.90***	4.23***	4.27***
			(5.09)	(4.30)	(4.24)
Takeover			-14.57***	-12.96***	-12.85***
			(-5.10)	(-4.62)	(-4.61)
Hostile			7.34***	8.66***	7.30***
			(3.52)	(4.40)	(3.52)
Rumor			-7.01***	-5.98***	-7.08***
			(-7.46)	(-6.05)	(-6.73)
Cash			9.56***	9.63***	10.18***
			(10.03)	(9.98)	(9.66)
Size				-0.82***	-0.41
				(-2.64)	(-1.18)
B/M				-2.79***	-2.66***
				(-4.53)	(-4.30)
Year and Industry Control					Yes
Intercept	14.79***	15.84***	10.17***	13.52***	-12.96***
	(31.48)	(26.38)	(11.41)	(5.20)	(-3.34)
N	1,543	1,541	1,541	1,538	1,538
Adj. R-sq	0.00	0.01	0.17	0.19	0.21

Panel B. IV skew

	Dependent Variable: $CAR_{i,[t,t+1]}$				
	(1)	(2)	(3)	(4)	(5)
IV skew	-18.88**	-18.19**	-17.59**	-13.83*	-15.16**
	(-2.38)	(-2.23)	(-2.37)	(-1.84)	(-2.00)
Pre-month Return		-9.57**	-13.47***	-17.12***	-19.44***
		(-2.26)	(-3.39)	(-4.31)	(-4.47)
Pre-Year Return		-0.31	-0.34	-1.09**	-1.25**
		(-0.56)	(-0.71)	(-2.11)	(-2.42)
Successful			4.21***	3.50**	2.86*
			(2.98)	(2.43)	(1.95)
Takeover			-14.67***	-13.74***	-15.92***
			(-2.75)	(-2.72)	(-2.84)
Hostile			7.01*	9.45***	6.52*
			(1.88)	(2.71)	(1.82)
Rumor			-6.95***	-5.76***	-6.73***
			(-5.43)	(-4.35)	(-4.70)
Cash			8.63***	8.92***	10.17***
			(5.83)	(6.26)	(6.27)
Size				-1.10**	-1.05**
				(-2.13)	(-2.00)
B/M				-2.86***	-3.10***
				(-3.95)	(-4.45)
Year and Industry Control					Yes
Intercept	11.65***	12.94***	9.98***	15.36***	-11.08**
	(15.33)	(13.46)	(7.73)	(3.33)	(-2.19)
N	474	473	473	472	472
Adj. R-sq	0.01	0.02	0.23	0.26	0.31

Table Appendix 1. Summary Statistics for M&A Events - Targets

This table presents summary statistics for targets in M&A events. Panel A shows the number of events and the number of targets in each year. The details of cumulative abnormal returns (CARs) from day *t* to *t+1* are listed in Panel B. The last row of each panel contains data for the whole sample period. *NOBS* represents the number of observations.

Panel A. M&A Events by Year

Year	Number of M&A Events	Number of Firms
1996	113	106
1997	147	129
1998	206	199
1999	245	224
2000	223	209
2001	139	130
2002	69	66
2003	97	86
2004	107	102
2005	146	135
2006	197	180
2007	232	211
2008	151	136
2009	136	128
2010	164	149
1996-2010	**2,372**	**1,990**

Panel B. CAR Summary Statistics by Year

Year	NOBS	MEAN	STD	MIN	Q1	MEDIAN	Q3	MAX
1996	113	12.83%	16.29%	-29.38%	0.39%	11.01%	23.38%	61.71%
1997	147	12.12%	19.09%	-46.74%	-0.25%	8.74%	22.74%	80.96%
1998	206	12.31%	18.23%	-38.11%	-0.94%	10.54%	21.87%	88.14%
1999	245	15.34%	21.05%	-37.59%	3.05%	12.11%	24.42%	146.26%
2000	223	16.95%	23.95%	-82.79%	1.51%	12.64%	30.32%	110.64%
2001	139	22.38%	32.39%	-35.62%	3.46%	14.78%	34.34%	204.51%
2002	69	18.19%	29.60%	-42.19%	1.00%	10.94%	27.82%	110.33%
2003	97	20.97%	31.60%	-5.58%	6.18%	12.86%	24.34%	254.37%
2004	107	14.30%	16.27%	-21.99%	1.77%	13.28%	24.71%	67.11%
2005	146	15.06%	20.44%	-91.33%	2.91%	14.01%	25.18%	77.15%
2006	197	14.53%	14.58%	-8.51%	3.90%	11.37%	20.85%	95.08%
2007	232	16.29%	19.52%	-23.73%	5.20%	13.34%	22.12%	161.87%
2008	151	21.17%	34.72%	-63.58%	3.31%	13.21%	30.11%	315.31%
2009	136	22.14%	42.02%	-59.30%	3.52%	11.57%	29.12%	291.83%
2010	164	19.11%	22.20%	-59.95%	5.07%	15.64%	30.25%	100.99%
1996-2010	**2,372**	**16.62%**	**24.56%**	**-91.33%**	**3.04%**	**12.32%**	**25.37%**	**315.31%**

Table Appendix 2. Summary Statistics for Option Measures-Targets

This table shows summary statistics for the two option measures of target firms, i.e. implied volatility (IV) spread and implied volatility (IV) skew. The details for each year are presented in Panel A and B, with the statistics for the whole sample period in the last row of each panel. *NOBS* represents the number of observations.

Panel A. IV spread Summary Statistics by Year

Year	NOBS	MEAN	STD	MIN	Q1	MEDIAN	Q3	MAX
1996	78	0.0030	0.1019	-0.3650	-0.0401	0.0065	0.0666	0.2227
1997	112	0.0160	0.0927	-0.1821	-0.0354	0.0121	0.0524	0.3422
1998	157	0.0088	0.1128	-0.6208	-0.0309	0.0018	0.0489	0.3862
1999	191	0.0261	0.1004	-0.3284	-0.0257	0.0189	0.0871	0.3964
2000	152	-0.0095	0.3305	-3.6914	-0.0409	0.0048	0.0505	1.0086
2001	67	0.0009	0.0885	-0.2598	-0.0404	-0.0051	0.0404	0.3841
2002	32	-0.0241	0.0766	-0.3165	-0.0528	-0.0150	0.0147	0.1210
2003	46	-0.0017	0.0431	-0.1431	-0.0164	-0.0008	0.0162	0.1497
2004	61	-0.0003	0.0435	-0.1349	-0.0157	-0.0029	0.0167	0.1934
2005	87	-0.0104	0.0459	-0.2068	-0.0248	-0.0005	0.0096	0.1301
2006	135	-0.0015	0.0438	-0.1518	-0.0172	-0.0042	0.0093	0.2761
2007	170	-0.0055	0.0356	-0.2040	-0.0223	-0.0048	0.0109	0.1022
2008	89	-0.0149	0.0911	-0.4568	-0.0382	-0.0063	0.0286	0.2290
2009	78	-0.0161	0.0716	-0.4288	-0.0322	-0.0077	0.0148	0.1665
2010	88	-0.0014	0.0662	-0.2667	-0.0222	-0.0040	0.0202	0.2634
1996-2010	**1,543**	**0.0009**	**0.1285**	**-3.6914**	**-0.0281**	**-0.0015**	**0.0303**	**1.0086**

Panel B. IV skew Summary Statistics by Year

Year	NOBS	MEAN	STD	MIN	Q1	MEDIAN	Q3	MAX
1996	24	0.0041	0.0520	-0.0940	-0.0352	-0.0002	0.0361	0.1517
1997	27	0.0169	0.0972	-0.2571	-0.0165	0.0103	0.0778	0.1965
1998	46	0.0165	0.0930	-0.2745	-0.0235	0.0183	0.0704	0.3042
1999	63	0.0214	0.0923	-0.1947	-0.0320	0.0240	0.0793	0.2300
2000	52	0.0378	0.1084	-0.3136	-0.0054	0.0253	0.0714	0.4952
2001	11	0.0631	0.1038	-0.0386	-0.0166	0.0340	0.1505	0.2881
2002	3	0.0354	0.0080	0.0263	0.0263	0.0386	0.0412	0.0412
2003	15	0.0495	0.0255	0.0108	0.0291	0.0487	0.0681	0.0976
2004	15	0.0136	0.0578	-0.1387	-0.0015	0.0342	0.0479	0.0785
2005	24	0.0542	0.0721	-0.0348	0.0172	0.0339	0.0679	0.2777
2006	36	0.0449	0.0361	-0.0289	0.0231	0.0404	0.0618	0.1657
2007	62	0.0473	0.0644	-0.0967	0.0053	0.0349	0.0816	0.2745
2008	29	0.0533	0.0961	-0.2163	0.0152	0.0522	0.1191	0.2037
2009	27	0.0572	0.0639	-0.0822	0.0206	0.0432	0.1162	0.1699
2010	40	0.0545	0.0432	0.0016	0.0273	0.0412	0.0718	0.1960
1996-2010	**474**	**0.0369**	**0.0794**	**-0.3136**	**0.0019**	**0.0341**	**0.0690**	**0.4952**

Table Appendix 3. Target CAR Sorted by IV spread and IV skew

This table shows the single sorting results of CAR $_{i, [t, t+1]}$ on day *t-1* implied volatility (IV) spread and implied volatility (IV) skew for target firms. The mean and t-statistics are reported for each quintile. The difference between the highest (Quintile 5) and the lowest (Quintile 1) IV spread or IV skew group is also computed in the last column.

	IV spread Quintiles					
	1 (Low)	**2**	**3**	**4**	**5 (High)**	**High-Low**
Target CAR	13.92%	14.70%	14.16%	14.58%	16.59%	2.67%
t-statistics	(12.03)	(15.88)	(16.38)	(15.24)	(12.83)	(1.54)
	IV skew Quintiles					
	1 (Low)	**2**	**3**	**4**	**5 (High)**	**High-Low**
Target CAR	12.25%	10.00%	13.74%	11.66%	7.15%	-5.09%
t-statistics	(8.04)	(7.29)	(7.56)	(7.72)	(5.32)	(-2.51)