Options Trading Volume and Stock Price Response to Earnings Announcements

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JEL classifications: G11; G14; G15; M41

Key words: Options, Trading Volume, Earnings Announcement, Stock Price

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We examine the effect of options trading volume on the stock price response to earnings announcements over the period 1996–2007. Contrary to prior studies, we find no significant difference in the immediate stock price response to earnings information announcements between firms with listed options and firms without listed options. However, within the sample of firms with listed options, we find that higher options trading volume reduces the immediate stock price response to earnings announcements. This is consistent with evidence that the stock prices of high options trading volume firms have anticipated and pre-empted some earnings information in the pre-announcement period. We also find that abnormal options trading volume around earnings announcements hastens the stock price adjustment to earnings news. We present evidence that post-earnings announcement drift is lower for stocks of firms with high abnormal options trading volume around earnings announcements.

1. Introduction

The information role of equity options has been widely examined and it is now accepted that options markets enhance the price efficiency of equity markets. In particular, there is a general consensus that for firms with exchange-traded options, the stock price adjustment to earnings information is faster (Jennings and Starks, 1986); post-earnings announcement drift is less pronounced (Ho, 1993); options trading brings private information to equity markets in both earnings announcement and non-earnings announcement periods (Amin and Lee, 1997); and the shape of the options-implied volatility smile anticipates the surprise in earnings announcements and predicts future stock returns (Zhang, Zhao and Xing, 2008). By contrast, studies examining the impact of options trading on the magnitude of the immediate stock

price response to earnings announcements have not reached a clear consensus. Motivated by the literature on the characteristics of information environments that affect the way security prices react to earnings releases, Skinner (1990) and Ho (1993) demonstrate that the stock price reaction to earnings news is smaller for firms with listed options than for firms without listed options. They suggest that private information is impounded into stock prices via options trading before earnings announcements, thereby pre-empting some of the news content of the subsequent announcements. Mendenhall and Fehrs (1999), however, find that the stock price response to earnings news for firms with listed options is larger and more complete because informed traders can take larger and less expensive positions in options markets than in stock markets. Furthermore, they find no evidence of a reduced earnings response coefficient for firms with listed options.

Most of the empirical literature on the informational role of options markets and the stock price response to earnings information is based on inferences from a simple dichotomy: firms with listed options versus firms without listed options. This approach implicitly assumes that the benefits of options trading are homogenous across firms with listed options. However, the information role of options can vary significantly depending on how easily informed traders can exploit trading opportunities in options. Where options trading volume is thin, an options listing may be meaningless as a factor determining stock price efficiency. Consider the argument made by Roll, Schwartz, and Subrahmanyam, (2009, pg.4) : "It can be argued that, *ceteris paribus*, markets for claims in firms with higher options trading volume should be more informationally efficient and thus valued more highly. It is worth noting that the mere *listing* of an option does not necessarily imply a valuation benefit of the type discussed above… Any valuation benefit of options listing should depend on substantial trading activity." Admati and Pfleiderer (1988) point out that if options markets have insufficient trading volume, informed traders would find no advantage to trading in options.

These arguments have strong relevance given the extreme differences in options trading volume observed among firms with listed options. For example, in our large sample of earnings announcements we find that in the three-day period surrounding the announcements 36.80% of our sample of optioned firms had on average less than 100 contracts traded per day, while only 18.60% had more than 2,000 contracts traded per day. This pronounced skewness in options trading volume makes the practice of splitting a sample into optioned and non-optioned firms a weak experimental design with which to measure the impact of options trading on stock price efficiency.[1] If as Roll, Schwartz and Subrahmanyam (2009) argue, the informational benefit of options trading is likely greatest among firms with actively traded options then only a minority of firms may enjoy these benefits to any significant degree.

Options' information role arguments coupled with the findings of studies on options trading volume suggest that the impact of options trading on the stock price response to earnings news should be most pronounced when options trading volume is high. Options trading volume should provide a good proxy for the ease with which informed traders can use options to act on private information. Using a large sample of firms over the 12-year period 1996 to 2007, we investigate the effects of options trading volume on the magnitude of the stock price response to earnings announcements in the announcement period, in the pre-announcement period, and in the post-announcement period. By focusing on options trading volume, and not just a simple dichotomy of an options listing versus no listing, our approach provides a more complete picture of the role of options trading in enhancing stock price efficiency with regard to earnings news. To the best of our knowledge, an analysis of the relationship between the level of options trading activity and the stock price response to earnings information has not yet been undertaken.

[1] Studies defining optioned firms as those with an options listing regardless of the level of options trading volume include Jennings and Starks (1989), Conrad (1989), Skinner (1989,1990), Ho (1993), and Mendenhall and Fehrs (1999) among others.

We use the level of options trading volume to measure the marginal impact of options trading on stock price efficiency. After dividing our sample into firms with listed options and firms without listed options, we stratify the optioned firm sample according to their corresponding levels of options trading volume during the pre-earnings announcement period from day -50 to day -10 relative to the day of an earnings announcement. From this stratified sample, we find that stocks with high options trading volume manifest a smaller immediate price reaction to earnings news than stocks with low options trading volume. Moreover, stocks with high options trading volume display stronger price anticipation in the pre-earnings announcement period than stocks with low options trading volume. Taken together, the attenuated stock price response around the announcement date and the stock price anticipation in the pre-announcement period for stocks with high options trading volume appears consistent with the hypothesis that some part of the response to earnings news is pre-empted in the pre-earnings announcement period. This finding supports the hypothesis that options trading activity diminishes the concurrent stock price response to an earnings announcement and resolves some conflicting results from previous studies that split their samples into stocks with an options listing and stocks without an options listing.

We also use abnormal options trading volume in the three-day period around an earnings announcement to measure options trading activity that can be attributed to earnings releases. Stratifying the sample of firms by the magnitude of abnormal options trading volume, we find that stocks with high abnormal options trading volume display notably stronger price reactions to earnings information than stocks with low abnormal options trading volume. This bolsters evidence that options trading activity around an earnings announcement is important for the price discovery process with regard to earnings information (Jennings and Starks, 1986). Previous studies (Harris, 1986; Karpoff, 1986, 1988; Jain and Joh, 1988; Stephan and Whaley, 1990) have established a significant cross-

sectional relationship between stock trading activity and stock price changes.[2] Our finding of a positive contemporaneous relationship between options trading activity and stock price changes complements these studies, and indicates that the price impact of trading volume is not confined to trading in equity markets, but encompasses derivative security markets as well.

Further examination reveals that post-announcement abnormal stock returns are smaller for firms that experience large abnormal options trading volume around earnings announcements. Thus, while a surge in options trading volume around earnings announcements serves to enhance the stock price response to earnings news, it also alleviates any delayed price response to earnings news in the post-announcement period.[3]

The remainder of the paper is organized as follows. Section 2 discusses the background and motivation for this study. Section 3 describes data sources, then defines and motivates variables used in the empirical tests. Section 4 presents and discusses the results, and Section 5 provides a summary and conclusions.

2. Background and Motivation

Black (1975) and Manaster and Rendleman (1982) argue that for traders with private information, exchange-traded put and call options offer a low cost alternative to trading

[2] It is an old adage of Wall Street that "It takes volume to make prices move." Findings in this study suggest that trading volume in both stock and options markets makes stock prices move, at least with regard to evidence from earnings announcements.

[3] Ball and Brown (1968), Jones and Litzenberger (1970), Latane, Joy and Jones (1970), Joy, Litzenberger and McEnally (1977), Latane and Jones (1979), Bernard and Thomas (1989, 1990), and others observe a consistently perceptible delay in the stock price response to earnings information in the post earnings announcement period. The academic literature offers three explanations: 1) methodological shortcomings in the studies examining such abnormal returns; 2) an increase in risk for companies experiencing extreme earnings surprises, where the abnormal return represents fair compensation for higher expected risk; 3) investors under-react to value-relevant information from earnings announcements or they process the information with a significant delay. The predominant hypothesis is that post-announcement drift is a delayed response to earnings information where a gradual, rather than immediate price adjustment occurs because the opinions of those best able to assess earnings surprises (market professionals) would be gradually disseminated to the general investing public. Daniel, Hirshleifer, and Subrahmanyam (1998) and Barberis, Shleifer, and Vishny (1998) offer behavioural explanations for why investors might under-react to new information.

directly in the underlying stocks. Investors can also get higher leverage at a lower cost for each dollar invested in options markets (Back, 1993; Biasis and Hillion, 1992).[4] In addition, the payoff of an option is truncated at the strike price, thereby limiting downside risk. In this respect, leverage provided by options has limited risk while a conventional loan or margined equity position exposes an investor to 100% of the downside stock price risk. Other benefits of options include lack of short sale restrictions, a greater range of investment strategies from combinations of call options, put options, and positions in the underlying stocks. These factors would make options preferable to stocks for informed traders or make options trading profitable while trading in stocks may not be. As the stock price is a determining element in an option price, private information should be impounded instantaneously into the stock price to eliminate potential arbitrage opportunities (Diamond and Verrecchia, 1987). This provides strong motivation for examining the efficiency of stock prices with respect to new information when options trading is readily available.[5]

Skinner (1990) examines the relationship between options listings and the stock price response to earnings information in a longitudinal setting over the period April 1973 through December 1986.[6] He finds that stocks exhibit both a smaller absolute price response to earnings information and a smaller earnings response coefficient after an options listing than before the options listing. This evidence adds to earlier findings that the variance of stock returns, on average, declines after options on a firm's stock begin trading on an options

[4] Ross (1976) suggests that the options market significantly improves market efficiency because it now permits an expansion of contingencies that are covered by traded securities. Since Ross' study, options markets have grown exponentially in both number of assets with options listings and in options trading volume. The current market size of $200 trillion is more than 100 times greater than 30 years ago (Stulz, 2004). The CBOE reports4.7 million options transactions representing $609 billion in the year 2007.

[5] Figlewski and Webb (1993) argue that options increase informational efficiency because put options and written call options effectively alleviate short-sale constraints. There is also an absence of the uptick rule for short selling in options markets. Recent studies providing evidence that private information is traded actively in options markets include Faff and Hillier (2005), Bali and Hovakimian (2008), Cremers and Weinbaum (2008), Diavatopoulos, Doran and Peterson (2008), and Zhang, Zhao and Xing (2008).

[6] Earlier empirical research on the interaction between stock prices and options markets can be found in Chiras and Manaster (1978), Patell and Wolfson (1979), Manaster and Rendleman (1982), and Jennings and Starks (1986).

exchange (Conrad, 1989; Skinner, 1989). The Skinner study complements Jennings and Starks (1986), who find that the intraday speed of adjustment to earnings releases is faster for firms whose stocks have an options listing. This result suggests a change of information environment around the time of an options listing.[7]

Ho (1993) suggests that there may be problems associated with longitudinal studies because firm characteristics may change across the periods before and after an options listing. She performs matched pairs' tests controlling for variables relevant to the stock price response to earnings information, such as firm size, analyst following, institutional holding, financial news, and trading volume. She finds results consistent with Skinner's study that stock prices of optioned firms anticipate earnings information earlier than those of non-optioned firms do. In particular, around 50% of the price change associated with a current year's earnings is realised in the pre-announcement period for optioned firms while about 70% of the price change associated with current year's earnings occurs in the announcement and post-announcement period for non-optioned firms. Thus, in Ho's study, post-earnings announcement drift was shown to be greater for non-optioned firms than for optioned firms.

Mendenhall and Fehrs (1999) criticise the Ho (1993) study, pointing out that it is based on a small sample and the results are somewhat weak. They argue that there is a lack of definitive empirical results regarding the effects of options listings and re-examine the price response to earnings information in both longitudinal and cross-sectional settings. After controlling for factors that are important to the stock price response to earnings information in longitudinal tests, they show that an options listing may increase the absolute value of the stock price response to earnings. Cross-sectional tests do not provide support for a reduction

[7] Several earlier studies find that the information content of an earnings announcement is negatively associated with a firm's information environment (Grant, 1980; Atiase, 1985; Collins, Kothari and Rayburn, 1987; Freeman, 1987; Dempsey, 1989; Lobo and Mahmoud, 1989; Shores, 1990), where a firm's information environment is proxied by firm size, by analyst following, or by the degree of financial press coverage. Skinner (1990) suggests a similar inverse relationship between the information content of earnings announcements and the firm's information environment in a setting where options trading is available versus options trading is not available.

in earnings response coefficient for optioned firms. Mendenhall and Fehrs interpret their results as indicating a more complete earnings announcement response for optioned firms because of the actions of informed traders.

The literature on options trading and the stock price response to earnings information provides no comparisons between stocks with heavily traded options and stocks with lightly traded options.[8] Roll, Schwartz and Subrahmanyam (2009) argue that an options listing does not automatically imply that informed traders can better act on their private information. They further suggest that options markets vary in their degree of thinness, which implies that there are varying degrees of informational efficiency. Following this argument, we propose that greater options trading activity entails greater price informativeness and hence, any difference in the stock price response to earnings information due to options trading should be most pronounced for stocks with high options trading volume than for stocks with low options trading volume.

Cao and Wei (2007) find evidence that information asymmetry is greater for options than for the underlying stock; implying agents with private information should find options markets a more effective place for trading. Moreover, options trading volume is an essential condition for information trading using options, as Admati and Pfleiderer (1988) point out that informed traders are more active when volume is greater.[9] Delong, Shleifer, Summers and Waldmann (1990), however, suggest an opposing hypothesis that options trading results

[8] Several studies have examined options trading volume in relation to earnings announcements, such as Philbrick and Stephan (1993), Amin and Lee (1997), Ni, Pan and Poteshman (2008), Choy and Wei (2009), and options trading volume in relation to take-over announcements, such as Cao, Chen and Griffin (2005). However, an examination of the linkage between options trading volume and the stock price response to earnings information is so far non-existent.

[9] Easly, O'Hara and Srinivas (1998) and Chakravarty, Gulen and Mayhew (2004) find that options order flow contains information about the future direction of the underlying stock price. Cao, Chen and Griffin (2005) find that options volume and options order imbalances can predict stock returns in take-over announcements. Other studies providing evidence of a relation between options trading volume and stock price efficiency include Anthony (1988), Stephan and Whaley (1990), Mayhew, Sarin and Shastri (1995), Kumar, Sarin and Shastri (1998), and Pan and Poteshman (2006).

in increased price uncertainty because of more speculative trading by uninformed traders.[10] If this is true, the stock price response to earnings information of high options trading volume stocks should exhibit more volatility and less efficiency. Therefore, this study also aims to find evidence to distinguish between these two competing hypotheses. We revisit the distinction between optioned and non-optioned firms and the impact on the stock price response to earnings by using a more recent and larger dataset, as most previous findings were from relatively small samples ending in 1993.[11] After splitting our sample into optioned firms and non-optioned firms, we then stratify the sample of optioned firms according to the level of options trading volume in the pre-announcement period. This contrasts with prior studies that split their sample into optioned and non-optioned firms but do not stratify optioned firms by options trading volume.

3. Data Sources and Empirical Procedures

3.1 Data

The sample includes all quarterly earnings announcements from the first quarter in 1996 to the fourth quarter in 2007 for which daily stock returns and trading volume data from the University of Chicago Center for Research in Security Prices (CRSP) database, quarterly earnings data from the Standard & Poor's Compustat database, earnings forecasts and actual earnings data from the Institutional Brokers' Estimate System (IBES) database are available. Data for options trading volume and option prices are obtained from OptionMetrics Ivy United States database (Ivy DB US). This dataset includes the daily number of contracts traded for each individual put and call option. We start at 1996 because the Ivy DB US

[10] Similarly, Vijh (1990), Chan, Chung and Johnson (1993), Chan, Chung and Fong (2002), and Choy and Wei (2009) suggest that options trading activity is not driven by informed trading.

[11] Skinner (1990) employs a sample of 212 firms with options listed on the Chicago Board Options Exchange and American Stock Exchange over the period April 1973–December 1986. Ho (1993) uses a sample of 255 optioned firms over the period 1980–1983. Mendenhall and Fehrs (1999) examine 420 optioned firms over the period 1973–1993. Our sample is several orders of magnitude larger than the samples in these studies.

dataset begins in this year.[12] To assure that earnings announcement dates are of high quality, we require that Compustat and IBES earnings announcement dates fall within one day of each other. The final sample includes firms whose stocks traded on the New York Stock Exchange, American Stock Exchange, and NASDAQ.

We conduct tests on two samples in this study. To determine the differences simply due to options trading availability as in prior studies, we use the full sample of both non-optioned and optioned firms. To determine the differences attributable to varying levels of options trading volume, we conduct separate tests on the sub-sample containing only firms with an options listing covered by Ivy DB US.[13] There are a total of 154,419 earnings announcements in the full sample, of which 85,334 fall within the optioned firm sample.

3.2 Measures of Options Trading Volume

In this study, we utilize two measures of options trading volume: 1) average options trading volume in the pre-earnings announcement period, and 2) abnormal options trading volume in the immediate earnings announcement period. The first measure proxies for the 'information environment' as prior research suggests that options trading increases the availability and the timeliness of pre-disclosure information about a firm. This measure also proxies for the convenience with which informed traders can act on their private information.[14] The second measure captures activity in options markets, which can be exclusively attributed to earnings

[12] The Ivy DB US dataset contains equity options data from all United States (U.S.) exchange-listed and NASDAQ equities and market indices, as well as all U.S. listed index and equity options, including options on exchange traded funds (ETF) and American depository receipts (ADR), starting from January 1996.

[13] Another approach is to construct a full sample, where any firm with no options volume data in Ivy DB US is assumed to have an options trading volume of zero. We repeated all tests with options trading volume using this sampling approach and achieved similar results as reported for the sample of firms with positive options trading volume.

[14] Several studies suggest that certain agents may have foreknowledge of earnings information. This may be due to information leaks (Seppi, 1992; Seyhun, 1992), increased information collection activities (Kim and Verrecchia, 1991), or possession of superior information (Ali, Durtschi, Lev and Trombley, 2004; Christophe, Ferri and Angel, 2004; Baker, Litov, Wachter and Wurgler, 2009; Berkman and McKenzie, 2009). These agents should find firms with high options trading volume in the pre-earnings announcement period suitable to act on their private information.

information. Essentially, this measure is important in tests to determine whether options trading in the earnings announcement period aids in hastening the stock price response to earnings information.

We use three measures of average options trading volume in the pre-earnings announcement period: 1) average total options trading volume (denoted by OPTVOL), 2) average call options trading volume (denoted by CALLVOL), and 3) average put options trading volume (denoted by PUTVOL), all measured over the period from day -50 to day -10 relative to the earnings announcement.[15,16]

Abnormal options trading volume is measured as the percentage difference between average options trading volume in the three-day announcement period and normal options trading volume, where normal options trading volume is measured by average options trading volume in the pre-announcement period. We use three abnormal options trading volume measures, corresponding to all options (denoted by AB_OPTVOL), call options (denoted by AB_CALLVOL) and put options (denoted by AB_PUTVOL), calculated as shown in equations (1), (2) and (3).

$$AB\_OPTVOL = OPTVOL(-1+1) / OPTVOL(-50,-10) - 1 \quad (1)$$

$$AB\_CALLVOL = CALLVOL(-1+1) / CALLVOL(-50,-10) - 1 \quad (2)$$

$$AB\_PUTVOL = PUTVOL(-1+1) / PUTTVOL(-50,-10) - 1 \quad (3)$$

3.3 Measure of Earnings Surprise

[15] We adopted several other window specifications such as [-270,-10], [-100,-10], [-100,-20] for our tests and found our results to be robust across these choices.

[16] Roll, Schwartz and Subrahmanyam (2009) use dollar options trading volume in their study to evaluate the effect of options trading on firm valuation. Philbrick and Stephan (1993) compute three measures of options trading volume: options volume scaled by open interest, options volume scaled by number of outstanding shares, and options volume scaled by the number of shares traded. We repeated the tests using options volume measures in Roll, Schwartz and Subrahmanyam, (2009) and Philbrick and Stephan (1993), and no inference in this study is changed.

Consistent with many prior studies, we use standardized unexpected earnings (SUE) to measure an earnings surprise. The SUE measure is defined as actual earnings minus expected earnings, with expected earnings proxied by the median of all latest analysts' forecasts in the 90-day period leading up to the earnings announcement, then scaled by the end of quarter stock price.[17] SUE is mathematically defined in equation (4).

$$SUE_{i,q} = \frac{E_{i,q}^{IBES} - F_{i,q}^{IBES}}{P_q} \qquad (4)$$

In equation (4), $E_{i,q}^{IBES}$ is the actual earnings per share reported in IBES for stock *i* in quarter *q*, and $F_{i,q}^{IBES}$ is the median of all latest forecasts of earnings per share made by analysts during the 90-day period prior to earnings announcements for stock *i* in quarter *q*. P_q is the stock price at the end of quarter *q*.[18]

We adopt the method of Bernard and Thomas (1990), Bhushan (1994), Bartov, Radhakrishnan and Krinsky (2000) and transform the SUE measure into decile scores, where within each calendar quarter, SUE values are coded from 0 to 9 according to their size decile, then divided by 9 to obtain scores ranging from 0 to 1. The intercept of a regression of stock price responses on SUE decile scores then represents the price response for the lowest SUE decile score and the slope coefficient is interpreted as the marginal price response moving from the lowest to the highest SUE decile scores. This scoring procedure serves to ameliorate the effects of outliers and potential nonlinearities in the price response and SUE relationship.

[17] Many prior studies examining SUE construct are based on historical time series, where market expectations of earnings are assumed to follow a seasonal random walk. This method has the benefit of not requiring analyst forecast data, but do require extensive past earnings data to fit the seasonal random walk model. Livnat and Mendenhall (2006) compare the magnitude of post-earnings announcement drift when SUE is computed using historical time series data as opposed to when SUE is computed using analyst forecast data, and find that the drift is significantly larger for the latter. Thus, SUE based on analyst forecasts appears to predict post-earnings announcement drift better than SUE based on a time series model. Prior studies examining the stock price reaction to earnings information between optioned and non-optioned firms, such as Ho (1993), and Mendenhall and Fehrs (1999) also rely on analyst-based SUE.

[18] Gu and Wu (2003) suggest that a median analysts' forecast is a superior proxy for market expectations as opposed to the mean because of skewness in earnings numbers. Imhoff and Lobo (1992) suggest that an earnings response coefficient depends on the standard deviation of analysts' forecasts before earnings announcements, and recommends that researchers replace the share price scalar with the share price deflated by the standard deviation of analysts' forecasts. We repeated the tests with the SUE measure recommended by Imhoff and Lobo or replace the price scalar by the standard deviation of earnings forecasts (Mendenhall, 2004; Jegadeesh and Livnat, 2006) and found the results insensitive to the various adjustments of the SUE measure.

3.4 Measures of Stock Price Response to Earnings

Skinner (1990) and Mendenhall and Fehrs (1999) compute the absolute value of the abnormal return from day -1 to day 0 to measure the stock price response to earnings information and then use this to estimate an earnings response coefficient. Berkman and Truong (2009) demonstrate that this short window, when applied to a more recent dataset, can produce a significant downward bias for the earnings response coefficient as almost half of the earnings announcements in the United States in the period 1999–2004 were made after the close of stock trading. Hence, ending the event window on day zero misses the price reaction to after-hours earnings announcements.

We use the absolute value of the abnormal return in the three days immediately surrounding earnings announcements to measure a firm's stock price response to earnings information and use this abnormal return to estimate an earnings response coefficient.[19] To provide a broader picture of the stock price response to earnings information, we also calculate abnormal returns for longer windows before and after earnings announcements. The abnormal return is the buy-and-hold stock return minus the buy-and-hold return of the equally-weighted size decile to which that stock belongs. Abnormal returns from the three different windows are defined as follows:

$$BHAR(-1,1)_{i,q} = \prod_{t=-1}^{t=+1}(1+r_{i,q,t}) - \prod_{t=-1}^{t=+1}(1+dec_{q,t}) \quad (5)$$

$$BHAR(-10,-2)_{i,q} = \prod_{t=-10}^{t=-2}(1+r_{i,q,t}) - \prod_{t=-10}^{t=-2}(1+dec_{q,t}) \quad (6)$$

$$BHAR(+2,+60)_{i,q} = \prod_{t=+2}^{t=+60}(1+r_{i,q,t}) - \prod_{t=+2}^{t=+60}(1+dec_{q,t}) \quad (7)$$

[19] We repeat the tests in this study using several modifications in the abnormal return definition, such as using the CRSP value-weighted index for risk adjustment, using Fama and French (1993) portfolios of size and book-to-market as benchmark returns, using cumulative abnormal returns in lieu of buy-and-hold abnormal returns. The results in this study are insensitive to these choices.

In equations (5), (6) and (7), $r_{i,q,t}$ is the return on stock i on day t relative to the earnings announcement in quarter q, and $dec_{i,q,t}$ is the equally-weighted return from the size decile that stock i belongs to on day t.

3.5 Other control variables

This paper employs cross-sectional tests and so raises the issue of which control variables to include. Simply comparing the stock price reaction between optioned and non-optioned firms or between high options trading volume and low options trading volume firms ignores the possibility that these groups are different systematically and that such differences may be related to the price-earnings relation. To control for these differences, we use seven variables widely applied in the literature when assessing an earnings price response: firm size, arbitrage risk, hedgable risk, stock trading volume, stock price, institutional holdings, and the number of financial analysts following the firm. Motivation for these variables is discussed next.

Bamber (1987) uses firm size as a proxy for the level of pre-disclosure information. If larger firms have more alternative sources of information, then the formal earnings announcement may contain less new information. Firm size has been shown to be negatively correlated to the magnitude of the stock price response to earnings (Atiase, 1985; Mendenhall and Fehrs, 1999), and firms with traded options tend to have a larger market capitalization than firms with no traded options (Skinner, 1990; Ho, 1993). Thus, firm size is included in the analysis, where SIZE is the market capitalization percentile for the firm at the beginning of the calendar year containing the earnings announcement.

Shleifer and Vishny (1997) and Wurgler and Zhuravskaya (2002) point out that stocks with higher idiosyncratic risk would be less attractive to arbitrageurs.[20] Therefore, on

[20] Wurgler and Zhuravskaya (2002) mention that arbitrageur demand for a stock is inversely related to the stock's arbitrage risk, or its idiosyncratic risk. Shleifer and Vishny (1997) also suggest that idiosyncratic risk impedes arbitrage. They show that arbitrage activity in their model of delegated arbitrage is deterred when a

observing comparable earnings surprises, arbitrageurs are more likely to take smaller positions in stocks with higher idiosyncratic risk or simply shun these stocks altogether. Mendenhall and Fehrs (1999) find that the variance of stock return is positively related to the immediate stock price reaction to earnings, and Mendenhall (2004) finds a strong relationship between arbitrage risk and the magnitude of the post-earnings announcement drift. We follow the approach of Mendenhall (2004) and compute arbitrage risk for a stock, denoted by ARBRISK, as the residual variance in a regression of stock returns on S&P 500 returns over the 48 months ending one month prior to the earnings announcement. We also estimate the systematic or hedgable risk, denoted as MRKRISK, as the explained variance in the regression used to estimate ARBRISK.[21]

Stoll (2000) finds that both the recent stock price and recent dollar trading volume are closely associated with the cost of trading and liquidity. Bhushan (1994) uses the stock price as a proxy for direct trading costs and dollar trading volume as a proxy for the inverse of direct trading costs, and finds that the magnitude of the post-earnings announcement drift is negatively associated with these two proxies. Mendenhall and Fehrs (1999) use trading volume as a control variable in their price response and earnings relation model. Therefore, we include the stock price 20 days prior to the earnings announcement, denoted as PRICE, and average dollar stock trading volume from day -270 to day -10 relative to the earnings announcement, denoted by STOCKVOL, as proxies for a stock's liquidity and transaction costs.

Hand (1990) shows that the likelihood that stock prices properly reflect a certain type of information depends on the probability that the marginal investor is sophisticated rather

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stock has high volatility. If, in general, investors under-react to earnings announcements, then high idiosyncratic-risk stocks will be mispriced due to limited arbitrage activity, and therefore, display larger post-earnings announcement drift.

[21] Shleifer and Vishny (1997) and Mendenhall (2004) suggest that both systematic and idiosyncratic risk may be important to investors.

than naïve. Lev (1988) suggests that it is less costly for institutional investors to gather information and so they are better informed. Kim and Verrechia (1994) show that institutional investors possess superior information and can process information better compared to individual investors. Bartov, Radhakrishnan and Krinsky (2000) find that the post-earnings announcement drift is smaller when the marginal investor of the company is likely to be sophisticated. We, therefore, include the fraction of shares held by institutions in the calendar quarter prior to the earnings announcement, denoted by INSTOWN, to proxy for investor sophistication. These data are recorded in the Security and Exchange Commission (SEC) Form 13f and are obtained from CDA Spectrum.

It is generally accepted that firms followed by more financial analysts have more publicly available information (Bhushan, 1994), and their stock price reflects future earnings earlier (Ayers and Freeman, 2003). We include the number of financial analysts providing forecasts for the firms in IBES to measure analyst following, denoted by ANAFOL, as a proxy for the richness of the information environment.

3.6 Explanatory Variable Transformation

To account for possible nonlinearities, Bhushan (1994) and Bartov, Radhakrishnan and Krinsky (2000) use within-year rank scores for some of their explanatory variables. We follow this approach, and transform explanatory variable values within each quarter into decile scores ranging from 0 to 1 in the same way as for SUE specified in Section 3.3.

4. Empirical Tests and Results

4.1 Sample Summary and Descriptive Statistics

Panel A of Table 1 reports the number of firms sampled in each year, ranging from 4,360 in 1996 to 4,239 in 2007, where the total of 50,297 includes firms sampled in multiple years. Columns 3 and 4 of Panel A reveal that firms with an options listing have become more

numerous over time, from 1,751 in 1996 to 2,442 in 2007, while firms without an options listing have declined from 2,609 in 1996 to 1,797 in 2007. Since 1999, firms with an options listing have outnumbered firms without an options listing. Column 5 of Panel A reports the number of optioned firms in each year experiencing zero options trading volume in the immediate three-day period surrounding all earnings announcements that year.

In Panel B, column 2 reports the number of quarterly earnings announcements sampled within each year. Column 3 reports the number of earnings announcements corresponding to firms without an options listing, while columns 4 and 5 report the number of earnings announcements for optioned firms with zero options trading volume and positive options trading volume, respectively, in the three days surrounding the earnings announcement. We note that for the total of 85,334 earnings announcements corresponding to firms with an options listing, 3,173, about 3.72%, had zero options trading volume in the three-day period surrounding the earnings announcement.

To illustrate the variation in liquidity of options trading in our sample, Figure 1 and Figure 2 graph the distributions of quarterly earnings announcements for optioned firms according to the average number of option contracts traded each day during the pre-announcement period, days -50 to -10, and the announcement period, days -1 to +1, respectively. Figure 1 shows that in the pre-announcement period, 45.49% of the sample had an average options trading volume of 100 or less contracts per day and only 11.56% of the sample had more than 2,000 contracts traded per day. Figure 2 reveals that during the announcement period, 36.80% of the sample had 100 or less contracts traded per day and 18.66% of the sample had more than 2,000 contracts traded per day. This pronounced dispersion in options trading volume indicates that the degree of options liquidity supporting informed traders acting on their private information varies greatly across firms with options listings. Thus, the conventional practice followed in prior studies of classifying firms merely

according to whether they have an options listing or not may not capture the marginal impact of options trading volume on the efficiency of stock prices to reflect earnings information.

Table 2 presents summary statistics for the dependent and independent variables used in this study. Panel A summarizes the full sample of optioned and non-optioned firms, while Panel B describes only optioned firms. The dependent variables are the buy-and-hold abnormal returns in the announcement period, BHAR[-1,+1]; the pre-announcement period, BHAR[-10,-2], and the post-announcement period, BHAR[+2,+60]. The descriptive statistics for each of these buy-and-hold returns vary little across the two panels. When statistics across the two panels describing the independent variables are compared, it is clear that optioned firms represented in Panel B are, on average, larger firms (SIZE), have higher institutional ownership (INSTOWN), and enjoy a larger analyst following (ANAFOL). Within Panel B, we observe large differences between mean and median values of options trading volume (OPTVOL), call options trading volume (CALLVOL), and put options trading volume (PUTVOL), indicating extreme positive skewness in the distribution of options trading volume. This was seen in Figure 1, which showed that over 80% of firms with an options listing had 1,000 or less contracts traded per day while the mean options trading volume (OPTVOL) reported in Panel B is 1,247 contracts traded per day. This highlights the fact that options trading volume for most firms is relatively light, while the bulk of options trading volume is concentrated in a minority of firms favoured by options traders.

Panel B of Table 2 also reveals that options trading activity is significantly heightened by earnings news, as manifested by a notable increase in average options trading volume around earnings announcements compared to the pre-announcement period. Options trading volume in the three days surrounding earnings announcements increases by 180% for total options trading volume (AB_OPTVOL), 178% for call options trading (AB_CALLVOL)

volume, and 226% for put options trading volume (AB_PUTVOL) compared to normal levels in the pre-announcement period.

Table 3 reports firm characteristics by options trading volume in the pre-announcement period, days -50 to -10. In preparing Table 3, we first sort stocks into quintiles according to their average daily options trading volume (OPTVOL) and then report average firm characteristics within each quintile. A Wilcoxon rank test is used to test hypotheses that each firm characteristic is equal between firms in quintile 1 and quintile 5. Table 3 reveals that high options trading volume firms in quintile 5 have higher SUE but lower absolute SUE values (|SUE|) compared to low options trading volume firms in quintile 1, and that both differences are statistically significant. This is consistent with the hypothesis in Ho (1993) that options trading is associated with smaller accounting earnings surprises.[22] Table 3 also reports that the average market capitalisation (SIZE) for firms in quintile 5 is almost 20 times larger than for firms in quintile 1. Firms in quintile 5 also have higher stock prices (PRICE), higher stock trading volume (STOCKVOL), higher institutional ownership (INSTOWN), and a larger analyst following (ANAFOL). Interestingly, both arbitrage risk (ARBRISK) and market risk (MRKRISK) are significantly higher for firms in quintile 5, perhaps because options traders prefer to trade in highly volatile and risky stocks. Overall, differences in firm characteristics reported in Table 3 suggest that the information environment for high options trading volume firms is richer than it is for low options trading volume firms.

4.2 The Effect of Options Trading Volume on the Magnitude of Stock Price Response to Earnings Information

[22] Given that options trading increases pre-disclosure information, Ho (1993) suggests that accounting earnings surprises of optioned firms should be less informative than those of non-optioned firms.

In this section, we first compare the magnitude of the stock price response to earnings information of optioned and non-optioned firms. We then differentiate price reactions across optioned firms according to their varying levels of options trading volume.

Table 4 reports the results of regressions based on the absolute stock price response to earnings announcements for the full sample of optioned and non-optioned firms, along with separate regressions for the sub-sample of optioned firms. The dependent variable is the absolute value of the three-day buy-and-hold abnormal return surrounding earnings announcements, as shown in equation (5), that is, |BHAR[-1,+1]|. The binary variable OPT is the first independent variable used only in the full-sample regression. This is equal to one for optioned firms and zero for non-optioned firms. For regressions using just the sub-sample of optioned firms, we run three separate regressions adding independent variables representing total options trading volume (OPTVOL), call options trading volume (CALLVOL), and put options trading volume (PUTVOL) in the pre-announcement period, days -50 to -10. Other independent variables common to all regressions are firm size (SIZE), arbitrage risk (ARBRISK), market risk (MRKRISK), stock price (PRICE), stock trading volume (STOCKVOL), institutional ownership (INSTOWN), and analyst following (ANAFOL). Due to the large sample size and potential bias in standard t-statistics (Bernard, 1987), we also compute Fama-MacBeth t-statistics (Fama and Macbeth, 1973). Essentially, this entails estimating cross-sectional regressions separately in each calendar quarter and forming time series for all coefficients from the quarterly estimates. We then divide the means of each coefficient series by their corresponding time-series standard deviations to obtain Fama-MacBeth t-statistics. Table 4 also reports the proportion of quarters, for which coefficients on OPT, OPTVOL, CALLVOL, and PUTVOL from the series of cross-sectional regressions are negative, and the corresponding *z*-statistics for binomial tests of significance.

In Column 1 of Table 4, the coefficient on the binary variable, OPT of -0.0007 indicates an insignificant difference in the absolute price response between optioned firms and non-optioned firms. This result differs from prior research where the presence of options trading was shown to either significantly decrease the stock price response to earnings information (Skinner, 1990; Ho, 1993) or significantly increase the stock price response to earnings information (Mendenhall and Fehrs, 1999).[23] At the bottom of column 1 of Table 4, the proportion of quarters for which the coefficient on the binary variable OPT is negative is 28/48, for which a binomial test indicates an insignificant difference from one-half.

In column 2 of Table 4, the coefficient on the options trading volume decile variable, OPTVOL of -0.0105 indicates that the immediate stock price response to earnings announcements for optioned firms in the highest options trading volume decile is on average 1.05% lower than for optioned firms in the lowest options trading volume decile. This is significant with a Fama-MacBeth t-statistic of -4.19. Thus, earnings surprise as proxied by stock return variability around earnings announcements is significantly lower for high options trading volume firms. This result is consistent with the result from Table 3 that the absolute accounting earnings surprise, |SUE|, is significantly lower for high options trading volume firms. When we distinguish between call and put options trading volume in columns 3 and 4, the coefficient on CALLVOL is -0.0118 with a Fama-MacBeth t-statistic of -6.69 and the coefficient on PUTVOL is -0.0054 with a Fama-MacBeth t-statistic of -2.50. The proportion of quarters with negative coefficients on OPTVOL, CALLVOL, and PUTVOL is 34/48, 40/48, and 33/48, respectively. The corresponding binomial *z*-statistics of 2.88, 4.61 and 2.60, respectively, confidently indicate that the proportion of quarters with negative coefficients are more than one-half. Thus, the reduced stock price response to earnings information associated

[23] Skinner (1990) and Mendenhall and Fehrs (1999) use |CAR(-1,0)| for their tests, while Ho (1993) uses a 'relative return variability' (RRV) for her tests (see also Patell, 1976). We repeat the test in column 1 of Table 4 by replacing |BHAR[-1,+1]| with the natural log of RRV (or with |CAR(-1,0)|) and inferences are not altered. The coefficient on OPT is -0.0023 (or -0.0051) with a Fama-MacBeth t-statistic of -0.532 (or -1.32).

with active options trading is predominantly attributable to call options trading. This result is not surprising since trading volume in call options is almost double the trading volume in put options in this sample. Table 4 also reveals that the control variables SIZE, PRICE, INSTOWN, and ANAFOL are significantly inversely related to the stock price response to earnings information, while ARBRISK, MRKRISK, and STOCKVOL are significantly positively related to the stock price response. These results accord with prior research.

Overall, the results in Table 4 demonstrate that for the full sample of optioned and non-optioned firms, the absolute price response to earnings information is not reduced for optioned firms relative to non-optioned firms. This appears to be a result of the fact that the sample of optioned firms is numerically dominated by firms with relatively light options trading volume which, on average, may be little different from firms without an options listing with regard to their price response to earnings information. By contrast, within the sub-sample of optioned firms segmented by options trading volume levels, we find that a significantly reduced stock price response is associated with high options trading volume firms compared to firms with low options trading volume. This association is more pronounced for firms segmented by call options trading volume and less pronounced for firms segmented by put options trading volume seemingly, because call options have higher trading volume than put options and so serve as a better proxy for liquidity.

4.3 The Effect of Options Trading Volume on the Earnings Response Coefficient

Following Bhushan (1994), Mendenhall and Fehrs (1999), and Bartov, Radhakrishnan and Krinsky (2000) we use interaction variables to test whether the earnings response coefficient is different between optioned firms and non-optioned firms and also across optioned firms stratified by options trading volume, while controlling for differences in firm characteristics. SUE, as specified in equation (4), is used to construct the interaction variables.

To evaluate how OPT, OPTVOL, CALLVOL, PUTVOL, and other explanatory variables might affect the magnitude of the earnings response coefficient, we use interaction variables to allow the slope of the SUE-abnormal return relationship to vary with each firm characteristic. Apart from OPT, which is a binary variable taking a value of one for optioned firms and zero for non-optioned firms, coding other explanatory variables by deciles incremented from 0 to 1, allows the coefficient on each interaction variable to be interpreted as the additional spread in earnings response coefficient between high and low SUE stocks for observations in the highest versus the lowest decile of each firm characteristic.

Table 5 reports the results of regressions of the stock price reaction to earnings announcements conditional on earnings surprise for the full sample of optioned and non-optioned firms, along with separate regressions for the sub-sample of optioned firms. The dependent variable is the stock price reaction measured by the three-day buy-and-hold abnormal return surrounding earnings announcements, that is, BHAR[-1,+1]. The primary independent variable in all regressions is SUE, while all other independent variables corresponding to options trading volume and firm characteristics are interacted with SUE.

In column 1 of Table 5, the earnings response coefficient on SUE of 0.0593 indicates that the abnormal return for the top earnings surprise decile is 5.93% higher than the abnormal return for the bottom earnings surprise decile after controlling SUE interactions with firm characteristics. The coefficient on SUE*OPT interaction is -0.0004 and insignificant, indicating that, after attempting to control for other variables related to an earnings response coefficient, there is no difference in earnings response coefficient between optioned firms and non-optioned firms when optioned firms are not stratified by options trading volume. In their cross-sectional test model with the most control variables (Model 1, Table 8), Mendenhall and Fehrs (1999) find that the interaction between earnings surprises and the optioned-firm binary variable is insignificant. Thus, the result in column 1 of Table 5

appears to be consistent with prior research that there is no reduced earnings response coefficient across the simple dichotomy of optioned firms versus non-optioned firms. Again, this appears to be because the sample of optioned firms is numerically dominated by firms with light options trading volume on average little differentiated from firms without an options listing with regard to their price response to earnings information.

However, within the sample of optioned firms segmented by options trading volume, column 2 of Table 5 reports a coefficient on SUE*OPTVOL interaction of -0.0137 which indicates an earnings response coefficient 1.37% lower for the top options trading volume decile as opposed to the bottom options trading volume decile after controlling for other explanatory variables. Both the standard t-statistic of -5.36 and the Fama-MacBeth t-statistic of -4.18 indicate a coefficient significantly different from zero. The quarterly series of coefficients on SUE*OPTVOL are negative in 39 of 48 quarters, for which the binomial *z*-statistic indicates a significant difference from one-half. The remaining results in Table 5 for call and put options trading volume interaction with SUE reinforce the finding that options trading volume accounts for a significant difference in earnings response coefficient between firms with high and low call and put options trading volume.

As discussed earlier, high options trading volume firms are expected to have greater information content impounded into their stock price before an earnings announcement, which would consequently reduce the contemporaneous stock price response to earnings announcements. This logic is consistent with the case that stock prices of high options trading volume firms anticipate and, therefore, pre-empt part of the information ultimately released in the earnings announcement. An extensive literature beginning with Ball and Brown (1968) shows that stock prices in the pre-announcement period exhibit patterns that are consistent with information subsequently released by earnings announcements. Amin and Lee (1997) find that options traders initiate a greater proportion of long (short) positions immediately

before good (bad) news. This implies that informed traders have already acted on their private information before an earnings announcement, and stock prices in the pre-announcement period reflect this anticipated information release. The next set of regression tests focus on the association between options trading volume and the extent to which stock prices anticipate earnings news in the pre-announcement period. We repeat the regressions in Table 5, replacing contemporaneous market reactions to earnings by pre-announcement abnormal stock returns. Table 6 presents the results of the regressions of the pre-announcement buy-and hold return BHAR[-10,-2] against the set of SUE interaction variables.[24]

Consistent with the insignificant result for the binary variable OPT in previous tables, the coefficient on SUE*OPT in column 1 in Table 6 is -0.0028 with an insignificant Fama-MacBeth t-statistic of -1.41. Thus, there is no evidence of earnings response pre-emption across the simple dichotomy of optioned firms versus non-optioned firms.

However, results reported in Table 6 for the sample of optioned firms stratified by options trading volume offer strong support for the pre-emption hypothesis. In column 2, the coefficient on SUE*OPTVOL is 0.0091 with a significant Fama-MacBeth t-statistic of 2.68. Thus, for comparable earnings surprises, the pre-announcement stock price reaction of the top options trading volume decile is significantly larger than that of the bottom options trading volume decile. Moreover, assuming that the total price reaction is equivalent for comparable earnings surprises after controlling for all factors that determine the price-earnings relationship, any reduction of a contemporaneous price reaction should be offset by a pre-announcement price reaction. Thus, a 0.91% incremental pre-announcement price reaction accounts for two-thirds of the 1.37% reduction in contemporaneous price reaction observed

[24] While the pre-emption of earnings news can occur during a longer window before an earnings announcement, it is expected that part of such trading activity on private information will occur a few days before and leading up to the earnings announcement. We, therefore, choose the window -10 to -2 to capture this anticipation trading.

for the top options trading volume decile, as previously shown in column 2 of Table 5. This indicates that the pre-announcement window from day -10 to day -2 does not capture all of the total stock price pre-emption, but it does capture a significant portion. Examining call options trading volume in column 3 and put options trading volume in column 4 of Table 6 also reveals that the stock prices of the top call and put options trading volume decile firms pre-empt more earnings information than those of the bottom call and put options trading volume decile firms. The incremental earnings response coefficient from the pre-announcement stock price is 1.21% and 0.78%, respectively for call and put options trading volume. The proportions of positive quarterly-estimated coefficients on SUE*OPTVOL, SUE*CALLVOL, and SUE*PUTVOL are 34/48, 36/48, and 33/48, respectively, and are all significantly greater than one-half.

4.4 Options Open Interest as an Alternative Measure to Options Trading Volume and the Magnitude of the Stock Price Response to Earnings Information

Another common measure of options market liquidity is options open interest. In this section, we replicate regression tests in Tables 4, 5, and 6 using options open interest as an alternative measure of options liquidity. For brevity, we present results using aggregate options open interest.[25]

Column 1 of Table 7 presents the results of regressing the absolute three-day buy-and-hold return |BHAR[-1,+1]| against options open interest (OPTINT) and other control variables. The coefficient on OPTINT is -0.0165 and the Fama-MacBeth t-statistic is -8.56. Quarterly-estimated coefficients on OPINT are negative in 47 of 48 quarters. Thus, the price response to earnings is 1.65% lower for firms in the top options open interest decile than for

[25] In tests not reported here, we use call option open interest and put option open interest independently and the results are in line with those obtained using total options open interest.

firms in the bottom options open interest decile. This result confirms results shown in Table 4 with an even stronger coefficient magnitude.

Column 2 of Table 7 presents the results from regressing the three-day buy-and hold return BHAR[-1,+1] on the interaction between SUE and OPTINT, and interactions between SUE and other control variables. The coefficient on SUE*OPTINT is -0.0122 and the Fama-MacBeth t-statistic is -4.65. Thus, the earnings response coefficient is 1.22% lower for the top options open interest decile firms than for the bottom options open interest decile firms. The quarterly-estimated coefficients are negative in 38 of 48 quarters. This result also confirms results reported in Table 5.

Finally, column 3 of Table 7 presents results from regressing the pre-announcement buy-and-hold return BHAR[-10,-2] against the interaction between SUE and OPTINT, and the interactions between SUE and other control variables. For this regression, the coefficient on SUE*OPTINT is 0.0071 with a Fama-MacBeth t-statistic of 2.21. Thus, there is evidence that more earnings information has already been incorporated into the pre-announcement stock price of high options open interest firms. This result supports results reported in Table 6.

Overall, the results reported in Table 7 where options open interest is used as an alternative to options trading volume accord well with results obtained using options trading volume. Both measures of options liquidity serve to verify the importance of options markets for promoting stock market efficiency.

4.5 The Effect of Abnormal Options Trading Volume Around Earnings Announcements on the Magnitude of the Stock Price Response to Earnings Information

Bernard and Thomas (1989, 1990) and Bhushan (1994) suggest that uninformed investors underestimate the implications current earnings have for future earnings, and therefore, under-react to earnings information, while informed investors react unbiasedly to earnings information. Thus, the trading activity of informed investors should move stock prices in the direction of the information contained in earnings news. Informed investors, however, will stop trading once stock prices are within threshold trading costs of the unbiased price. Mendenhall and Fehrs (1999) suggest that optioned firms should exhibit a more complete immediate price reaction to earnings than non-optioned firms because of reduced trading costs. Following Mendenhall and Fehrs' argument, we propose that if informed traders rely on cheaper-to-trade, higher-leverage options to exploit information in earnings announcements then higher (lower) abnormal options trading volume around earnings announcements should cause a greater (lesser) immediate stock price response. Abnormal options trading volume around earnings announcements should also more effectively capture informed investors' reactions to earnings information than a binary variable representing only an options listing versus no options listing.

For the sample of optioned firms, Table 8 reports the results of regressions similar to those in Table 5, but where the average options trading volume from day -50 to -10 is replaced by the average abnormal options trading volume over days -1 to +1 relative to the earnings announcement. In column 1 of Table 8, the coefficient on SUE*AB_OPTVOL of 0.0490 indicates that the earnings response coefficient is 4.90% higher for firms in the top decile of abnormal options trading volume versus firms in the bottom decile of abnormal options trading volume after controlling for other explanatory variables. The standard t-statistic is 28.89, the Fama-MacBeth t-statistic is 13.46, and the quarterly-estimated coefficients are positive in 48 of 48 total quarters. Splitting abnormal options trading volume into abnormal call options trading volume and abnormal put options trading volume in

columns 2 and 3 of Table 8 reveals a similar picture. The earnings response coefficient is incremented by 5.24% between top and bottom deciles for abnormal call options trading volume and by 1.32% between top and bottom deciles for abnormal put options trading volume. The quarterly-estimated coefficients on SUE*AB_CALLVOL are positive in 47 of 48 quarters and the coefficients on SUE*AB_PUTVOL are positive in 44 of 48 quarters. Both binomial *z*-statistics indicate significant differences from one-half. Results reported in Table 8 strongly support the hypothesis that abnormal trading activity in options markets on the days surrounding earnings announcements generates a greater earnings response coefficient. This is also consistent with the proposition in Mendenhall and Fehrs (1999), that when informed traders acting on earnings information take larger and less expensive positions in options markets, there is a larger and more complete immediate stock price response.

4.6 The Effect of Abnormal Options Trading Volume Around Earnings Announcements on the Magnitude of the Post-Earnings Announcement Drift

Abnormal options trading surrounding earnings announcements indicates that options traders take advantage of options markets to act on earnings information, thereby leading to speedier price discovery. If this assertion is correct, stock prices of firms with high abnormal options trading volume around earnings announcements should exhibit smaller post-earnings announcement drift.

Table 9 presents regressions of post-earnings announcement drift, that is, BHAR[+2,+60], against SUE interacting with abnormal options trading volume and other control variables. In column 1 of Table 9 we see that the coefficient on the interaction variable, SUE*OPT indicates no significant difference in post-earnings announcement drift between optioned and non-optioned firms. However, for the sample of optioned firms

stratified by abnormal options trading volume, coefficients on the interaction variables, SUE*AB_OPTVOL, SUE*AB_CALLVOL, and SUE*AB_PUTVOL are all significantly negative, indicating that within the sample of optioned firms, post-earnings announcement drift is smaller for earnings surprises associated with high abnormal options trading volume. Thus, abnormal trading in options markets around earnings announcements attenuates the post-announcement drift phenomenon. The coefficient on SUE*AB_OPTVOL of -0.0139 with a Fama-MacBeth t-statistic of -2.45 implies that the post-announcement drift spread is 1.39% smaller for firms in the top abnormal options trading volume decile than for firms in the bottom abnormal options trading volume decile.

5. Summary and Conclusions

We examine the effect of options trading on the stock price response to earnings announcements, extending prior studies by examining a more recent time period and a more comprehensive dataset. More importantly, our study is motivated by a methodological refinement using the level of options trading volume instead of a simple dichotomy between firms with listed options and firms without listed options as in prior research. We argue that any impact from options trading on the stock price response to earnings information should be most pronounced for stocks with high options trading volume since these options provide the most convenience to informed investors acting on private information. We find the refined approach of stratifying the sample of optioned firms according to options trading volume to be superior to an approach using only a binary variable representing an options listing versus no options listing.

We find no evidence of a difference in the immediate stock price response to earnings or in the earnings response coefficient between optioned firms and non-optioned firms when

optioned firms are not stratified by options trading volume. This indicates that previous mixed findings regarding the impact of options listing on stock price response to earnings does not extend to a more recent time period and an expanded sample. Further, we demonstrate that the measurable impact of options trading lies chiefly in the level of options trading volume. Controlling for other firm characteristics that might relate to the stock price response to earnings information, we find that high options trading volume firms manifest a smaller immediate price response and smaller earnings response coefficient than low options trading volume firms. This phenomenon is most pronounced when inferred from call options trading volume and less so from put options trading volume. This result is also consistent with the proposition that some earnings information has already been reflected in the stock prices of high options trading volume firms in the pre-announcement period.

Examining abnormal options trading volume around earnings announcements, we find that abnormal options trading volume generates higher immediate price reactions to earnings information. The impact is strong for both call and put options abnormal trading volume. This is consistent with the argument that informed trading in options markets enhances the efficient incorporation of earnings information into stock prices. We also find a significant relationship between abnormal options trading volume around earnings announcements and post-earnings announcement drift, indicating that high options trading volume attenuates the post-announcement drift.

Finally, this study demonstrates that research examining the economic value of options markets should consider expanding their research design to include the level of options trading activity in addition to the availability of options trading.

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Table 1. Sample Summary

Panel A: Number of Firms by Year

Year	Number of Firms	Firms without Options Listing	Firms with Options Listing	Optioned Firms with Zero Options Trading Volume
1996	4,360	2,609	1,751	38
1997	4,705	2,606	2,099	49
1998	4,787	2,443	2,344	46
1999	4,660	2,211	2,449	54
2000	4,444	2,170	2,274	84
2001	3,830	7,753	2,077	39
2002	3,646	1,569	2,077	43
2003	3,580	1,605	1,975	52
2004	3,885	1,774	2,111	19
2005	4,054	1,762	2,292	22
2006	4,107	1,664	2,443	16
2007	4,239	1,797	2,442	29
Total	50,297	23,963	26,334	491

Panel B: Number of Earnings Announcements by Year

Year	Number of Earnings Announcements	Non-optioned Firm Announcements	Optioned-Firm Announcements	
			Announcements with Zero Options Trading Volume	Announcements with Positive Options Trading Volume
1996	12,550	6,979	289	5,282
1997	13,444	6,855	337	6,252
1998	13,655	6,220	364	7,071
1999	13,579	5,702	517	7,360
2000	11,853	5,435	318	6,100
2001	11,287	4,721	236	6,330
2002	11,252	4,359	336	6,557
2003	11,093	4,544	220	6,329
2004	11,879	4,844	140	6,895
2005	12,806	5,086	157	7,563
2006	13,383	5,083	112	8,188
2007	17,638	9,257	147	8,234
Total	154,419	69,085	3,173	82,161

This table summarizes the sample for the period 1996-2007. Panel A lists the number of firms by year and Panel B lists the number of earnings announcements by year. Firms with an options listing are covered by IvyDB US OptionMetrics. Optioned firms with zero options trading volume have no options trading volume in the three days around all earnings announcements that year. Optioned firm announcements with zero options trading volume have no options trading volume in the three days around earnings announcements. Optioned firm announcements with positive options trading volume have non-zero options trading volume in the three days around earnings announcements.

Table 2. Descriptive Statistics

Panel A: Full Sample, 154,419 observations

	Mean	Std.Dev.	Quartile 1	Median	Quartile 3
BHAR[-1,+1]	0.0026	0.0892	-0.0347	0.0010	0.0396
BHAR[-10-2]	0.0055	0.2725	-0.1203	-0.0094	0.1034
BHAR[+2,+60]	-0.0028	0.2556	-0.1218	-0.0013	0.0963
SUE	-0.0008	0.0489	-0.0005	0.0004	0.0020
SIZE	3,882.71	16,460.26	187.27	571.20	1,924.08
ARBRISK	0.0252	0.0459	0.0060	0.0131	0.0289
MRKRISK	0.0423	8.6199	0.0004	0.0013	0.0038
PRICE	33.81	856.99	10.69	20.25	33.75
STOCKVOL	23,498.59	91,382.88	830.02	3,519.35	13,916.96
INSTOWN	0.46	0.31	0.20	0.48	0.71
ANAFOL	4.85	4.81	2.00	3.00	6.00

Panel B: Optioned Firm Sample, 85,334 observations

	Mean	Std.Dev.	Quartile 1	Median	Quartile 3
BHAR[-1,+1]	0.0023	0.0897	-0.0357	0.0017	0.0417
BHAR[-10-2]	0.0019	0.2510	-0.1182	-0.0083	0.1010
BHAR[+2,+60]	-0.0022	0.2381	-0.1167	-0.0013	0.0961
OPTVOL	1,247.93	5,093.29	40.90	136.89	558.73
CALLVOL	789.22	3,189.58	28.10	93.90	375.56
PUTVOL	458.72	1,987.93	9.96	38.35	176.09
AB_OPTVOL	1.80	20.25	-0.34	0.54	2.11
AB_CALLVOL	1.78	19.26	-0.44	0.42	2.01
AB_PUTVOL	2.26	16.58	-0.68	0.29	2.22
SUE	-0.0001	0.0441	-0.0001	0.0004	0.0018
SIZE	6,301.52	21,306.45	497.22	1,317.92	3,980.98
ARBRISK	0.0255	0.0449	0.0063	0.0135	0.0297
MRKRISK	0.0060	0.1410	0.0006	0.0017	0.0047
PRICE	29.96	22.67	14.22	25.19	39.95
STOCKVOL	37,046.87	115,135.59	3,724.26	9,721.43	28,086.10
INSTOWN	0.56	0.29	0.38	0.61	0.77
ANAFOL	6.69	5.45	3.00	5.00	9.00

This table presents sample descriptive statistics for the period 1996-2007. BHAR is the stock's buy-and-hold return minus the buy-and-hold return of the stock's size decile. OPTVOL, CALLVOL, and PUTVOL are average daily total, call, and put options trading volume on days -50 to -10 relative to the earnings announcement. AB_OPTVOL, AB_CALLVOL, and AB_PUTVOL are average abnormal total, call, and put options trading volume, measured as the percent difference of average daily announcement period volume on days -1 to +1 from average daily pre-announcement volume on days -50 to -10. SUE is actual earnings minus expected earnings proxied by analysts' median forecast in the 90-day period leading to the earnings announcement, scaled by the prior quarter's ending stock price. SIZE is the market value of equity ($ millions) at end of prior year. ARBRISK and MRKRISK are residual and explained variance from a regression of stock returns on S&P500 returns over 48 months prior to the earnings announcement. PRICE is the stock price 20 days prior to the earnings announcement. STOCKVOL is average daily dollar trading volume ($ thousands) on days -270 to -10 relative to the earnings announcement. INSTOWN is the fraction of the firm's shares held by institutions in the calendar quarter prior to the announcement. ANAFOL is the number of analysts providing quarterly earnings forecasts to IBES in the 90 days prior to the earnings announcement.

Table 3. Optioned Firm Characteristics across Pre-Announcement Period Options Trading Volume Quintiles, 1996-2007

	Optioned Firm Sample						
	Low	**Q2**	**Q3**	**Q4**	**High**	**High - Low**	**Wilcoxon p-value**
SUE	-0.0004	-0.0004	-0.0006	-0.0007	-0.0001	0.0003	0.002
|SUE|	0.0056	0.0052	0.0053	0.0053	0.0046	-0.0010	< 0.0001
SIZE	1,071.49	1,569.01	2,356.12	4,105.48	22,020.00	20,948.50	< 0.0001
ARBRISK	0.0195	0.0234	0.0277	0.0298	0.0267	0.0072	< 0.0001
MRKRISK	0.0041	0.0071	0.0048	0.0059	0.0065	0.0025	< 0.0001
PRICE	22.56	25.00	28.43	31.54	40.47	17.91	< 0.0001
STOCKVOL	3,992.81	7,222.18	12,741.49	25,119.15	137,276.74	133,283.92	< 0.0001
INSTOWN	0.5110	0.5432	0.5597	0.5799	0.5755	0.0645	< 0.0001
ANAFOL	3.79	4.80	5.76	7.33	11.36	7.57	< 0.0001

This table presents firm characteristics across quintiles based on average daily total options trading volume from the pre-announcement period days -50 to -10 relative to the earnings announcement. SUE is actual earnings less expected earnings proxied by analysts' median forecast prior to the earnings announcement, scaled by the prior quarter's ending stock price. SIZE is the market value of equity ($ millions) at end of prior year. ARBRISK and MRKRISK are residual and explained variance from a regression of stock returns on S&P500 returns over 48 months prior to the earnings announcement. STOCKVOL is average dollar stock trading volume on days -270 to -10 relative to the earnings announcement. PRICE is stock price 20 days prior to the earnings announcement. INSTOWN is the fraction of the firm's shares held by institutions in the calendar quarter prior to the announcement. ANAFOL is the number of analysts providing earnings forecasts to IBES prior to the announcement. Wilcoxon p-value indicates probability from a two-sample Wilcoxon rank test that the distribution of each firm characteristic is the same for the top quintile and bottom quintile based on pre-announcement period options trading volume. There are 85,334 observations for the optioned firm sample.

Table 4. Regressions of Absolute Three-Day Earnings Announcement Abnormal Returns |BHAR[-1.+1]| on a Binary Variable for Optioned Versus Non-optioned Firms, and Pre-Announcement Period Options Trading Volume, 1996-2007

	Full Sample	**Optioned Firm Sample**		
	Coeff. (1)	**Coeff. (2)**	**Coeff. (3)**	**Coeff. (4)**
Intercept	0.0345 (53.36/22.75**)	0.0345 (36.25/16.54**)	0.0345 (36.27/16.37**)	0.0345 (36.18/16.56**)
OPT	**-0.0007 (-1.45/-1.32)**			
OPTVOL		**-0.0105 (-7.52/-4.19**)**		
CALLVOL			**-0.0118 (-9.96/-6.69**)**	
PUTVOL				**-0.0054 (-4.42/-2.50*)**
SIZE	-0.0304 (-24.05/-15.98**)	-0.0221 (-14.62/-12.56**)	-0.0223 (-14.92/-12.98**)	-0.0218 (-14.58/-12.56**)
ARBRISK	0.0457 (60.88/26.85**)	0.0504 (45.36/17.85**)	0.0511 (47.08/18.26**)	0.0493 (45.66/17.25**)
MRKRISK	0.0094 (14.55/11.36**)	0.0096 (12.87/7.42**)	0.0098 (12.56/7.45**)	0.0100 (12.46/7.15**)
PRICE	-0.0101 (-12.56/-5.12**)	-0.0087 (-8.77/-3.56**)	-0.0091 (-9.05/-3.64**)	-0.0079 (-7.95/-3.45**)
STOCKVOL	0.0411 (31.72/19.89**)	0.0353 (18.56/12.09**)	0.0364 (19.19/13.82**)	0.0303 (16.56/10.86**)
INSTOWN	-0.0026 (-4.35/-1.89*)	-0.0013 (-1.91/-0.32)	-0.0016 (-2.26/-0.46)	-0.0009 (-1.46/-0.05)
ANAFOL	-0.0050 (-7.23/-5.32**)	-0.0017 (-5.69/-4.65**)	-0.0047 (-5.56/-4.53**)	-0.0047 (-5.66/-4.56**)
Adjusted R^2	0.98%	0.98%	0.99%	0.96%
Sample size	154,419	85,334	85,334	85,334
Qtrs. OPT < 0	28/48 (1.15)			
Qtrs. OPTVOL < 0		34/48 (2.88**)		
Qtrs. CALLVOL < 0			40/48 (4.61**)	
Qtrs. PUTVOL < 0				33/48 (2.60**)

This table presents four regressions of absolute three-day abnormal returns around earnings announcements, |BHAR[-1,+1]|, on a binary variable for optioned/non-optioned firms, and pre-announcement period options trading volume. Abnormal return is the stock's buy-and-hold return less the buy-and-hold return of the stock's size decile. OPT is a binary variable equal to 1 for an optioned firm and 0 for a non-optioned firm. OPTVOL, CALLVOL, and PUTVOL are average total, call, and put options trading volume on days -50 to -10 relative to the earnings announcement. SIZE is the percentile rank of the firm's market value of equity. ARBRISK and MRKRISK are residual and explained variance from a regression of stock returns on S&P500 returns over 48 months prior to the earnings announcement. STOCKVOL is average dollar stock trading volume on days -270 to -10 relative to the earnings announcement. PRICE is stock price 20 days prior to the earnings announcement. INSTOWN is the fraction of the firm's shares held by institutions prior to the announcement. ANAFOL is the number of analysts providing earnings forecasts to IBES prior to the announcement. Standard and Fama-Macbeth t-statistics in parentheses below regression coefficients. Binomial z-statistics in parentheses below fraction of negative quarterly coefficients. */** indicate significance with 95/99 percent confidence.

Table 5. Regressions of Cross-Sectional Differences in Announcement Period Earnings Response Coefficients between Optioned Firms and Non-optioned Firms, and between High Options Trading Volume Firms and Low Options Trading Volume Firms, 1996-2007

	Full Sample	**Optioned Firm Sample**		
	Coeff.	**Coeff.**	**Coeff.**	**Coeff.**
	(1)	**(2)**	**(3)**	**(4)**
Intercept	-0.0327	-0.0344	-0.0344	-0.0344
	(-77.23/-25.26**)	(-61.75/-22.46**)	(-61.77/-22.61**)	(-61.45/-22.48**)
SUE	0.0593	0.0605	0.0607	0.0604
	(37.68/17.38**)	(25.72/14.35**)	(25.78/14.50**)	(25.72/14.56**)
SUE*OPT	**-0.0004**			
	(-0.45/-0.05)			
SUE*OPTVOL		**-0.0137**		
		(-5.36/-4.18)**		
SUE*CALLVOL			**-0.0167**	
			(-5.78/-5.46)**	
SUE*PUTVOL				**-0.0089**
				(-4.18/-3.82)**
SUE*SIZE	-0.0053	0.0500	0.0052	0.0060
	(-1.90/-0.82)	(1.45/1.69)	(1.51/1.73)	(1.75/1.88)
SUE*ARBRISK	0.0084	0.0105	0.0114	0.0084
	(4.98/2.12**)	(4.21/2.60**)	(4.66/2.86**)	(3.44/2.14**)
SUE*MRKRISK	0.0026	0.0022	0.0021	0.0023
	(1.23/1.01)	(1.22/0.81)	(1.19/0.78)	(1.30/0.89)
SUE*PRICE	0.0064	0.0002	0.0003	0.0013
	(3.58/1.13)	(0.12/0.58)	(0.16/0.73)	(0.61/0.35)
SUE*STOCKVOL	0.0069	0.0031	0.0069	0.0044
	(2.46/2.01**)	(0.75/0.83)	(1.45/1.24)	(1.16/0.55)
SUE*INSTOWN	0.0168	0.0182	0.0179	0.0186
	(12.58/10.39**)	(11.13/9.92**)	(10.89/9.90**)	(11.37/10.25**)
SUE*ANAFOL	0.0057	0.0038	0.0038	0.0036
	(3.62/2.68**)	(1.96/1.17)	(1.98/1.15)	(1.86/1.12)
Adjusted R^2	0.68%	0.69%	0.69%	0.69%
Sample size	154,419	85,334	85,334	85,334
Qtrs. SUE*OPT < 0	26/48			
	(0.57)			
Qtrs. SUE*OPTVOL < 0		39/48		
		(4.33**)		
Qtrs. SUE*CALLVOL < 0			40/48	
			(4.61**)	
Qtrs. SUE*PUTVOL < 0				37/48
				(3.75**)

This table presents four regressions of three-day abnormal returns around earnings announcements, BHAR[-1,+1], on SUE and a SUE-interacting binary variable for optioned/non-optioned firms, and SUE-interacting pre-announcement period options trading volume. Abnormal return is the stock's buy-and-hold return less the buy-and-hold return of the stock's size decile. SUE is actual earnings less expected earnings proxied by analysts' median forecast prior to the earnings announcement, scaled by the prior quarter's ending stock price. OPT is a binary variable equal to 1 for an optioned firm and 0 for a non-optioned firm. OPTVOL, CALLVOL, and PUTVOL are average total, call, and put options trading volume on days -50 to -10 relative to the earnings announcement. SIZE is the percentile rank of the firm's market value of equity. ARBRISK and MRKRISK are residual and explained variance from a regression of stock returns on S&P500 returns over 48 months prior to the earnings announcement. STOCKVOL is average dollar stock trading volume on days -270 to -10 relative to the earnings announcement. PRICE is stock price 20 days prior to the earnings announcement. INSTOWN is the fraction of the firm's shares held by institutions prior to the announcement. ANAFOL is the number of analysts providing earnings forecasts to IBES prior to the announcement. Standard and Fama-Macbeth t-statistics in parentheses below regression coefficients. Binomial z-statistics in parentheses below fraction of negative quarterly coefficients. */** indicate significance with 95/99 percent confidence.

Table 6. Regression Results of Cross-Sectional Differences in the Pre-Announcement Period Earnings Response Coefficient between Optioned Firms and Non-optioned Firms and between High Options Trading Volume Firms and Low Options Trading Volume Firms, 1996-2007

	Full Sample	**Optioned Firm Sample**		
	Coeff.	**Coeff.**	**Coeff.**	**Coeff.**
	(1)	**(2)**	**(3)**	**(4)**
Intercept	-0.0078	-0.0066	-0.0066	-0.0066
	(-15.81/-5.66**)	(-10.46/-3.45**)	(-10.47/-3.45**)	(-10.44/-3.45**)
SUE	0.0154	0.0110	0.0111	0.0111
	(8.35/4.95**)	(6.13/4.23**)	(6.11/4.21**)	(6.16/4.32**)
SUE*OPT	**-0.0028**			
	(-1.66/-1.41)			
SUE*OPTVOL		**0.0091**		
		(3.89/2.68)**		
SUE*CALLVOL			**0.0121**	
			(4.75/3.63)**	
SUE*PUTVOL				**0.0078**
				(3.24/2.14*)
SUE*SIZE	-0.0149	-0.0082	-0.0082	-0.0081
	(-3.12/-2.59**)	(-2.09/-0.75)	(-2.08/-0.74)	(-2.06/-0.74)
SUE*ARBRISK	0.0162	0.0198	0.0199	0.0193
	(8.23/2.72**)	(6.98/2.53**)	(7.01/2.52**)	(6.72/2.53**)
SUE*MRKRISK	0.0038	0.0008	0.0001	0.0004
	(2.34/0.86)	(0.01/0.10)	(0.05/0.10)	(0.02/0.11)
SUE*PRICE	-0.0146	-0.0182	-0.0183	-0.0179
	(-6.47/-2.15*)	(-7.01/-2.22*)	(-7.05/-2.20*)	(-6.93/-2.22*)
SUE*STOCKVOL	0.0296	0.0308	0.0309	0.0291
	(6.30/2.15*)	(6.30/2.15*)	(6.25/2.18*)	(6.08/2.18*)
SUE*INSTOWN	0.0019	0.0032	0.0031	0.0034
	(1.25/1.34)	(2.73/2.30*)	(2.67/2.33*)	(2.82/2.34*)
SUE*ANAFOL	0.0005	-0.0027	-0.0027	-0.0027
	(0.27/0.04)	(-1.22/-0.24)	(-1.24/-0.22)	(-1.23/-0.22)
Adjusted R^2	0.84%	0.82%	0.81%	0.83%
Sample size	154,419	85,334	85,334	85,334
Qtrs. SUE*OPT > 0	21/48			
	(-0.86)			
Qtrs. SUE*OPTVOL > 0		34/48		
		(2.88**)		
Qtrs. SUE*CALLVOL > 0			36/48	
			(3.46**)	
Qtrs. SUE*PUTVOL > 0				33/48
				(2.59**)

This table presents four regressions of pre-announcement abnormal returns over days -10 to -2 relative to the earnings announcement, BHAR[-10,-2], on SUE and a SUE-interacting binary variable for optioned/non-optioned firms, and SUE-interacting pre-announcement period options trading volume. Abnormal return is the stock's buy-and-hold return less the buy-and-hold return of the stock's size decile. SUE is actual earnings less expected earnings proxied by analysts' median forecast prior to the earnings announcement, scaled by the prior quarter's ending stock price. OPT is a binary variable equal to 1 for an optioned firm and 0 for a non-optioned firm. OPTVOL, CALLVOL, and PUTVOL are average total, call, and put options trading volume on days -50 to -10 relative to the earnings announcement. SIZE is the percentile rank of the firm's market value of equity. ARBRISK and MRKRISK are residual and explained variance from a regression of stock returns on S&P500 returns over 48 months prior to the earnings announcement. STOCKVOL is average dollar stock trading volume on days -270 to -10 relative to the earnings announcement. PRICE is stock price 20 days prior to the earnings announcement. INSTOWN is the fraction of the firm's shares held by institutions prior to the announcement. ANAFOL is the number of analysts providing earnings forecasts to IBES prior to the announcement. Standard and Fama-Macbeth t-statistics in parentheses below regression coefficients. Binomial z-statistics in parentheses below fraction of positive quarterly coefficients. */** indicate significance with 95/99 percent confidence.

Table 7. Regressions Using Options Open Interest as an Alternative Liquidity Measure for Options Trading Volume, 1996-2007

	|BHAR[-1,+1]| Coeff.		**BHAR[-1,+1] Coeff.**		**BHAR[-10,-2] Coeff.**
Intercept	0.0364	Intercept	-0.0344	Intercept	-0.0067
	(37.65/16.71**)		(-61.79/-23.82)		(-10.82/-3.56)
		SUE	(0.0606	SUE	0.0118
			(25.82/14.05**)		(6.11/4.10**)
OPINT	**-0.0165**	**SUE*OPINT**	**-0.0122**	**SUE*OPINT**	**0.0071**
	(-14.72/-8.56)**		**(-6.37/-4.65**)**		**(2.86/2.21*)**
SIZE	-0.0212	SUE*SIZE	0.0068	SUE*SIZE	-0.0075
	(-14.29/-12.55)		(2.01/2.16*)		(-1.95/-0.88)
ARBRISK	0.0513	SUE*ARBRISK	0.0097	SUE*ARBRISK	0.0197
	(47.87/19.25**)		(4.05/2.63**)		(7.02/2.54*)
MRKRISK	0.0102	SUE*MRKRISK	0.0023	SUE*MRKRISK	0.0003
	(12.86/8.02**)		(1.32/0.85)		(0.14/0.04)
PRICE	-0.0410	SUE*PRICE	-0.0006	SUE*PRICE	-0.0199
	(-11.01/-4.22**)		(-0.26/-0.72)		(-7.48/-2.21*)
STOCKVOL	0.0410	SUE*STOCKVOL	0.0003	SUE*STOCKVOL	0.0327
	(23.75/15.45**)		(0.08/0.02)		(7.25/2.26*)
INSTOWN	-0.0016	SUE*INSTOWN	0.0187	SUE*INSTOWN	0.0035
	(-2.21/-0.56)		(11.48/10.82**)		(1.92/2.27*)
ANAFOL	-0.0045	SUE*ANAFOL	0.0039	SUE*ANAFOL	-0.0029
	(-5.46/-4.23**)		(2.36/1.32)		(-1.34/-0.58)
Adjusted R^2	0.98%	Adjusted R^2	0.68%	Adjusted R^2	0.86%
Sample size	85.334	Sample size	85.334	Sample size	85.334
Qtrs. OPINT < 0	47/48	Qtrs. SUE*OPINT < 0	38/48	Qtrs. SUE*OPINT > 0	33/48
	(6.63**)		(4.04**)		(2.59*)

This table presents regressions in Tables 4, 5, 6 substituting average options open interest for average options trading volume. Abnormal return is the stock's buy-and-hold return less the buy-and-hold return of the stock's size decile. SUE is actual earnings less expected earnings proxied by analysts' median forecast prior to the earnings announcement, scaled by the prior quarter's ending stock price. OPINT is average options open interest on days -50 to -10 relative to the earnings announcement. SIZE is the percentile rank of the firm's market value of equity. ARBRISK and MRKRISK are residual and explained variance from a regression of stock returns on S&P500 returns over 48 months prior to the earnings announcement. STOCKVOL is average dollar stock trading volume on days -270 to -10 relative to the earnings announcement. PRICE is stock price 20 days prior to the earnings announcement. INSTOWN is the fraction of the firm's shares held by institutions prior to the announcement. ANAFOL is the number of analysts providing earnings forecasts to IBES prior to the announcement. Standard and Fama-Macbeth t-statistics in parentheses below regression coefficients. Binomial z-statistics in parentheses below fraction of negative (positive) quarterly coefficients. */** indicate significance with 95/99 percent confidence.

Table 8. Regression Results of Cross-Sectional Differences in the Announcement Period Earnings Response Coefficient between High Abnormal Options Trading Volume Firms and Low Abnormal Options Trading Volume Firms, 1996-2007

	Optioned Firm Sample		
	Coeff. (1)	**Coeff. (2)**	**Coeff. (3)**
Intercept	-0.0322	-0.327	-0.0336
	(-56.63/(-23.71**)	(-57.21/-15.18**)	(-57.05/-15.47)
SUE	0.0409	0.0345	0.0571
	(16.71/8.41**)	(12.14/5.94**)	(17.26/8.35**)
SUE*AB_OPTVOL	**0.0490**		
	(28.89/13.46)**		
SUE*AB_CALLVOL		**0.0524**	
		(36.68/17.22)**	
SUE*AB_PUTVOL			**0.0132**
			(7.32/6.23)**
SUE*SIZE	0.0048	0.0051	0.0044
	(1.39/1.38)	(1.44/1.32)	(1.22/1.11)
SUE*ARBRISK	0.0005	0.0005	0.0022
	(0.31/0.24)	(0.03/0.26)	(0.89/0.58)
SUE*MRKRISK	0.0004	0.0044	0.0037
	(1.89/1.62)	(1.86/1.42)	(1.98/1.71)
SUE*PRICE	0.0009	0.0008	0.0038
	(0.52/0.42)	(0.47/0.44)	(1.65/1.23)
SUE*STOCKVOL	-0.0090	-0.0086	-0.0098
	(-2.72/1.78)	(-1.85/-1.24)	(-3.08/-1.81)
SUE*INSTOWN	0.0117	0.0115	0.0168
	(8.95/8.41**)	(8.75/8.72**)	(9.93/9.36**)
SUE*ANAFOL	0.0048	0.0046	0.0028
	(3.00/2.59*)	(2.86/1.35)	(1.44/1.09)
Adjusted R^2	8.00%	8.00%	8.00%
Sample size	85,334	85,334	85,334
Qtrs. SUE*AB_OPTVOL > 0	48/48		
	(6.92**)		
Qtrs. SUE*AB_CALLVOL > 0		47/48	
		(6.63**)	
Qtrs. SUE*AB_PUTVOL > 0			44/48
			(5.77**)

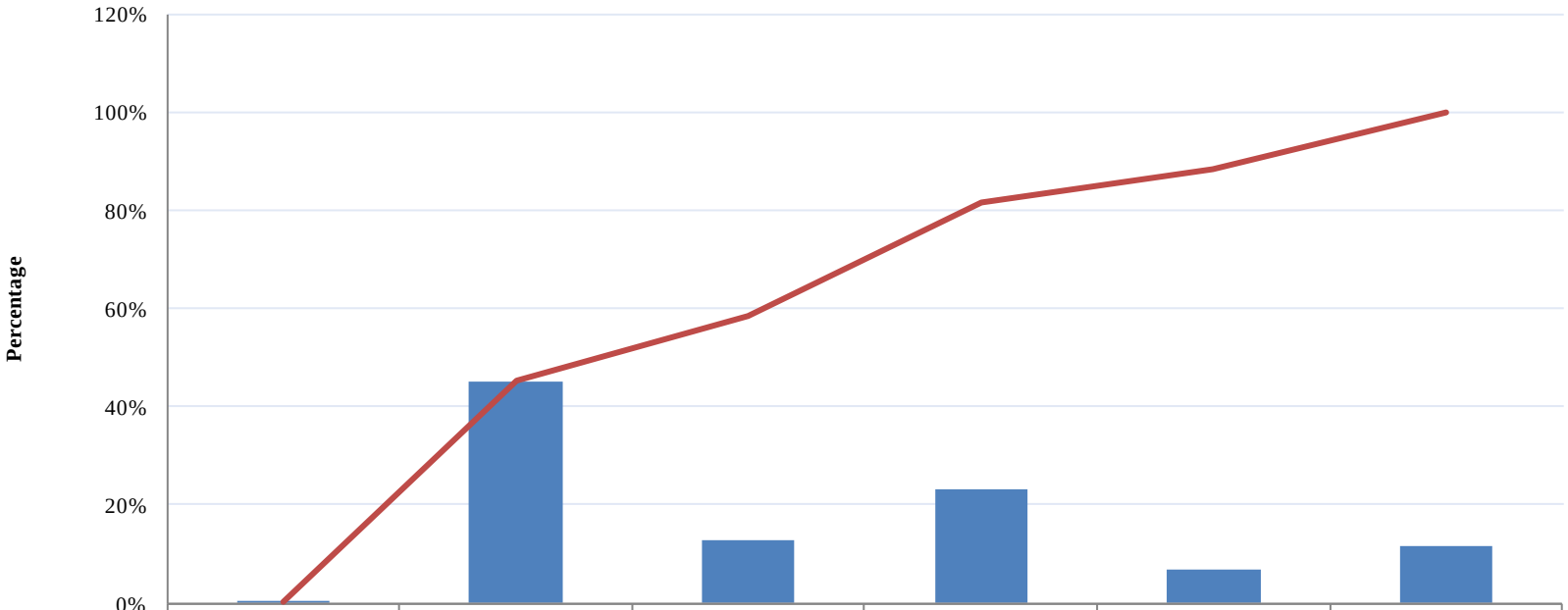
This table presents three regressions of three-day abnormal returns around earnings announcements, BHAR[-1,+1], on SUE-interacting announcement period abnormal options trading volume. Abnormal return is the stock's buy-and-hold return less the buy-and-hold return of the stock's size decile. SUE is actual earnings less expected earnings proxied by analysts' median forecast prior to the earnings announcement, scaled by the prior quarter's ending stock price. AB_OPTVOL, AB_CALLVOL, and AB_PUTVOL are average abnormal total, call, and put options trading volume, measured by the percent difference of average daily announcement period volume on days -1 to +1 from average daily pre-announcement volume on days -50 to -10. SIZE is the percentile rank of the firm's market value of equity. ARBRISK and MRKRISK are residual and explained variance from a regression of stock returns on S&P500 returns over 48 months prior to the earnings announcement. STOCKVOL is average dollar stock trading volume on days -270 to -10 relative to the earnings announcement. PRICE is stock price 20 days prior to the earnings announcement. INSTOWN is the fraction of the firm's shares held by institutions prior to the announcement. ANAFOL is the number of analysts providing earnings forecasts to IBES prior to the announcement. Standard and Fama-Macbeth t-statistics in parentheses below regression coefficients. Binomial z-statistics in parentheses below fraction of positive quarterly coefficients. */** indicate significance with 95/99 percent confidence.

Table 9. Regression Results of Cross-Sectional Differences in Post Earnings Announcement Drift between Optioned Firms and Non-Optioned Firms, and between High Abnormal Options Trading Volume Firms and Low Abnormal Options Trading Volume Firms, 1996-2007

	Full Sample	**Optioned Firm Sample**		
	Coeff. (1)	**Coeff. (2)**	**Coeff. (3)**	**Coeff. (4)**
Intercept	-0.0428	-0.0396	-0.0378	-0.0389
	(-27.16/-7.19**)	(-14.27/-4.99**)	(-14.39/(-4.69**)	(-14.79/-5.01**)
SUE	0.0586	0.0532	0.0528	0.0533
	(12.62/6.55**)	(9.64/5.50**)	(10.82/5.87**)	(8.99/5.73**)
SUE*OPT	**-0.0062**			
	(-1.62/-1.02)			
SUE*AB_OPTVOL		**-0.0139**		
		(-3.62/-2.45*)		
SUE*AB_CALLVOL			**-0.0191**	
			(-3.88/-2.69)**	
SUE*AB_PUTVOL				**-0.086**
				(-2.33/-1.84*)
SUE*SIZE	-0.0021	0.0110	0.0238	0.0090
	(-0.26/-0.76)	(1.18/0.83)	(1.35/0.89)	(1.00/0.81)
SUE*ARBRISK	0.0056	0.0040	0.0543	0.0040
	(3.01/2.08*)	(3.61/2.44*)	(3.21/2.01*)	(3.64/2.46*)
SUE*MRKRISK	0.0007	0.0087	0.0111	0.0070
	(0.17/0.56)	(1.69/1.33)	(1.16/0.90)	(1.49/1.23)
SUE*PRICE	0.0225	0.0069	0.0554	0.0079
	(2.31/0.42)	(1.11/0.03)	(1.02/0.05)	(1.26/0.01)
SUE*STOCKVOL	-0.0299	-0.0209	-0.0186	-0.0212
	(-2.51/-1.88*)	(-2.57/-1.21)	(-3.77/-1.30)	(-3.65/-1.16)
SUE*INSTOWN	0.0004	0.0045	-0.0065	0.0050
	(1.25/0.72)	(1.36/0.77)	(-0.73/-0.54)	(1.44/0.88)
SUE*ANAFOL	0.0010	0.0017	0.0072	0.0018
	(1.30/0.05)	(1.49/0.07)	(0.71/0.85)	(2.08/0.04)
Adjusted R^2	0.69%	0.47%	0.46%	0.48%
Sample size	154,419	85,334	85,334	85,334
Qtrs. OPT < 0	27/48			
	(0.86)			
Qtrs. SUE*AB_OPTVOL < 0		33/48		
		(2.59**)		
Qtrs. SUE*AB_CALLVOL < 0			34/48	
			(2.88**)	
Qtrs. SUE*AB_PUTVOL < 0				30/48
				(1.73*)

This table presents four regressions of post earnings announcement abnormal returns, BHAR[+2,+60], on SUE, a SUE-interacting binary variable for optioned/non-optioned firms, and SUE-interacting with announcement period abnormal options trading volume. Abnormal return is the stock's buy-and-hold return less the buy-and-hold return of the stock's size decile. SUE is actual earnings less expected earnings proxied by analysts' median forecast prior to the earnings announcement, scaled by the prior quarter's ending stock price. OPT is a binary variable equal to 1 for an optioned firm and 0 for a non-optioned firm. AB_OPTVOL, AB_CALLVOL, and AB_PUTVOL are average abnormal total, call, and put options trading volume, measured by the percent difference of average daily announcement period volume on days -1 to +1 from average daily pre-announcement volume on days -50 to -10. SIZE is the percentile rank of the firm's market value of equity. ARBRISK and MRKRISK are residual and explained variance from a regression of stock returns on S&P500 returns over 48 months prior to the earnings announcement. STOCKVOL is average dollar stock trading volume on days -270 to -10 relative to the earnings announcement. PRICE is stock price 20 days prior to the earnings announcement. INSTOWN is the fraction of the firm's shares held by institutions prior to the announcement. ANAFOL is the number of analysts providing earnings forecasts to IBES prior to the announcement. Standard and Fama-Macbeth t-statistics in parentheses below regression coefficients. Binomial z-statistics in parentheses below fraction of negative quarterly coefficients. */** indicate significance with 95/99 percent confidence.

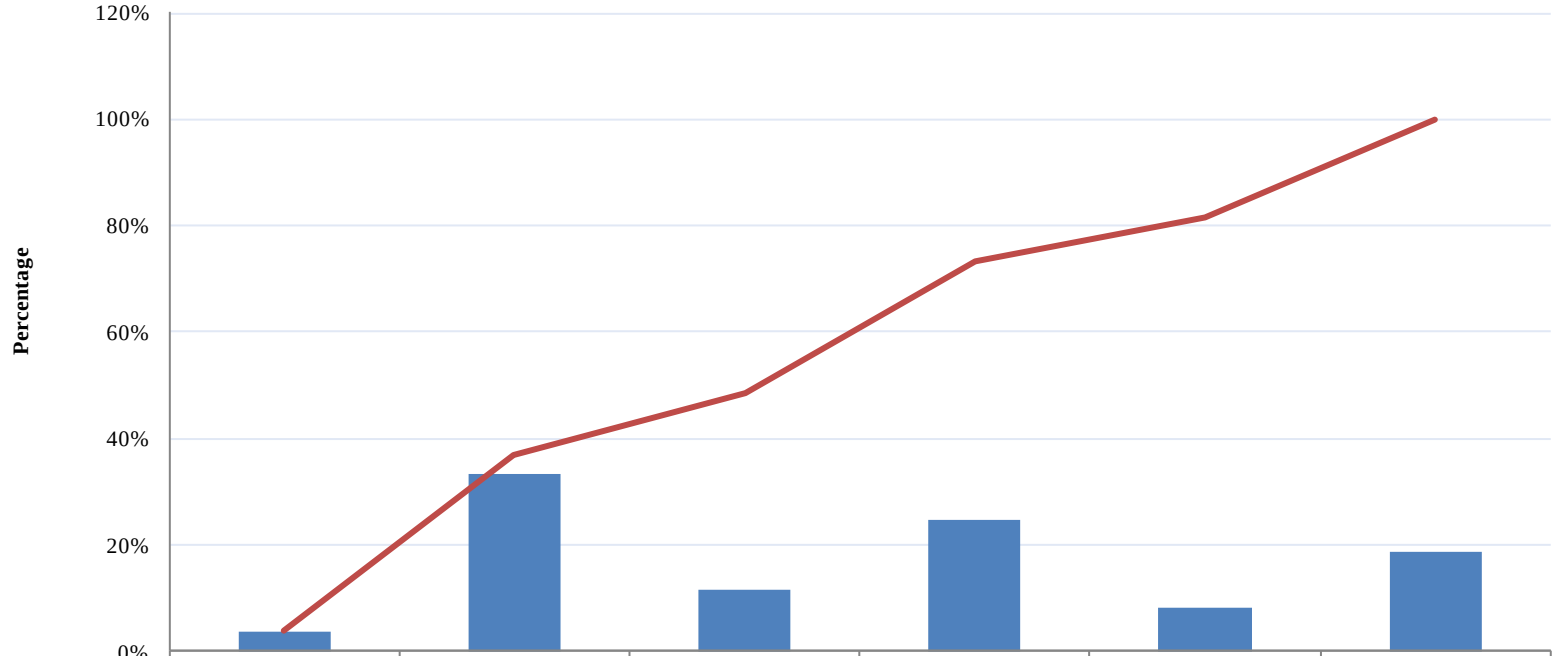
Figure 1: Distribution of Earnings Announcements for Options-listed Firms by Average Daily Options Trading Volume in the Pre-announcemenet Period [-50, -10]



	0	1-100	101-200	201-1000	1001-2000	>2000
Percentage	0.43%	45.06%	13.00%	23.20%	6.74%	11.56%
Cumulative percentage	0.43%	45.49%	58.50%	81.70%	88.44%	100.00%

Average Daily Trading Volume

Figure 2: Distribution of Earnings Announcements for Options-listed Firms by Average Daily Options Trading Volume in the Earnings Announcement Period [-1,+1]



	0	1-100	101-200	201-1000	1001-2000	>2000
Percentage	3.72%	33.08%	11.50%	24.77%	8.27%	18.66%
Cumulative percentage	3.72%	36.80%	48.30%	73.07%	81.34%	100.00%

Average Daily Trading Volume