

Using Option Implied Volatilities to Predict Absolute Stock Returns

- Evidence from Earnings Announcements and Annual Shareholders' Meetings

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Abstract

We provide evidence that an option implied volatility-based measure predicts future absolute excess returns of the underlying stock around earnings announcements and annual meetings of shareholders, even after controlling for the realized stock return volatility shortly before these information events, and the volatility of excess stock returns around these two events in the past. Our results imply that option traders anticipate the change in uncertainty around these two scheduled events, and also trade on the expected volatility. In addition, we show that net straddle returns (after transaction costs) around earnings announcements and annual meetings of shareholders are significantly and negatively related to the predicted volatility of returns around the events. This suggests that the writers of call and put options expect to be compensated for the predicted volatility. Overall, we find that option traders anticipate and correctly incorporate the volatility induced by the information released in quarterly earnings announcements, and annual meetings of shareholders.

Keywords: Earnings Announcement, Annual Meeting of Shareholders, Option Implied Volatility, Absolute Stock Return.

JEL Classification: M41, G11, G13, G14, G17

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1. Introduction

In recent decades, the capital markets have experienced an impressive proliferation of derivative securities. Prior research argues that informed investors might choose to trade derivatives because of the higher leverage offered by such instruments, and protected downside risk. Consistent with these arguments, a number of studies have shown that investors use options to trade on their directional information about the price of the underlying stock (e.g. Amin and Lee (1997), Cao, Chen and Griffin (2005), Pan and Poteshman (2006), Xing, Zhang and Zhao (2010) and Jin, Livnat and Zhang (2012)). Furthermore, equity options also provide a good venue for traders with information about future volatility. For example, traders with private information about future stock volatility can profit in the option market using a straddle/strangle strategy. While there is a relatively large literature on informed traders exploiting directional information, there is comparatively little written on informed traders exploiting future volatility in the option market. Ni, Pan and Poteshman (2008) is an exception. They construct non-market maker net demand for volatility from the trading volume of individual options, and find that this demand is informative about the future realized volatility of underlying stocks.

The main question in our paper is whether option traders set option prices that incorporate volatility and/or absolute stock returns around firm-specific information events. Specifically, we examine two scheduled information events: (1) quarterly earnings announcements, and (2) annual meetings of shareholders. A well-known fact about earnings announcements is that uncertainty builds up before the earnings releases and declines afterwards (e.g. Patell and Wolfson (1979, 1981)). Additionally, option implied volatility is also very sensitive to the earnings announcement date (see Appendix for an example). Given these facts, we consider earnings announcements to be a particularly interesting venue to study the proper incorporation of uncertainty in the option market. The annual meeting of shareholders is another

significant and scheduled information event for a firm. At the annual meeting, the management discusses the company's performance and strategy and shareholders vote on the election of directors and a variety of other governance topics, such as the appointment of outside directors, the issuance of new shares, major mergers and acquisitions etc. Brickley (1986) finds that significant abnormal stock returns around a random sample of annual meetings dates. Consequently, we examine whether option traders anticipate and correctly price the option to incorporate the volatility changes induced by information released in quarterly earnings announcements and annual meetings of shareholders.

First, we estimate the 3-day $([-1, +1])$ volatility around the information event from option implied volatilities immediately before the event and investigate its predictive ability for absolute excess stock returns in the 3-day window around the information event. To estimate the 3-day volatility around information events, we decompose option implied volatilities as the weighted average of baseline volatility and volatility associated with the information event (Patell and Wolfson (1979; 1981)), Dubinsky and Johannes (2006), Barth and So (2014)). Note that our estimate of the 3-day volatility around the event is also used to estimate the absolute value of the excess stock return during the short-event period (magnitude, but not direction). Thus, we can examine whether our estimates predict the actual (realized) absolute value of returns around the event.

Next, we examine whether we can take advantage of the increase in volatility around the information event using an option straddle strategy. A straddle consists of a pair of *at-the-money* call option and *at-the-money* put option with the same strike price and time-to-maturity, which allows one to trade on underlying uncertainty without directional exposure to the underlying security. We implement the straddle strategy by buying the straddle contract shortly before the information event and sell the straddle one day after the information event. If the option market correctly forecasts the magnitude of the sharp increase in uncertainty associated with the information event and prices the options correctly, then straddle holders should not earn positive returns around the event.

Our first main finding is that our option implied volatility-based measure does predict future absolute excess returns of the underlying stock around earnings announcements and annual meetings of shareholders, even after controlling for realized stock return volatility shortly before these information events and the volatility of excess stock returns around these two information events in past periods. This suggests that information contained in the option implied volatility complements the historic volatility signals in predicting future uncertainty around information events. The result is consistent with the fact that option traders anticipate the change in uncertainty and trade on volatility information around these two events. We also find that, relative to a randomly selected pseudo-event date, the option implied volatility-based measure has significantly higher predictive ability for short-window absolute excess returns around earnings announcements and annual meetings of shareholders. The higher predictability during information intensive periods suggests that there is informed trading linked to the uncertainty around earnings announcements and annual meetings of shareholders in the option market.

Our second main finding is that a straddle strategy constructed around earnings announcements and annual shareholders meetings yields negative returns (after transaction costs), implying that the option market correctly forecasts the magnitude of the sharp increase in uncertainty associated with the information event and prices options correctly. We also document a negative correlation between net straddle returns and predicted volatility around the two information events based on our implied volatility-based measure. This result suggests that option market makers adjust straddle prices in a way that ensures they get compensated for the predicted higher volatility. This is consistent with Barth and So (2014), which show that earnings announcements pose non-diversifiable volatility risk and investors pay a premium to hedge this non-diversifiable risk. Additionally, we find that the magnitude of the negative impact of our implied volatility-based measure on straddle returns is higher around earnings releases and annual meetings, relative to a random date. This is consistent with the fact that in anticipation of increased information flow into the market and increased uncertainty, market makers increase prices to protect themselves from informed traders.

Our study makes several contributions. First, our paper is related to the literature on the pricing of options around firm-specific information events. For example, Amin and Lee (1997) investigate abnormal trading volume in the option market around the announcement of earnings news, and provide evidence of directional information trading in the option market. Barth and So (2014) find that earnings announcements pose non-diversifiable volatility risks that command a risk premium. Cao, Chen and Griffin (2005) focus on takeovers and find that takeover targets with the largest preannouncement call imbalance increases experience the highest announcement-day returns. Jin, Livnat and Zhang (2012) show that implied volatility spread and skewness immediately before an earnings announcement have significant predictive ability for event signed stock returns, and implied volatility spread and skewness immediately after unscheduled events (such as announcements related to clients and products, executive/board changes) have significant predictability for subsequent (drift) returns. Our study adds to this literature by exploring the predictive ability of the option market for uncertainty around annual meetings of shareholders, another important firm-specific information event which has not been examined in the options literature. Second, our paper extends the literature on the predictability of option implied volatility for future realized volatility. A common finding of such studies is that the implied volatility of an option predicts the ex-post realized volatility over the remaining life of the option (e.g. Jorion (1995), Christensen and Prabhala (1998), and Ederington and Wei (2002)). However, whether the predictability comes from an information advantage of option traders has remained unclear. Our paper makes a twofold contribution to this literature: (1) We focus on the predictability of implied volatility for uncertainty around scheduled information events, and find that the predictability is higher relative to a base case (random date). This provides evidence that option traders indeed utilize information about future volatility in returns around particular information events; (2) Instead of using the implied volatility from option prices (which is a forecast for the volatility of future returns over the entire remaining life of the option), we estimate the implied volatility for the 3-day return around the particular information events of interest, and document its incremental predictive ability for future uncertainty.

The results of our study carry practical implications as well. Market participants alter their investment decisions around significant information events. They track and predict known information events such as earnings announcements. For example, the firm Wall Street Horizon¹ predicts and attempts to verify earnings announcement dates for the coming four quarters. This information can be used by option traders in their pricing of options and their option strategies. Predictions of greater volatility of excess returns around scheduled events can also benefit stock investors. They can invest resources in attempting to predict the direction of these excess returns and take advantage of them, or they can also increase trading of these stocks around the scheduled events to take advantage of the increased market liquidity.

The next section reviews the related literature. Section 3 describes our research design. Section 4 presents the data and descriptive statistics for our sample. Section 5 provides the results of our empirical analysis, and the last section concludes our paper.

2. A Review of Prior Literature

Our paper combines insights from (1) studies of the option market around firm-specific information events (2) studies on the presence of informed trading in the option market (3) studies about the predictive ability of implied volatility for future realized volatility.

2.1 Option market characteristics around firm-specific information events

One of the most frequently investigated information events is the quarterly earnings announcement. Early research examines the impact of earnings announcements on implied volatility, trading volume, open interest and spreads in the stock option market. For example, Patell and Wolfson (1979, 1981) find that implied volatilities increase as earnings announcement dates approach and decline afterwards. They also find that the increase in implied volatilities prior to earnings announcements could predict realized volatilities for the two-day ($[0, 1]$) or three-day ($[-1, +1]$) announcement period. Donders, Kouwenberg,

¹<http://www.wallstreethorizon.com/>

and Vorst (2000) document that open interest tends to increase during the days before the earnings announcement but declines to regular levels afterwards, and the effective spread² increases on the event day and on the first two days following the earnings announcement. Recent work is focused on the predictive ability of option market for stock returns around earnings announcements. For example, Roll, Schwartz and Subrahmanyam (2012) document that options/stock trading volume ratio (O/S) averaged over the window [-3, -1] prior to the earnings announcement is positively related to post-announcement absolute returns. A follow-up paper on O/S by Johnson and So (2012) find that prior calendar week's O/S decile carries predictive power for future earnings surprises and abnormal returns around earnings announcements. Diavatopoulos et al. (2012) show that changes in skewness and kurtosis stock returns prior to earnings announcements provide information about subsequent stock returns.

In addition to studies on earnings announcements, Cao, Chen and Griffin (2005) focus on takeovers, and find that takeover targets with the largest increases in preannouncement call imbalance experience the highest announcement-day returns. Rogers, Skinner and Van Buskirk (2009) document that option implied volatilities increase surrounding management earnings forecast, especially forecasts that convey bad news. Jin, Livnat and Zhang (2012) show that implied volatility spread and skewness immediately after unscheduled events (such as firms' clients and products, executive/board changes) have significant predictability for subsequent (drift) returns. In summary, the studies discussed above show that the option market exhibits significant reaction to information events (both *ex ante* and *ex post*). The options market also has predictability for stock returns around firm-specific information events.

2.2 Informed trading in the option market

Earlier studies provide somewhat mixed results about more informed trading in the option market. Consistent with the view that options listing improves the informational efficiency of the market for the underlying stock, Skinner (1990) shows that the information content of firms' accounting earnings

² The effective spread is calculated as 2 times the difference between the trading price of options and the mid-point price. The mid-point price is the average of the bid quote and the offer quote.

releases is lower after exchange-traded options are listed on their stocks. Building on the insight that options offer a leverage advantage over stocks (Black, 1975), Easley, O'Hara and Srinivas (1998) develop an asymmetric information model in which informed traders may trade in both the stock and the option markets. There has been significant effort subsequently to verify the price discovery role of options (e.g., Chakravarty, Gulen and Mayhew (2004), Cao, Chen and Griffin (2005), Pan and Poteshman (2006), Ni, Pan and Poteshman (2008), Bali and Hovakimian (2009), Xing, Zhang and Zhao (2010), and Jin, Livnat and Zhang (2012)). For example, using a unique data set from the Chicago Board Options Exchange (CBOE) that records purchases and sales of put and call options by non-market makers over the 1990 to 2001 period, Ni, Pan and Poteshman (2008) find that non-market maker net demand for volatility constructed from the trading volume of individual equity options is informative about the future realized volatility of underlying stocks. Van Buskirk (2011) shows that volatility skew identifies which firms are likely to experience stock crashes, but only in the short window around earnings announcements. Jin, Livnat and Zhang (2012) provide evidence on the predictability of option traders before scheduled information events and superior ability of option traders to process less anticipated information.

However, there is also evidence against the price discovery role of option trading. Chan, Chung and Fong (2002) find that stock net trade volume (buyer-initiated volume minus seller-initiated volume) has strong predictive ability for stock and option quote revisions, but option net trade volume has no incremental predictive ability. Using tick-by-tick quote data for 39 liquid US stocks and options on them, Muravyev, Pearson and Broussard (2013) show that option price quotes do not contain economically significant information about future stock prices beyond what is already reflected in current stock prices.

To summarize, although the leveraged nature of option contracts attracts sophisticated investors who wish to exploit public and private information, the option market also has relatively high transaction costs (e.g., high bid-ask spread) that may impede option prices from incorporating all available information (Govindaraj, Li and Zhao, 2014). The existing empirical literature provides mixed evidence on the price discovery role of option trading or the information advantage of option traders over stock traders.

2.3 The predictability of implied volatility for future realized volatility

Our predictive analysis is related to studies that examine the information content of option implied volatility for future realized volatility. These studies show that the implied volatility of an option can predict the ex-post realized volatility over the remaining life of the option. For example, Jorion (1995) reports that implied volatility is an efficient predictor of future return volatility for foreign currency futures. Christensen and Prabhala (1998) document that volatility implied by S&P 100 index option prices outperforms past volatility in forecasting future volatility. Ederington and Wei (2002) show that the implied volatility from S&P500 futures options has strong predictive power and generally subsumes the information in historical volatility. Goodman, Neamtiu and Zhang (2013) use information from financial statements to predict future volatilities and show that such information has incremental predictive power beyond both historical realized volatility or option implied volatilities. They use the predicted volatilities to form straddle strategies, but are unable to earn abnormal returns unless transaction costs can be significantly reduced.

3. Methodology

(Insert Figure 1)

To predict the volatility of 3-day returns around earnings announcements (or other scheduled events), we assume that the *ex ante* stock return volatility is constant (σ_{normal}) over time except for the earnings announcement days ($[-1, 1]$) on which volatility is higher (σ_{high}) (Patell and Wolfson (1979; 1981), Dubinsky and Johannes (2006), Barth and So (2014))³. As illustrated in figure 1, at time t_a , we use two at-

³ Patell and Wolfson (1979; 1981) express the expected equity return volatility in the Black and Scholes (1974) option pricing formula as the weighted average of the firm's baseline volatility and increases in its volatility associated with an anticipated information event. Dubinsky and Johannes (2006) find that incorporating increases in firms' equity return volatility associated with information events into the option pricing model significantly reduces the option pricing errors. Barth and So (2014) use similar assumptions in estimating the stock return volatility around earnings announcements.

the-money (ATM) call options to calculate the predicted volatility of the 3-day returns around earnings announcements. Option 1 expires at t_b and the time to maturity is T_1 . The implied volatility of option 1 is IV_1 . Option 2 expires at t_c and the time to maturity is T_2 , which is greater than T_1 . The implied volatility of option 2 is IV_2 . T_1 and T_2 are measured in number of trading days and IV_1 and IV_2 are annualized implied volatility. We identify call options that are at the money shortly (5 to 10 days) before the earnings announcement (i.e. $-10 \leq t_a \leq -5$) and expire at least 10 days after the earnings announcement (i.e. $t_b \geq 10, t_c \geq 10$). We select all call options that have a delta in the range of $[0.4, 0.7]$, and choose the one closest to 0.5. Its implied volatility is the ATM implied volatility. We only include call options with positive (non-zero) open interests. Assuming that the stock return of each day between t_a and t_c is independent and identically distributed, we have the following two equations:

$$\frac{T_1}{252} \times IV_1^2 = \frac{3}{252} \times S_{high}^2 + \frac{(T_1 - 3)}{252} \times S_{normal}^2 \quad (1)$$

$$\frac{T_2}{252} \times IV_2^2 = \frac{3}{252} \times S_{high}^2 + \frac{(T_2 - 3)}{252} \times S_{normal}^2 \quad (2)$$

In the above two equations, the only two unknown variables are σ_{normal} and σ_{high} . Thus, the predicted volatility of stock returns around earnings announcements can be calculated as⁴:

$$S_{high} = \sqrt{\frac{IV_2^2 \times (3T_2 - T_1T_2) - IV_1^2 \times (3T_1 - T_1T_2)}{3 \times (T_2 - T_1)}} \quad (3)$$

If the formula under the square root is *non-positive*, we estimate σ_{high} as the average of implied volatility of Option 1 and historic volatility, which is the annualized standard deviation of daily stock returns in the 60 calendar days prior to t_a .⁵ σ_{high} is the annualized volatility of daily stock returns around earnings announcement. We multiply it by square root of $(3/252)$ to measure the predicted 3-day volatility around earnings announcements (IVOL3).

⁴ By convention, we take the positive square root.

⁵ For the earnings announcement sample and the shareholder annual meeting sample, the term under the square root is non-positive for about 15% and 25% of observations, respectively.

We present one example to illustrate the above methodology. Amazon was scheduled to release its earnings for the first quarter of 2013 on April 25, 2013. On April 19, 2013 (a week before the anticipated earnings announcement), we identify two ATM call options: Option 1 expires on May 11, 2013 (T1=15 trading days), with delta at 0.526 and implied volatility (IV1) at 0.459. Option 2 expires on May 18, 2013 (T2=20 trading days), with delta at 0.527 and implied volatility (IV2) at 0.404. Plugging these numbers into the equation (3), we get σ_{high} equal to 0.985. σ_{high} is the annualized volatility. To get the 3-day expected volatility, we multiply 0.985 with the square root of 3/252 and get 0.107. Thus, the 3-day expected volatility is 0.107.

We now describe another example to show the usefulness of our method. We conducted an *ex ante* analysis for Children's Place (PLCE), a retail store on November 8, 2013. The stock returns for retail companies are generally not very volatile. Using a similar methodology as above, we estimated the expected volatility on the next scheduled earnings announcement day (November 26, 2013) to be about 8%. On November 26, 2013, the company released its earnings and stock price jumped by 5%. In fact, in the last three years (756 daily returns), it had only 19 days (or roughly 2.5% of the days) of absolute returns in excess of 5%. Thus, we were able to correctly predict the significant large abnormal volatility or absolute value of abnormal return around the earnings announcement.

To show the incremental predictive ability of our implied volatility measure beyond realized volatility, we calculate two additional measures that are based on realized volatility: HIST and STDXRET. HIST is the standard deviation of daily stock returns in the 60 calendar days prior to t_a multiplied by $\sqrt{3}$ (to make it comparable with IVOL3). STDXRET is the standard deviation of 3-day excess returns around prior earnings announcements using all available quarters since the year 1986. In our regression analysis, within each quarter, we rank the three volatility measures into deciles (0-9), divide by 9 and subtract 0.5. Thus, each decile variable has a value between -0.5 and +0.5 and the coefficients of decile variables provide an estimate of the return differential between firms that are in the bottom and top deciles. We measure abnormal (or excess) returns as the buy-and-hold return over the 3-day window ([-1, 1]) around

earnings announcement minus the buy-and-hold return on a portfolio of stocks with similar size (market value of equity, two groups), book-to-market ratio (three groups), and 12-month momentum (three groups). Our tests are based on the absolute value of abnormal returns around the earnings announcements, since the predicted volatility around earnings announcement does not predict the sign of the return, only its magnitude.

To examine whether we can take advantage of the increase in volatility around earnings announcements, we investigate a straddle strategy. Specifically, for every earnings announcement of a firm, we buy a straddle contract (i.e., purchasing an ATM call option and a put option with the same strike price and expiration date) at t_a , the time we calculate IVOL3. We then sell the straddle one day after the earnings announcement. To conservatively adjust for transaction costs, the purchase price of the straddle is calculated as the sum of ask prices of the ATM call and ATM put options on day t_a . The selling price of the straddle is the sum of bid prices of the same ATM call and ATM put options one day after the earnings announcements. Net straddle returns are estimated as the selling price of the straddle minus its purchase price divided by its purchase price. A straddle strategy is likely to generate positive returns if the implied volatility increases, because both the option call and put will become more valuable with an increased implied volatility. If option market makers do not fully adjust for the increase in volatility around earnings announcements, we expect to see a positive correlation between our predicted volatility and straddle returns.

In addition to earnings announcements, we also examine the predictability of our option implied volatility-based measure for absolute abnormal returns around annual meetings of shareholders. We use the same methodology described above to calculate the 3-day absolute excess returns around annual meetings of shareholders, estimate the three volatility measures shortly before annual meetings and construct the straddle trading strategy.

One potential concern about the research design is that our option implied volatility-based measure may have predictive ability for future absolute excess returns around any random day. To more directly gauge the information advantage option traders have immediately before earnings announcements or annual shareholders meetings, we provide a robustness test to benchmark our results against a randomly selected pseudo-event date. For each earnings announcement or annual meeting (treatment sample), we randomly select a trading date in the window of [30, 60] relative to the earnings announcement date or annual meeting date (day 0) and treat it as our pseudo-event date (control sample). We calculate absolute abnormal returns, the three volatility measures and straddle returns in the same fashion as for the scheduled information event date. For each information event (earnings announcements or annual meetings), the treatment sample has the same number of observations as the control sample. In the regression analysis, we pool the treatment sample with its corresponding control sample and use dummy variables RDQ or AMS to indicate observations of earnings announcements or annual meetings. We then interact RDQ or AMS with the three volatility measures to capture the incremental predictive ability of volatility measures before earnings announcements and annual meetings of shareholders relative to those before the pseudo-event dates.

4. Data and sample

4.1 Data

The sample period in our study ranges from the first quarter of 1996 to the fourth quarter of 2011. We obtain earnings announcement dates from Compustat and return information from CRSP. We obtain annual meeting dates from the S&P Filing Dates database. Our option data is from OptionMetrics, which provides end of day bid and ask quotes, open interest, volume, implied volatilities and option Greeks for all put and call options listed in the U.S. option market. In particular, OptionMetrics calculates the

underlying implied volatilities of individual options based on binomial trees that account for early exercise of individual stock options and the dividends expected to be paid over the lives of the options.

4.2 Descriptive statistics of the sample

(Insert Table 1)

Panel A in Table 1 reports summary statistics for the earnings announcement sample. It has 101,241 firm-quarter observations. The mean and median of 3-day absolute excess returns (AXRET) are 6.23% and 4.20%, respectively. The mean of net straddle returns (STRADDLE) is -11.8%. This is consistent with Coval and Shumway (2001), which documents negative returns of straddles on the S&P500 index. The volatility of returns in the 60 days prior to the event (HIST) is on average 0.0517, smaller than the volatility of excess returns around past events (STDXRET). The predicted volatility in the 3-day window (-1, +1) of earnings announcements (IVOL3) is on average 0.0825. It is higher than the other two past realized volatility measures, which is consistent with option prices reflecting greater future uncertainty around earnings announcements. Panel B reports similar summary statistics for the annual meetings sample. Compared to the sample of earnings announcements, the 3-day absolute excess returns, straddle returns and three volatility measures are all lower in the annual meetings sample. The standard deviations of these variables are also smaller.

Panel C in Table 1 compares means of key variables between treatment sample and control sample for both earnings announcements and annual meetings. Columns (1) and (2) are based on earnings announcement sample and its corresponding pseudo-event date (a random day in the window of [30,60] relative to the date of earnings announcement) sample, respectively. For each earnings announcement observation in the treatment group, we identify one random event observation for the control group. This

results in 87,088 observations with all available data for each group. Similarly, we get treatment group and control group for annual meetings of shareholders, each with 17,108 observations⁶.

As shown in Panel C, the absolute excess returns (AXRET) are significantly higher around earnings announcements and annual meetings than the random event days. This is intuitively reasonable, as earnings announcements and annual meetings are important information events for firms. Net straddle returns (STRADDLE) around earnings announcements and annual meetings are higher than those around a random day, which is due to the increased volatility around these information events. However, they are still significantly negative, which implies that option market makers protect themselves against the increase in uncertainty associated with earnings announcements and annual meetings. The volatility of returns in the 60 days prior to the event (HIST) in the random day sample is higher than that in the earnings announcement sample. This is probably due to the fact that the random day is a day between day 30 to day 60 after earnings announcements and the calculation of HIST covers the volatile earnings release period. As expected, both the volatility of excess returns around past events (STDXRET) and our option based volatility measure are significantly higher around earnings announcements and annual meetings. In addition, the magnitude of the differences for all these variables is higher for earnings announcement than annual meetings, suggesting that the earnings announcement is a more important information event, at least as evidenced by the associated market reaction.

(Insert Table 2)

Panel A and B in Table 2 shows the correlation matrix of key variables in the earnings announcement sample and the annual meetings sample, respectively. Pearson correlations are reported above the main diagonal and Spearman correlations are reported below the main diagonal. The three volatility measures are significantly and positively correlated with each other, which suggests that the realized volatility measures (HIST and STDXRET) and option predicted volatility measure (IVOL3) contain some

⁶ There is typically only one shareholders meeting per year, but four earnings announcements.

overlapping information. In the earnings announcement sample, the Pearson (Spearman) correlation coefficient for HIST and STDXRET is 0.309 (0.366), similar to the correlation between IVOL3 and STDXRET at 0.309 (0.410). The correlation between HIST and IVOL3 is the highest at 0.594 (0.643). In the annual meetings of shareholders sample, the direction of the correlations among the three volatility measures is the same as that in the earnings announcement sample but the magnitude is smaller, especially for the correlation between IVOL3 and STDXRET, which is only 0.181 (Pearson) and 0.233 (Spearman). The positive correlation between IVOL3 and HIST is still as high as 0.60. This may potentially reduce the significance of IVOL3 in predicting future volatility and straddle returns when HIST is controlled for in the regression.

The three volatility measures are also positively and significantly associated with absolute excess returns. In the earnings announcement sample, the correlation coefficients between each volatility measure and absolute excess returns are of similar magnitude (about 0.30), with the correlation between AXRET and STDXRET as the highest at 0.335 (0.365). However, in the annual meetings sample, the correlation coefficient between AXRET and STDXRET is the lowest among the three correlation coefficients, only at 0.140 (0.140).

Then we turn to the correlation between the three volatility measures and straddle returns. The negative correlation between IVOL3 and STRADDLE is significant and robust in both the earnings announcement and annual meetings samples. This suggests that option market makers do price-protect against the anticipated volatility. The correlation between STDXRET and STRADDLE is significantly positive in the earnings announcement sample but significantly negative in the annual meetings sample. The negative correlation between HIST and STRADDLE is not robust in both the earnings announcement sample and the annual meetings sample.

5. Results

5.1 Predictive analysis

We argue that our option implied volatility based measure (IVOL3) reflects investors' expectation about the future uncertainty around earnings announcements and annual meetings of shareholders. In this section, we illustrate the predictability of IVOL3 for future absolute excess returns around earnings announcements and annual meetings of shareholders. Firstly, we show the absolute excess returns in portfolios double sorted by IVOL3 and one of the two realized volatility measures (HIST and STDXRET). Then, we conduct Fama-Macbeth regressions to examine whether our option implied volatility-based measure can predict absolute excess returns after controlling for other factors, and whether this predictability is higher around information events (i.e. earnings announcements and annual meetings of shareholders) than the predictability around a randomly chosen day.

(Insert Table 3)

Table 3 displays absolute excess returns in portfolios double sorted by IVOL3 and one of the two realized volatility measures (HIST and STDXRET). Each quarter, firms are sorted into quartile based on HIST, STDXRET or IVOL3. The first (fourth) quartile includes firms with lowest (highest) value of HIST, STDXRET or IVOL3, respectively. In the earnings announcement sample (Panels A and B), absolute excess returns increase monotonically with the quartile of IVOL3. Specifically, absolute excess returns increase from 4.2% to 8.5% going from the first quartile to the fourth quartile of IVOL3. More importantly, within each quartile of HIST or STDXRET, absolute excess returns still increase monotonically with the quartile of IVOL3. This implies that IVOL3 has incremental predictive ability beyond the realized volatility measures. We document similar findings for the sample of annual meetings of shareholders (Panel C and Panel D). These results provide preliminary support for option traders incorporating new information about future absolute returns into option prices beyond what is captured by stock market historic volatilities either in the immediate 60-day period before the event or around the same event in prior quarters or years.

(Insert Table 4)

In Table 4, we present Fama-Macbeth regression analyses of the predictive ability of our option implied volatility-based measure. The dependent variable is AXRET, which is the absolute excess return in the short window around the event (earnings announcements, annual meetings of shareholders or pseudo-event dates). Each volatility measure is sorted quarterly into deciles (0-9), then divided by 9 and subtracting 0.5. Thus, each decile variable has a value between -0.5 and +0.5 and the coefficients of decile variables provide an estimate of the return differential between firms that are in the bottom and top deciles. T-statistics reported in parentheses are based on Newey-West adjusted standard errors.

Panel A shows the regressions results for earnings announcements. Results in regressions (1) and (2) are based on earnings announcement sample alone, which has 101,241 observations (as described in Panel A of Table 1). Due to the high correlation between HIST and IVOL3, HIST is not controlled for in regression (1). In regression (2), both STDRET and HIST are included. The coefficients of RIVOL are significant in both regressions (1) and (2). This implies that our option implied volatility-based measure has incremental predictability for future absolute abnormal returns beyond that captured by stock market historic volatilities. This is consistent with results in Panels A and B of Table 3. As to the magnitude of the predictability, the difference in the 3-day absolute abnormal returns around earnings announcement between decile 9 and decile 0 of IVOL3 is 1.9%, after controlling for HIST and STDRET.

To more directly gauge the information advantage option traders have immediately before an earnings announcement, we run regressions (3) and (4). Results in regressions (3) and (4) are based on both earnings announcements sample (treatment sample) and its corresponding pseudo event dates sample (control sample), which includes 174,716 observations in total and 87,358 observations for each sample. HIST is controlled for in regression (4), but not in regression (3). The baseline in regressions (3) and (4) is the pseudo-event date. The fact that RIVOL is positive and significant on a random date in regressions (3) and (4) is not surprising as RIVOL is a predictor of realized volatility, which is positively correlated

with absolute returns. The positive and significant interacted coefficients (RIVOL3_RDQ) measure the incremental association of the predictions based on the implied volatilities around the earnings announcements beyond the random event dates. This suggests that option traders have information advantage before earnings announcements in setting up the option prices after properly predicting future volatilities.

Panel B shows the regression results for annual meetings of shareholders. Results in regressions (1) and (2) are based on annual meetings sample alone, which has 19,551 firm-year observations (as described in Panel B of Table 1). Results in regressions (3) and (4) are based on annual meetings sample (treatment sample) and its corresponding pseudo-event dates sample (control sample), which includes 34,216 observations in total and 17,108 observations for each. The findings are similar to what we document for earnings announcements. The positive and significant interacted coefficients (RIVOL3_AMS) indicate that option traders also have information advantage in predicting volatilities around future annual meetings of shareholders. It should be noted that the interacted variables of the realized historical volatility (i.e., RSTDRET_AMS and RHIST_AMS) are not significantly associated with the absolute excess returns, suggesting that the incremental realized volatilities do not add much beyond the “normal” or base (random date) case.

5.2 Straddle returns and predicted volatility

(Insert Table 5)

Table 5 examines the relation between net straddle returns and volatility measures. Panel A shows the Fama-Macbeth regression results for earnings announcements. As in Table 4, results in regressions (1) and (2) are based on earnings announcement sample alone. Results in regressions (3) and (4) are based on both earnings announcements sample (treatment sample) and its corresponding pseudo-event dates sample (control sample). Due to the high correlation between RHIST and RIVOL3, which may

potentially reduce the significance of RIVOL3, RHIST is not controlled for in regressions (1) and (3). In regressions (2) and (4), both RSTDRET and RHIST are included.

The coefficients of RIVOL3 are significantly negative in both regressions (1) and (2) of Panel A. This implies that option market makers adjust straddle prices in a way that they get compensated for the predicted volatility. Specifically, when RIVOL3 increases from the bottom decile (i.e. decile 0) to the top decile (i.e. decile 9), the net straddle returns decrease by 6.9%, after controlling for RHIST and RSTDRET. Additionally, the net straddle returns are significantly and positively related to RSTDRET, implying that a straddle strategy can potentially be used to take advantage of the expected increase in volatility around earnings announcements. In regression (3) of Panel A, RIVOL3_RDQ is significantly negative, implying that option market makers will require even higher compensation for the expected increase in volatility around earnings announcements relative to random days. This is consistent with the notion that market makers are more concerned about and price-protect against informed traders during information events relative to a random day. After adding RHIST and RHIST_RDQ in regression (4), the coefficient of RIVOL3_RDQ is still positive but becomes insignificant.

Panel B reports similar analysis for the sample of annual meetings of shareholders. As in Table 4, results in regressions (1) and (2) are based on annual meetings sample alone. Results in regressions (3) and (4) are based on both annual meetings sample (treatment sample) and its corresponding pseudo-event dates sample (control sample). In regressions (1) and (2), only our option implied volatility-based measure is significant and past realized volatility measure remain insignificant. This implies that the option implied volatilities are more important than realized volatilities when option's market makers set prices for straddles around annual meetings. The coefficient of RIVOL3_AMS in regression (3) is negative and marginally significant, suggesting a higher compensation required by option market makers during annual meetings relative to a random day. After adding RHIST and RHIST_AMS in regression (4), the coefficient of RIVOL3_AMS remains negative but is insignificant.

6. Conclusions

Equity options are particularly suited to investors with information about future volatility. In this study, we investigate whether option prices anticipate and correctly incorporate the magnitude of uncertainty associated with quarterly earnings announcements and annual meetings of shareholders. We find that our option implied volatility-based measure predicts future absolute excess returns of the underlying stock around earnings announcements and annual meetings of shareholders, even after controlling for realized stock return volatility shortly before the information events and volatility of excess stock returns around these prior information events. The predictability of our option implied volatility-based measure is higher around these information events than a random selected date, implying that option traders anticipate the change in uncertainty and trade on volatility information around these two information events. In addition, our analysis of the straddle strategy shows that option market makers adjust straddle prices in a way that they get compensated for the predicted volatility and require higher volatility risk premium around information events than a random selected day.

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Appendix

The sensitivity of option implied volatility to earnings announcement date

On August 4, 2014, JinkoSolar Holdings Co. Ltd. (JKS) announced that it will release earnings for the second quarter of 2014 on August 18, 2014. Wall Street Horizon, a company that tracks upcoming events for publicly listed companies, has forecasted that JKS will announce earnings on August 12, 2014. Although this announcement delayed the earnings release date by just six days, it had a subtle effect on outstanding options. The August 2014 options expired on August 16, 2014. Thus, if option traders followed the expectations of the Wall Street Horizon, they would have priced the August option to include the higher volatility around the earnings announcement date. When the date was finalized for August 18, 2014, i.e. after the expiration of the August options, the option prices should have reflected just normal volatility, and the option implied volatility (IV) should have dropped. The actual option implied volatilities observed were:

	8/4/2014	8/5/2014	8/6/2014	8/7/2014
IV of call options expiring at 8/16/2014 and strike price at \$23	83%	76%	77%	70%
IV of call options expiring at 8/16/2014 and strike price at \$24	78%	72%	77%	73%
IV of call options expiring at 9/20/2014 and strike price at \$23	78%	74%	74%	77%
IV of call options expiring at 9/20/2014 and strike price at \$24	77%	72%	73%	75%
Stock Price (in dollars)	23.40	25.37	25.42	25.48

As can be seen, the implied volatility of the 8/16/2014 call options dropped after the company's announcement that earnings will be released after the option expiration date. In addition, the decrease of implied volatility of the 8/16/2014 call options is larger than that of call options expiring at 9/20/2014, which was not or less affected by the announcement on August 4, 2014.

Variable Definitions

AXRET	Absolute excess return, calculated as the absolute value of buy-and-hold return over the 3-day window $([-1, 1])$ around a firm specific event (earnings announcements, annual meetings of shareholders or random events) minus the buy-and-hold return on a portfolio of stocks with similar size (market value of equity, two groups), book-to-market ratio (three groups), and momentum (three groups).
STRADDLE	Net straddle return. A straddle contract is bought shortly (5 to 10 days) before the firm specific event and sold one day after the event. The purchase (selling) price of the straddle is calculated as the sum of ask (bid) prices of the ATM call and ATM put options. Net straddle returns are estimated as the selling price of the straddle minus its purchase price divided by its purchase price.
HIST	Standard deviation of daily stock returns in the 60 calendar days prior to the firm specific event (earnings announcements, annual meetings of shareholders or random events) multiplied by square root of 3.
STDXRET	Standard deviation of 3-day $([-1, +1])$ excess returns around prior earnings announcements, annual meetings of shareholders or random events using all available data since the year 1986.
IVOL3	Predicted 3-day volatility around earnings announcements, annual meetings of shareholders or random events. It is calculated as σ_{high} multiplied by $\sqrt{3}/252$. σ_{high} is obtained from formula (3).
RHIST	HIST sorted quarterly into deciles (0-9), then divided by 9 and subtracting 0.5.
RSTDXRET	STDXRET sorted quarterly into deciles (0-9), then divided by 9 and subtracting 0.5.
RIVOL3	IVOL3 sorted quarterly into deciles (0-9), then divided by 9 and subtracting 0.5.
RDQ	A dummy variable, which is equal to 1 when the information event is the earnings announcement and 0 otherwise.
AMS	A dummy variable, which is equal to 1 when the information event is the annual meeting of shareholders and 0 otherwise.
RHIST_RDQ	RHIST multiplied by RDQ.
RHIST_AMS	RHIST multiplied by AMS.
RSTDXRET_RDQ	RSTDXRET multiplied by RDQ.
RSTDXRET_AMS	RSTDXRET multiplied by AMS.
RIVOL3_RDQ	RIVOL3 multiplied by RDQ.
RIVOL3_AMS	RIVOL3 multiplied by AMS.

Figure 1: Timeline of events and estimation windows

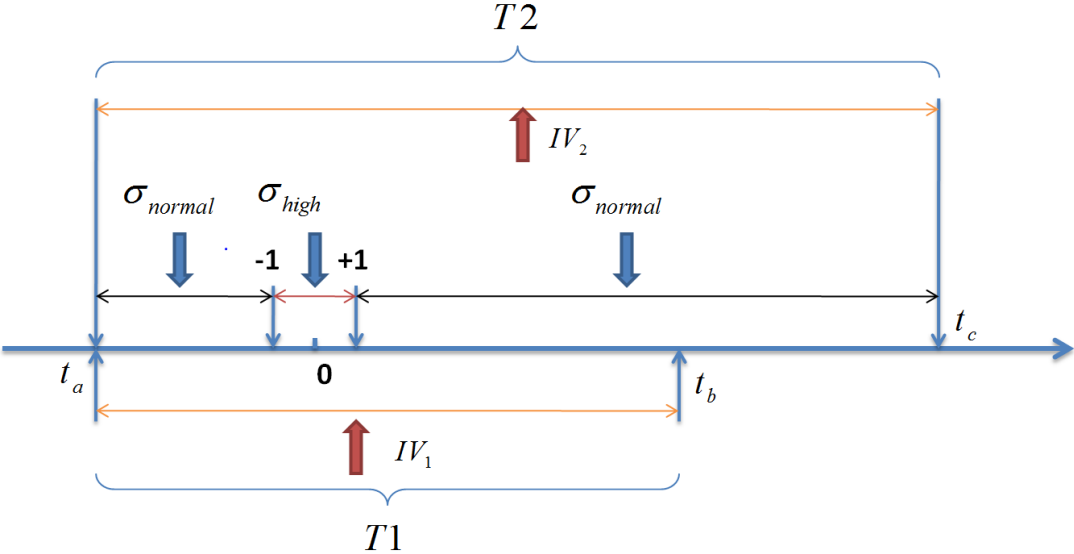


Table 1: Summary Statistics

Panel A and Panel B reports summary statistics for variables in the earnings announcements sample and annual meetings of shareholders sample, respectively. Panel C shows the difference of sample means and its significance. ***, **, and * denote significance at 1%, 5%, and 10% levels, based on one-sided t-test. In the column of earnings announcement, "treatment" refers to the earnings announcement sample and "control" refers to the sample of pseudo-event, which is a random day between Day 30 to Day 60 relative to the day of earnings announcements. Similarly, in the column of annual meetings of shareholders, "treatment" refers to the sample of shareholders annual meetings and "control" refers to the sample of pseudo-event, which is a random day between Day 30 to Day 60 relative to the day of annual meetings of shareholders. See the appendix for variable definitions.

Panel A: Earnings Announcements

Variable	N	Mean	StdDev	5th	25th	Median	75th	95th
AXRET	101,241	0.0623	0.0666	0.0035	0.0184	0.0420	0.0834	0.1881
STRADDLE	101,241	-0.1180	0.3813	-0.5275	-0.3250	-0.2000	-0.0137	0.5854
HIST	101,241	0.0517	0.0321	0.0185	0.0301	0.0434	0.0638	0.1130
STDXRET	101,241	0.0778	0.0417	0.0293	0.0479	0.0704	0.0970	0.1524
IVOL3	101,241	0.0825	0.0599	0.0225	0.0486	0.0712	0.1032	0.1895

Panel B: Annual Meetings of Shareholders

Variable	N	Mean	StdDev	5th	25th	Median	75th	95th
AXRET	19,551	0.0332	0.0390	0.0019	0.0096	0.0218	0.0422	0.1028
STRADDLE	19,551	-0.1762	0.2845	-0.5185	-0.3250	-0.2143	-0.0833	0.3089
HIST	19,551	0.0517	0.0313	0.0191	0.0305	0.0434	0.0639	0.1131
STDXRET	19,551	0.0467	0.0339	0.0112	0.0256	0.0388	0.0586	0.1073
IVOL3	19,551	0.0679	0.0518	0.0187	0.0357	0.0549	0.0840	0.1614

Panel C: Comparison of Sample Means

Variable	Earnings Announcements			Annual Meetings of Shareholders		
	(1) Treatment	(2) Control	(1)-(2)	(3) Treatment	(4) Control	(3)-(4)
AXRET	0.0627	0.0306	0.0322***	0.0333	0.0288	0.0045***
STRADDLE	-0.1042	-0.1772	0.0730***	-0.1633	-0.1762	0.0129***
HIST	0.0518	0.0543	-0.0025***	0.0519	0.0502	0.0017***
STDXRET	0.0780	0.0481	0.0309***	0.0467	0.0422	0.0045***
IVOL3	0.0818	0.0651	0.0167***	0.0675	0.0625	0.0045***
N of obs	87,088	87,088		17,108	17,108	

Table 2: Correlation Analysis

Panel A and Panel B show the correlation matrix of key variables in earnings announcements sample and annual meetings of shareholders sample, respectively. Pearson correlations are reported above the main diagonal and Spearman correlations are reported below the main diagonal. In each cell, the first row shows the correlation coefficient and the second row shows the p-value. See appendix for variable definitions.

Panel A: Earnings Announcements

	AXRET	STRADDLE	HIST	STDXRET	IVOL3
AXRET	1.000	0.463 <.0001	0.282 <.0001	0.335 <.0001	0.273 <.0001
STRADDLE	0.276 <.0001	1.000	-0.007 0.0038	0.054 <.0001	-0.058 <.0001
HIST	0.287 <.0001	-0.002 0.4935	1.000	0.309 <.0001	0.594 <.0001
STDXRET	0.365 <.0001	0.015 <.0001	0.366 <.0001	1.000	0.309 <.0001
IVOL3	0.283 <.0001	-0.047 <0.0001	0.643 <.0001	0.410 <.0001	1.000

Panel B: Annual Meetings of Shareholders

	AXRET	STRADDLE	HIST	STDXRET	IVOL3
AXRET	1.000	0.337 <.0001	0.322 <.0001	0.140 <.0001	0.278 <.0001
STRADDLE	0.168 <.0001	1.000	-0.005 0.443	-0.017 0.0178	-0.067 <.0001
HIST	0.326 <.0001	-0.023 0.0014	1.000	0.222 <.0001	0.566 <.0001
STDXRET	0.140 <.0001	-0.031 <.0001	0.272 <.0001	1.000	0.181 <.0001
IVOL3	0.287 <.0001	-0.069 <.0001	0.632 <.0001	0.233 <.0001	1.000

Table 3: Cross Tabulation of Volatility Measures and Absolute Excess Returns

This table shows the absolute excess stock returns in the 3-day ([-1, +1]) window around earnings announcements and annual meetings of shareholders. Each quarter, firms are sorted into quartile based on HIST, STDXRET or IVOL3. The first (fourth) quartile includes firms with lowest (highest) value of HIST, STDXRET or IVOL3, respectively. Panels A and B report absolute excess returns for the sample of earnings announcements. Panel C and D report absolute excess returns for the sample of annual meetings of shareholders. See appendix for variable definitions.

Panel A: Absolute Excess Returns around Earnings Announcements, Sorted by HIST and IVOL3

Rank for HIST	AXRET				
	Rank for IVOL3				All
	1	2	3	4	
1	0.034	0.042	0.048	0.055	0.039
2	0.047	0.053	0.059	0.068	0.055
3	0.059	0.062	0.070	0.080	0.070
4	0.070	0.074	0.078	0.094	0.086
All	0.042	0.055	0.067	0.085	0.062

Panel B: Absolute Excess Returns around Earnings Announcements, Sorted by STDXRET and IVOL3

Rank for STDXRET	AXRET				
	Rank for IVOL3				All
	1	2	3	4	
1	0.032	0.039	0.047	0.068	0.039
2	0.045	0.051	0.058	0.073	0.055
3	0.057	0.064	0.069	0.079	0.069
4	0.070	0.075	0.084	0.097	0.087
All	0.042	0.055	0.067	0.085	0.062

Panel C: Absolute Excess Returns around Annual Meetings of Shareholders, Sorted by HIST and IVOL3

	AXRET				
	Rank for IVOL3				All
	1	2	3	4	
Rank for HIST					
1	0.020	0.023	0.028	0.029	0.022
2	0.025	0.028	0.031	0.036	0.029
3	0.029	0.030	0.036	0.041	0.035
4	0.038	0.038	0.040	0.054	0.047
All	0.023	0.029	0.035	0.046	0.033

Panel D: Absolute Excess Returns around Annual Meetings of Shareholders, Sorted by STDXRET and IVOL3

	AXRET				
	Rank for IVOL3				All
	1	2	3	4	
Rank for STDXRET					
1	0.020	0.025	0.031	0.044	0.027
2	0.022	0.027	0.031	0.043	0.030
3	0.027	0.030	0.036	0.045	0.035
4	0.031	0.034	0.041	0.049	0.041
All	0.023	0.029	0.035	0.046	0.033

Table 4: The Predictability of Option Implied Volatility-based Measure for Future Absolute Excess Returns

This table reports Fama–MacBeth statistics based on 64 quarterly regressions. The dependent variable is the 3-day ([-1, +1]) absolute excess return. Panels A and B show the regression results for earnings announcements and annual meetings of shareholders, respectively. Variables indicated by *R* are the underlying variables sorted quarterly into deciles (0-9), then divided by 9 and subtracting 0.5. Thus, each decile variable has a value between -0.5 to 0.5. T-statistics reported in parentheses are based on Newey-West adjusted standard errors. ***, **, and * indicate that the mean is significant at 1%, 5%, and 10% levels, respectively. See appendix for variable definitions.

Panel A: Earnings Announcements

Variable	(1)	(2)	(3)	(4)
Intercept	0.062*** (24.73)	0.062*** (24.73)	0.031*** (12.94)	0.031*** (12.94)
RDQ			0.032*** (17.9)	0.032*** (17.9)
RIVOL3	0.032*** (14.22)	0.019*** (12.97)	0.018*** (10.89)	0.008*** (8.45)
RIVOL3_RDQ			0.013*** (9.30)	0.011*** (9.67)
RSTDXRET	0.043*** (23.34)	0.034*** (23.14)	0.017*** (9.26)	0.008*** (9.75)
RSTDXRET_RDQ			0.027*** (17.36)	0.027*** (16.49)
RHIST		0.028*** (11.47)		0.022*** (11.02)
RHIST_RDQ				0.004*** (2.41)
N	101,241	101,241	174,716	174,716
R square	0.107	0.118	0.189	0.200

Panel B: Annual Meetings of Shareholders

Variable	(1)	(2)	(3)	(4)
Intercept	0.036*** (17.28)	0.036*** (17.28)	0.031*** (12.18)	0.031*** (12.17)
AMS			0.005*** (8.40)	0.005*** (8.43)
RIVOL3	0.026*** (12.02)	0.016*** (4.58)	0.022*** (7.06)	0.008*** (4.65)
RIVOL3_AMS			0.006*** (2.43)	0.009*** (3.60)
RSTDRET	0.012*** (5.93)	0.010*** (4.30)	0.010*** (7.47)	0.004*** (3.52)
RSTDRET_AMS			0.002 (0.59)	0.004 (1.32)
RHIST		0.020*** (5.72)		0.025*** (7.36)
RHIST_AMS				-0.006 (-1.64)
N	19,551	19,551	34,216	34,216
R square	0.088	0.114	0.099	0.132

Table 5: Straddle Returns Regressions

This table reports Fama–MacBeth statistics based on 64 quarterly regressions. The dependent variable is the straddle return. Panels A and B show the regression results for earnings announcements and annual meetings of shareholders, respectively. Variables indicated by *R* are the underlying variables sorted quarterly into deciles (0-9), then divided by 9 and subtracting 0.5. Thus, each decile variable has a value between -0.5 to 0.5. T-statistics reported in parentheses are based on Newey-West adjusted standard errors. ***, **, and * indicate that the mean is significant at 1%, 5%, and 10% levels, respectively. See appendix for variable definitions.

Panel A: Earnings Announcements

Variable	(1)	(2)	(3)	(4)
Intercept	-0.117*** (-14.05)	-0.117*** (-14.05)	-0.176*** (-23.09)	-0.176*** (-23.09)
RDQ			0.073*** (11.40)	0.073*** (11.40)
RIVOL3	-0.080*** (-10.15)	-0.069*** (-7.73)	-0.046*** (-7.14)	-0.062*** (-8.05)
RIVOL3_RDQ			-0.033*** (-4.24)	-0.004 (-0.44)
RSTDYRET	0.059*** (6.39)	0.067*** (6.69)	-0.003 (-0.45)	-0.016*** (-3.11)
RSTDYRET_RDQ			0.063*** (6.57)	0.085*** (7.88)
RHIST		-0.027*** (-1.85)		0.035*** (3.18)
RHIST_RDQ				-0.064*** (-7.13)
N	101,241	101,241	174,716	174,716
R square	0.007	0.010	0.023	0.025

Panel B: Annual Meetings of Shareholders

Variable	(1)	(2)	(3)	(4)
Intercept	-0.169*** (-20.88)	-0.169*** (-20.89)	-0.175*** (-25.27)	-0.175*** (-25.29)
AMS			0.017*** (3.64)	0.017*** (3.68)
RIVOL3	-0.055*** (-3.83)	-0.063*** (-2.61)	-0.015 (-1.01)	-0.026 (-1.66)
RIVOL3_AMS			-0.022* (-1.73)	-0.010 (-0.71)
RSTDRET	0.003 (0.35)	0.012 (1.27)	0.005 (0.41)	-0.002 (-0.13)
RSTDRET_AMS			-0.012 (-0.73)	0.003 (0.20)
RHIST		-0.007 (-0.28)		0.020 (1.16)
RHIST_AMS				-0.040** (-2.19)
N	19,551	19,551	34,216	34,216
R square	0.022	0.038	0.034	0.048