Implied Volatility Spreads and Future Options Returns around Information Events and Conditions

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ABSTRACT

While numerous prior studies report that call–put implied volatility spreads positively predict future stock returns, recent literature shows that the predictive relation is negative for future call option returns. We investigate whether and, if so, how the predictive relation for options returns is influenced by various information events and conditions. In addition to confirming an opposite predictive relation for both call and put returns, we show that the predictive relation is stronger during periods of earnings announcement and/or high sentiment. In addition, we find that investors learn from informed trading and revise their predictability bias by examining the impacts of information asymmetry, stock liquidity, and options liquidity on the predictive relationships.

Keywords: Volatility spreads; Option returns; Earnings announcements; Investor sentiment; Investor learning

JEL Classification: G14

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1. INTRODUCTION

Several prior related studies provide strong support for the importance of derivatives implied information in the prediction of the price dynamics of the underlying asset. Particularly, some research shows that call–put implied volatility (CPIV) spreads can positively predict the returns of the underlying stocks (e.g., Bali and Hovakimian, 2009; Cremers and Weinbaum, 2010; Doran and Krieger, 2010; An, Ang, Bali and Cakici, 2014). These findings are consistent with the argument that, based on the advantages of low transaction and high leverage levels, informed traders may initiate the realization of their privileged information in the options markets (Manaster and Rendleman, 1982; Back, 1993; Sheikh and Ronn, 1994; Easley, O'Hara, and Srinivas, 1998; Cao, 1999; Pan and Poteshman, 2006). Moreover, Atilgan (2014) and Chan, Ge, and Lin (2015) find that the predictability of stock returns made by CPIV is stronger during earnings announcement and merger and acquisition (M&A) announcement events. They indicate that the trading activity of informed traders is an important driver of CPIV and hence the predictability of stock returns is more pronounced during corporate events.

Doran, Fodor, and Jiang (2013) recently find that CPIV is negatively, rather than positively, related to the future returns of call options, particularly for out-of-the-money (OTM) contracts. In line with Mahani and Poteshman (2008), Goyal and Saretto (2009), and An et al. (2014), they argue that options demand from the mispricing attributable to individual investors drives this negative relation. Because most studies in the existent literature discussing the predictability of

CPIV with corporate events focus on the stock return (Atilgan, 2014; Lei, Wang and Yan, 2017), we therefore aim to fill this gap by investigating how earnings announcement affects the predictive relation between the CPIV and future options returns.

Prior studies find evidence of more aggressive trading activity and/or higher trading volume around earnings announcement (Kandel and Pearson, 1995; Amin and Lee, 1997; Choy and Wei, 2012; Choy 2015). However, whether this change represents useful information for prediction or is merely a reflection of divergent opinions among traders remains an open question. While one stream of literature argues that earnings announcements are informationally intensive events (Beaver, 1968; Ball and Brown, 1968; Battalio and Mendenhall, 2005; Diavatopoulos, Doran, Fodor and Peterso, 2012), the other stream suggests that trading around earnings announcement is due to difference in invests' opinions (Harris and Raviv, 1993; Kim and Verrecchia, 1994).[1]

In addition to examining the effect of earnings announcement on the predictive relation between the CPIV and future options returns, we also investigate the power of prediction in relation to investor sentiment. Numerous studies find that investor sentiment contains a market-wide component that has a direct effect on the prices of both stocks and options[2] and that investor

[1] In particular, Mahani and Poteshman (2008) find that unsophisticated investors in the options market overreact to past news on the underlying stocks and tend to believe that the stock prices would move away from their fundamental values on the release of earnings announcement news.

[2] Baker and Wurgler (2006) provide evidence that this market-wide sentiment was related to differences in the characteristics of cross-sectional stock returns. Several studies further show that sentiment-driven investors lead prices to deviate from their fundamental value in the options markets (see Figlewski, 1989; Figlewski and Green, 1999; Han, 2008; Lemmon and Ni, 2010; Ofek, Richardson and Whitelaw, 2004).

misreaction is dependent on investor sentiment.[3] As such, investor sentiment may affect the beliefs of investors and thus the evaluation of assets.[4] Consequently, the likelihood of investor misreaction increases during periods of high sentiment, leading to investors trading more often and more aggressively. Thus, if mispricing drives the predictive relation in the options market, we would expect mispricing to become stronger during periods of high sentiment.

We further examine whether investors learn from informed trading and mitigate their predictability bias in the options markets. Prior studies report that investors do, in fact, learn in the financial markets (Daniel, Hirshleifer, and Subrahmanyam, 1998; Gervais and Odean, 2001; Nicolosi, Peng, and Zhu, 2009; Seru, Shumway, and Stoffman, 2010). Specifically, we investigate whether the predictive relation is weaker during periods of high information asymmetry, low stock liquidity, and high options liquidity. Easley et al. (1998) show that informed investors are more likely to trade in options under these conditions. If the investors learn from informed traders and adjust their trading behavior, then we would expect to find the predictive relation to become weaker during periods when informed investors participate more aggressively in the options market.

We report several key findings supported by the empirical studies based on all US listed stocks and options. First, earnings announcements have a significant influence on the

[3] Yu and Yuan (2011) indicate the existence of a positive mean-variance relationship in low-sentiment periods, while Chung, Hung and Yeh (2012) note that the return predictability of sentiment was more pronounced in an expansion state. Stambaugh, Yu, and Yuan (2012) find a broad set of anomalies in cross-sectional stock returns, which they show are stronger following periods of high investor sentiment levels.

[4] See, for example, De Long, Shleifer, Summers, and Waldmann (1990), Lee, Shleifer, and Thaler (1991), and Kumar and Lee (2006).

predictability of the options returns indicated by CPIV. The negative (positive) relation between CPIV and future call (put) options returns is stronger when it coincides with an earnings announcement event. This finding is consistent with the findings of Choy and Wei (2012) and Choy (2015). Second, we find that an increase in investor sentiment strengthens the negative (positive) relation between CPIV and the future returns of call (put) options. This result is in line with extant behavioral theories that suggest that investors tend to form incorrect beliefs, causing them misevaluate their assets, especially during periods of high investor sentiment. Finally, we find that lower stock liquidity, higher options liquidity, and higher information asymmetry in the stock market weakens the negative (positive) relation between CPIV and the future returns of call (put) options. This result is consistent with prior research that shows that investors engage in learning behavior and hence improve their trading ability.

To the best of our knowledge, this paper is the first study to investigate the predictability of CPIV on options returns around information events and conditions. Doran et al. (2013) is most relevant to this study. In addition to confirming the negative predictive relation between CPIV and future returns of call options, our investigation, also investigating the predictive relation between CPIV and future returns of put options, adds to the literature in several aspects. First, we examine the effect of earnings announcement on the predictive relation. Second, we show how the predictive relationship changes with investor sentiment. Finally, we find that investors learn from informed trading and thus adjust the prediction bias.

The remainder of this paper is organized as follows. Section 2 develops our hypothesis. Section 3 describes the data. Section 4 explains the empirical methodology. Section 5 provides and discusses the empirical results. Finally, Section 6 offers some conclusions.

2. HYPOTHESIS DEVELOPMENT

Whether the trading activity around earnings announcement contains useful information or is a result of divergent opinions is still an open question. Amin and Lee (1997) identify a tendency for trading activity to increase prior to earnings announcements in the options market but not in the market of the underlying stock. Although the options market provides a more effective channel for investors to realize their beliefs or privileged information, the question is whether noise traders who believe themselves to be informed or actual informed traders drive the increase in trading activity.

Choy and Wei (2012) find increased participation by individual investors in the options market around earnings announcement periods. Choy (2015) show behavior biases among individual investors in the options market and report that such biases are more pronounced prior to earnings announcement periods. Mahani and Poteshman (2008) also find that unsophisticated option investors tend to overreact to prior news on the stock market and that the mispriced stock price moves further away from the fundamental value once the scheduled news is released. Consequently, individual investors are likely to play an important role in the options market during such earnings announcement periods.

Manaster and Rendleman (1982) and Sheikh and Ronn (1994) report that investors tend to trade on their information in the options market prior to trading in the market of the underlying stock. In line with these studies, Atilgan (2014) finds that stocks with higher implied volatility spread (defined as the implied puts minus calls) earn significantly negative stock returns. However, Doran et al. (2013) find that this relation does not hold in the options market; instead, they find a negative predictive relation from CPIV to call option returns. They posit that options mispricing by individual investors drives the negative relation. In other words, trading by individual investors leads to the mispricing of options, with the options prices subsequently reverting. Consequently, CPIV can predict contrary returns for call options.

In sum, prior studies have not reached a consensus on whether and, if so, how earnings announcements affect the relation between CPIV and future options returns. We therefore state our first hypothesis:

Hypothesis 1a: *Due to the effect of noise trading, the ability of CPIV to negatively (positively) predict call (put) option returns is more pronounced around earnings announcement periods.*

Hypothesis 1b: *Due to the effect of informed trading, the ability of CPIV to negatively (positively) predict call (put) option returns is less pronounced around earnings announcement periods.*

Previous research shows that misreaction is clearly discernible in the options market (Stein, 1989; Poteshman, 2001; Chao, Li, and Yu, 2005; Mahani and Poteshman, 2008). Indeed, Chang,

Hsieh, and Wang (2015) find that misreaction tends to be more severe during periods of high investor sentiment. Other related studies report that sentiment-driven investors can cause prices to deviate from their fundamental values in both the stock (Brown and Cliff, 2005; Coval and Shumway, 2005; Kumar and Lee, 2006; Lemmon and Portniaguina, 2006; Baker and Wurgler, 2006, 2007; Yu and Yuan, 2011; Stambaugh et al., 2012) and options (Figlewski, 1989; Figlewski and Green, 1999; Ofek et al., 2004; Han, 2008; Lemmon and Ni, 2010) markets.

Doran et al. (2013) suggest that mispricing attributable to individual investors causes the negative relation between CPIV and future call options returns. Investors' behavior bias is associated with both their beliefs and their sentiment. Mian and Sankaraguruswamy (2012) demonstrate that market-wide investor sentiment affects the sensitivity of stock prices to earnings news. They conclude that the sentiment-driven mispricing of earnings contributes to the general mispricing of stocks due to investor sentiment. We therefore posit that investor sentiment is an important influence on the relation between CPIV and future options returns. In addition, we examine whether the effect of earnings announcements on the predictive relation is stronger during periods of high investor sentiment. We expect that the sentiment effect is similarly applicable to put options, which leads on to our second hypothesis:

Hypothesis 2a: *The ability of CPIV to negatively (positively) predict call (put) option returns is more pronounced during periods of high investor sentiment.*

Hypothesis 2b: *The impact of earnings announcements on the ability of CPIV to negatively (positively) predict call (put) option returns is stronger during*

periods of high investor sentiment.

Easley et al. (1998) demonstrate that when stock liquidity is low, options liquidity is high, or information asymmetry is high in the stock market, informed investors are more likely to try to take advantage of their private information within the options market. Therefore, the number of informed investors trading in the options market is likely to increase when any one of these three condition exists. Given that Doran et al. (2013) find that mispricing attributable to the demand of individual investors drives the ability of CPIV to negatively predict call option returns, we posit that this negative relation is weakened under any of these three market conditions.

Several studies indicate that trading experience helps to improve individual investors' predictability ability and hence reduces their behavior bias. Choy and Wei (2012) and Choy (2015) report that greater numbers of individual investors trade in the options market during earnings announcement periods. In addition, Battalio and Mendenhall (2005) and Atilgan (2014) find that earnings announcements contain information and that informed traders take advantage of their private information prior to the announcement. The question, then, is whether investors learn and adjust their beliefs from informed trading.

We also examine whether the effect of earnings announcements on the predictive relation is discernibly reduced under certain market conditions: namely, when stock liquidity is low, information asymmetry in the stock market is high, or options liquidity is high. We conjecture

that investors learn from informed trading and thus mitigate the mispricing that results in the predictive relation. We also expect that the effects of these relations are similarly applicable to put options. Accordingly, we propose our third hypothesis:

Hypothesis 3a: *The prediction of CPIV for call (put) option returns is less negative (positive) when information asymmetry in the stock market is high, stock liquidity is low, or options liquidity is high.*

Hypothesis 3b: *The impact of earnings announcement on CPIV's ability to predict call (put) option returns is less negative (positive) when information asymmetry in the stock market is high, stock liquidity is low, or options liquidity is high.*

3. DATA

Our primary data set comprises the daily transaction details of all options and optioned stocks traded in the US exchanges. The sample period is from January 1996 to December 2010. Following the general practice within the literature, we exclude financial and utility firms (those with CRSP share codes other than 10 or 11). We obtain data on stock options and their underlying stocks from OptionMetrics and CRSP, respectively. Accounting information, including earnings announcement dates and book values of the announcing firms, is also obtained from Compustat.[5] Table 1 reports the total number of earnings announcement events and corresponding firms. Both number of events and firms show an increasing trend over time;

[5] We use the quarterly earnings announcement dates from Compustat.

the total number of events (firms) increased from 93 (87) in 1996 to 812 (479) in 2010.

<TABLE 1 ABOUT HERE>

The stock data include daily prices, returns, volume, and outstanding shares; the stock options traded in the US market are all American-style options. The options data include daily closing bid and ask quotes, implied volatilities, and deltas. Following Doran et al. (2013), we define moneyness as the strike price over the stock price (K/S) and use the range of 0.95 to 1.05 to group the moneyness of options. In specific terms, $0.95 \leq K/S \leq 1.05$ is at-the-money (ATM) for both call and put options, $K/S > 1.05$ is OTM for calls, and $K/S < 0.95$ is OTM for puts.

Following Atilgan (2014), we exclude options that meet any of the following conditions: (i) prices violate the no-arbitrage condition; (ii) the midpoints are less than or equal to 0.125; (iii) maturities are not within 10–60 days; (iv) implied volatilities are not between 3 percent and 120 percent; (v) open interest is non-positive; or (vi) details are missing for the volume of trading. Transactions are also required for all four option moneyness categories (ATM call/put and OTM call/put) for a stock on any particular day.

The implied volatilities of a put option and a call option with the same strike price and expiration date should essentially be equal; therefore, the difference between the implied volatilities of a matched pair of put and call options, which is referred to as the *implied volatility*

spread, can be used to proxy for the price pressure in the options market.[6] Following Cremers and Weinbaum (2010), we compute the weighted average volatility spread for stock *i* on day *t* as

$$CPIV_{it} = \sum_{j=1}^{N_{it}} w_{jt}\left(IVcall_{jt} - IVput_{jt}\right), \quad (1)$$

where *j* represents the *j*th matched pair of put and call options with the same strike price and expiration date on stock *i*; N_{it} represents the number of valid option pairs for stock *i* on day *t*; $IVcall_{jt}$ ($IVput_{jt}$) is the implied volatility of the call (put) option in the *j*th pair of options *j*; and w_{jt} are the weights computed based on the average open interest of the *j*th pair of call and put options.

This study adopts two investor sentiment measures to facilitate the investigation into the influence of investor sentiment on the relation between CPIV and future option returns: Baker and Wurgler sentiment (BW sentiment) index and the University of Michigan consumer sentiment (UOM sentiment) index, which are obtained from the Wurgler website and the Federal Reserve Economic Data database, respectively.

Easley et al. (1998) show that the probability of informed trading (PIN) can capture informed trading within the market. We use an updated version of the PIN as a proxy for information asymmetry.[7] We also create an information asymmetry measure (ASY index), as proposed by Drobetz et al. (2010). See Drobetz et al. for a more detailed discussion of the

[6] The implied volatilities are adjusted for expected dividends and early exercise.
[7] The updated PIN is obtained from Stephen Brown's website: http://scholar.rhsmith.umd.edu/sbrown/pin-data.

process.

We use Amihud's (2002) illiquidity and Pastor and Stambaugh's (2003) liquidity (PS liquidity) measures to assess stock liquidity.[8] We follow Atilgan (2014) to measure option liquidity by option volume and option bid–ask spread. Table 2 provides the descriptive statistics of CPIV and the other variables, including the means, medians, standard deviations, and the 10%, 50% and 90% percentiles.

<TABLE 2 ABOUT HERE>

4. EMPIRICAL METHOD

We adopt two frameworks to examine the effect of a particular factor on the predictive relation between CPIV and option returns. First, based on our full sample, we run a regression model with a dummy variable to examine the impact of earnings announcements, investor sentiment, information asymmetry, stock liquidity, and options liquidity on the predictive relation. Second, based on our sample of observations around earnings announcement periods, we run a regression model for various samples grouped by the levels of investor sentiment, information asymmetry, stock liquidity, or options liquidity to examine the joint effects of earnings announcements and any of the other factors on the predictive relation.

4.1 Full-Sample Method

To investigate the impact of earnings announcements, investor sentiment, information

[8] The Amihud illiquidity and PS liquidity measures are obtained, respectively, from the websites of Hasbrouck (http://people.stern.nyu.edu/jhasbrou/) and Stambaugh (http://finance.wharton.upenn.edu/~stambaug/).

asymmetry, stock liquidity, and options liquidity on the ability of CPIV to predict call and put options returns. We calculate buy-and-hold option returns over days [t, t+1] and option returns by purchasing options at the ask price and selling at the bid price. However, most trades are transacted near the midpoint price, we therefore follow Diavatopoulos, Doran, Fodor and Peterson (2012) and thus weight option returns by mid-point prices.[9] We modify the regression model adopted by Doran et al. (2013) as

$$R^{O}_{i,t+1} = a_0 + \beta_1 CPIV_{i,t} + \beta_2 D_{i,t} + \beta_3 CPIV_{i,t} \times D_{i,t}$$
$$+\beta_4 IV_{i,t} + \beta_5 MOM_{i,t} + \beta_6 BM_{i,t} + \beta_7 ME_{i,t} + \varepsilon_{i,t} \quad (2)$$

where $R^{O}_{i,t+1}$ is defined as the buy-and-hold option/stock return over period [*t*, *t*+1] and $D_{i,t}$ is a dummy variable that equals 1 if time *t* is the earnings announcement date or if time *t* is characterized by high sentiment, high information asymmetry, low stock liquidity, or high options liquidity for stock *i*.

We follow Doran et al. (2013) to control for the effects of market equity (*ME*) in billions, book-to-market equity (*BM*), momentum (*MOM*) and implied volatility (*IV*) on option returns. Specifically, $ME_{i,t}$ is the number of shares outstanding multiplied by the stock price at the end of the month; $BM_{i,t}$ is the book equity at the end of the prior fiscal year over market equity; $MOM_{i,t}$ is defined as the buy-and-hold stock returns over the past 12-month period; and $IV_{i,t}$ is computed as the moneyness-weighted mean of the implied volatilities of all options on the first day of the month

[9] Because of the look-ahead bias, we compute option returns only when the option prices are available for both day t and day *t*+1.

of the CPIV measurement.

4.2 Earnings Announcement Sample Method

Following Atilgan (2014), we set the earnings announcement date as time 0, and CPIV is measured as time -1. We then calculate buy-and-hold option/stock returns for the earnings announcement window over the time period [0, 1]. For our examination of the return predictability made by CPIV during the earnings announcement periods, we drop the dummy variable and its interaction term with CPIV from Equation (2):

$$R^{O}_{i,t+1} = a_0 + \beta_1 CPIV_{i,t} + \beta_4 IV_{i,t} + \beta_5 MOM_{i,t} + \beta_6 BM_{i,t} + \beta_7 ME_{i,t} + \varepsilon_{i,t}. \quad (3)$$

For our investigation of the ways in which investor sentiment, information asymmetry, stock liquidity, and options liquidity affect the role of earnings announcement on the predicative relation between CPIV and the option/stock returns, we run the regression model for subsamples grouped by the levels of investor sentiment, information asymmetry, stock liquidity, and option liquidity. Specifically, we divide the sample into three groups—low (<33%), mid (33-67%) and high (>67%)—based on investor sentiment, information asymmetry, stock liquidity. or option liquidity, respectively. We then run the regression model with panel data for the returns of the stocks or options across various categories of moneyness-maturity.

5. EMPIRICAL RESULTS

5.1 Earnings Announcements

Prior to formally testing for the impact of earnings announcements on the predictability of option

returns from CPIV, we use the sample around earnings announcement periods to provide some preliminary evidence on the relation between CPIV and option returns as reported by Doran et al. (2013).

Following Atilgan (2014), we set the earnings announcement date as day 0 and then sort the stocks into five quintiles based on CPIV measured on day –1. We subsequently calculate the buy-and-hold option returns for the earnings announcement window over the period [0, 1] for each group of firms across various moneyness categories for call and put options. We follow the same procedure for stocks.

Table 3 reports CPIV mean levels and the average stock and option returns for all categories. The average call (put) option return for the highest CPIV group is significantly lower (higher) than that of the lowest CPIV group at the 10 percent (5 percent) level. The results are not dependent on whether ATM or OTM contracts are considered. The average stock return with the highest CPIV is larger than that with the lowest CPIV, although the difference is not statistically significant. Overall, these preliminary results are in line with the findings of Doran et al. (2013) and Atilgan (2014) for the stock options market, respectively.

<TABLE 3 ABOUT HERE>

To test the effects of earnings announcements, we use the regression model in Equation (2) with *t*-statistics based on robust standard errors clustered by firm. Table 4 shows that earnings announcements weaken the positive predictive relation between CPIV and future

stock returns. Conversely, earnings announcements strengthen the negative predictive relation between CPIV and future option returns. Specifically, for both ATM and OTM calls (puts), the regression coefficients of both CPIV and its interaction term with the event day are negatively (positively) significant at the 1 percent level.

<TABLE 4 ABOUT HERE>

The results in Table 4 are consistent with the contrary predictive relation reported by Doran et al. (2013). In addition, our results suggest that the contrary predictive relation becomes stronger around earnings announcements, which are driven by the mispricing caused by the greater involvement of individual investors during these periods (Choy and Wei, 2012; Choy, 2015). In contrast, the involvement of more individual investors around periods of earnings announcement leads to the positive predictive relation in the stock market to become negative; the sum of the coefficient on CPIV and the interaction term is –0.0055.

In sum, the results from our preliminary and formal tests both support Hypothesis 1a: The ability of CPIV to predict option returns increases. This finding reflects the mispricing driven by the demand from individual investors (Doran et al., 2013) and the tendency for greater numbers of individual investors to participate in the markets around earnings announcement periods (Choy and Wei, 2012; Choy, 2015). In addition, the positive predictability in the stock market disappears during earnings announcement periods.[10]

[10] We also run a regression of earnings announcement stock/option returns on CPIV. The dependent variable is the [0, 1] return around the earnings announcement date (day 0). We include the same control variables (ME, BM,

5.2 Investor Sentiment

We use two measures of investor sentiment, BW and UOM, to investigate the impact of investor sentiment on the ability of CPIV to predict option returns. To examine whether the contrary predictive relation is more pronounced during a regime of high investor sentiment, we run the regression model specified in Equation (2). The dummy variable equals 1 if the sentiment level is ranked in the top 20 percent, and zero otherwise. The *t*-statistics are based on robust standard errors clustered by firm. Table 5 provides the estimation results of the regression model across various asset and moneyness categories.

<TABLE 5 ABOUT HERE>

Panel A of Table 5 shows that the coefficient on the interaction term of CPIV and BW sentiment is negatively significant at the 10 percent level for ATM call options and at the 5 percent level for OTM call options. Although the coefficient is statistically insignificant for put options, the signs for both the ATM and OTM contracts are consistent with the expectations of Hypothesis 2a. That is, when investor sentiment is high, the contrary predictive relation driven by the demand from individual investors is stronger, particularly for call options. For stocks, the positive predictive relation is weaker, although the effect is not statistically significance.

Panel B of Table 5 shows that the results based on the UOM sentiment measure consistent with those based on the BW sentiment measure. Our empirical results on investor sentiment

and MOM). The coefficient of CPIV for stocks is insignificantly negative and is significantly negative (positive) at the 1 percent level for call (put) options. Results are available on request.

are therefore in line our Hypothesis 2a. Given that individual investors are more likely to be driven by sentiment, if the contrary predictive relation arises as a result of their demand, then it should be more clearly discernible during periods of high investor sentiment.

In the previous subsection we show that the contrary predictive relation between CPIV and future option returns is particularly strong around earnings announcement periods. We now focus on these specific periods for our further examination of whether the earnings announcement effect is dependent on investor sentiment. Specifically, we run the panel regression model specified in Equation (3) using the earnings announcement returns of options across various moneyness categories for the three groups of firms sorted by investor sentiment levels.

Table 6 provides the coefficients on CPIV, along with their *t*-statistics from the regressions with the same control variables. The results reported in Panel A are based on the BW sentiment measure and show that the CPIV coefficients for both ATM and OTM call options are negatively significant at the 1 percent level for the high-sentiment group. Results for the other two sentiment groups are statistically insignificant.

<TABLE 6 ABOUT HERE>

Table 6, Panel A, also shows that although the CPIV coefficients for ATM put options are larger than those of the OTM put options, both ATM and OTM put options are positively significant at the 5 percent level for the high- and mid-sentiment groups. The coefficients are

insignificant for the low-sentiment group. The coefficients for stock returns are insignificant for all sentiment groups. Results based on the UOM sentiment, reported in Panel B, are consistent with those based on the BW sentiment measure.

In sum, our results suggest that during periods of high investor sentiment investors may act more irrational and individual (sentiment-driven) investors participating in the options market may increase. As a result, the contrary predictive relation between CPIV and call and put options prices is more pronounced when sentiment is high, including earnings announcement periods. These results are consistent with Hypothesis 2b and are particularly strong for call options.

5.3 Investors' Learning Effect

Easley et al. (1998) find that informed traders are more likely to trade in the options market when information asymmetry (liquidity) in the stock market is high (low) or when liquidity in the options market is high. Because the demand from individual investors in the options market drives the contrary predictive relation between CPIV and future options returns, we expect the predictive relationship to be weaker when the likelihood of informed investors trading in options is greater because investors learn from informed trading.

To determine whether the likelihood of informed trading from which investors learn to adjust their behavior bias affects this contrary predictive relation, we rerun the regression model specified in Equation (2) with alternative measures for information asymmetry, stock liquidity

and options liquidity.

5.3.1. Information asymmetry

Table 7 reports the results based on the two alternative information asymmetry measures. The dummy variable equals 1 if the information asymmetry measure is ranked in the top 20 percent, and zero otherwise. Panel A shows the results for the ASY index (Drobetz et al., 2010). The regression coefficients on the interaction term of CPIV and the ASY index for ATM (OTM) are significantly positive at the 5 percent (1 percent) level. The regression coefficients for both ATM and OTM puts are significantly negative at the 1 percent level.

<TABLE 7 ABOUT HERE>

The results in Table 7 indicate that the contrary predictive relation is weaker when information asymmetry is high in the stock market, which provides motivation for informed investors to trade in the options market. In addition, the production term of CPIV and the ASY index is statistically insignificant, which shows that the positive predictive relation in the stock market is unaffected by the level of information asymmetry.

Panel B of Table 7 shows the results based on the PIN as an alternative information asymmetry measure (Easley et al., 1998). Although the sign of the interaction term is the same as that for CPIV, all of the coefficients for are nevertheless found to be statistically insignificant across all option categories.

The results on information asymmetry are consistent with Hypothesis 3a: Higher

information asymmetry in the stock market is positively related to increased trading by informed investors in the options market and thus weakens the contrary predictive relation between CPIV and future stock returns. This relation is essentially driven by the misreaction of individual investors in the options market.

Next, we exclude the dummy variable and its interaction term with CPIV and run the panel regression model specified in Equation (3) with the earnings announcement returns of options as the dependent variable. We run the regression was run across various categories of moneyness for the three groups of firms sorted by their information asymmetry levels. Table 8 provides the coefficients on CPIV and the *t*-statistics.

<TABLE 8 ABOUT HERE>

Panel A of Table 8 shows that, based on the ASY index, the coefficients of CPIV for the lower information asymmetry groups are significant at the 1 percent level and more negative (positive) than those of the higher information asymmetry groups for call (put) options. No significant pattern is discernible for the stock market. The coefficients of CPIV are statistically insignificant for call options when information asymmetry is higher.

In other words, if more informed investors are trading in the options market, the predictive relationship driven by the misreaction attributable to individual investors around earnings announcement periods can be significantly weakened. However, Panel B of Table 8 shows no clear pattern when using the PIN value as an alternative measure. These results are in line with

Hypothesis 3b on information asymmetry.

5.3.2 Stock liquidity

A further prediction of Easley's et al. (1998) sequential trading model is that the likelihood of informed investors trading in options is greater when the liquidity of the underlying stock is lower. We run the panel regression specified in Equation (2) with the PS liquidity and Amihud illiquidity measures. The dummy variable takes the value of 1 if the liquidity (illiquidity) level is ranked in the bottom (top) 20 percent, and zero otherwise. Table 9 reports the results.

<TABLE 9 ABOUT HERE>

Panel A of Table 9 shows that under the PS liquidity measure the coefficients of the interaction term of CPIV and the dummy variable are positive for all categories of stocks and options although most are statistically insignificance. Panel B shows that under the Amihud illiquidity measure all of the signs on the interaction term of CPIV and the dummy variable for options remain the same as those of CPIV, and most are statistical significance.

In sum, we do not find clear-cut evidence of the ways in which stock liquidity affects the predictive relation, despite the potential for informed investors to trade in more options when stock liquidity is lower. Given that we find no evidence to support the effect of stock liquidity on the full sample, we run the panel regression model specified in Equation (3) focusing on the earnings announcement returns of options across various categories of moneyness for the three groups of firms sorted by their stock liquidity levels. Table 10 provides the results.

<TABLE 10 ABOUT HERE>

If lower stock liquidity does indeed motivate informed investors to trade in more options, we expect the return predictability produced by CPIV to be weaker when stock liquidity (illiquidity) is lower (higher). Panel A of Table 10 shows that under the PS liquidity measure, for both ATM and OTM call options, the CPIV coefficients of the low-liquidity groups are less negative than those of the high-liquidity groups. The comparison between the low and high groups under the Amihud illiquidity measure, reported in Panel B, provide similar results.

In sum, although we do not identify any clear evidence to support the impact of stock liquidity on the return predictability produced by the CPIV for the full sample, we do find that such predictability is weakened when stock liquidity (illiquidity) is lower (higher) around earnings announcement periods, particularly for call options. In other words, our analysis based on earnings announcement events is consistent with our Hypothesis 3b: The likelihood of informed trading motivated by lower stock liquidity results in the predictability around earnings announcement periods becoming less significant.

5.3.3. Options liquidity

Easley et al. (1998) find that informed investors prefer to take advantage of their private information in the options market when trading in the options market is more liquid. Thus, if the contrary return predictability produced by CPIV is driven by the behavioral biases of individual investors, we expect this predictability to be weaker when options liquidity is high,

since high liquidity tends to attract more informed trading.

Following Atilgan (2014), we run the regression model specified in Equation (2) using option bid–ask spread and option volume to measure option liquidity. The dummy variable takes the value of 1 if the spread (volume) is ranked in the bottom (top) 20 percent, and zero otherwise. Table 11 shows the estimation results and *t*-statistics based on robust standard errors clustered by firm.

<TABLE 11 ABOUT HERE>

Panel A of Table 11 shows that when the bid–ask spread is used as the measure of liquidity, the coefficients on the product term of CPIV and the dummy variable are significantly positive for both ATM and OTM call options at the 1 percent level and significantly negative for both ATM and OTM put options at the 5 percent level. These results indicate that the more aggressive participation of informed traders in the options market during periods of high liquidity weakens the predictive relation between CPIV and future option returns.

Furthermore, Table 11 shows that the positive predictive relation in the stock market is strengthened, although it is only significant at the 10 percent level. Panel B reports the results with trading volume as the alternative liquidity measure show a similar pattern. These findings are, however, provide less insight. Overall, the results are consistent with Hypothesis 3a on options liquidity.

To facilitate an additional investigation into whether options liquidity affects the

predictive relation around earnings announcement periods, we drop the dummy variable and its product term with CPIV and run the panel regression model specified in Equation (3) across various moneyness categories for the three groups of firms sorted by their option liquidity levels. Table 12 reports the CPIV coefficients.

<TABLE 12 ABOUT HERE>

Panels A and B of Table 12 show that the CPIV coefficients for the higher liquidity groups of call (put) options are more negative (positive) than those of the lower liquidity groups for both moneyness categories. These results are inconsistent with Hypothesis 3b, which is derived from Easley et al.'s (1998) argument that the number of informed investors trading in the options market is likely higher when liquidity is higher.

These results are, however, in line with the findings of Choy and Wei (2012) and Choy (2015) who show that options trading around earnings announcement periods tends to be dominated by individual investors. Therefore, increased numbers of individual investors, rather than the presence of more informed investors, drives the higher liquidity in the options market around earnings announcement periods. Although informed investors may tend to trade more options during periods of high liquidity, they may not increase trading activity around earnings announcement periods, given their awareness of the aggressive participation in the market by individual investors.

In sum, we provide clear evidence of the effect of options liquidity in the predictive

relationship between CPIV and future options returns. Specifically, the contrary predictive relation is weaker when greater numbers of informed investors trade in options during periods of high liquidity. However, this finding does not hold for trading around earnings announcement periods.

6. CONCLUSION

Based on the extant literature on the negative predictive relation between CPIV and future call options returns, we contribute to the literature by examining whether and, if so, how earnings announcements, investor sentiment, and informed trading affect the predictive relation on the returns of both call and put options. In particular, by investigating the relation under various conditions that are widely cited in the extant literature to proxy for the extent of involvement of informed traders, we examine whether investors learn from informed traders and adjust their behavior bias.

Our empirical results, which are based on optioned stocks traded in the US market, show that earnings announcements and investor sentiment have a significant effect on the predictive relation. In addition, we provide evidence that investors learn from informed trading and thus mitigate mispricing in the options market.

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Table 1 Summary statistics on earnings announcement events, 1996-2010

This table reports the summary statistics on the total number of earnings announcement events in each of the sample years. Options exist for all firms in each of the four option categories, comprising of ATM and OTM calls and puts.

Year	No. of Events	No. of Firms
1996	93	87
1997	173	153
1998	229	179
1999	256	221
2000	246	213
2001	282	229
2002	279	219
2003	335	258
2004	417	288
2005	437	311
2006	431	304
2007	576	405
2008	500	360
2009	586	371
2010	812	479
1996-2010	5,652	4,077

Table 2 Summary statistics on the call–put implied volatility spread, sentiment, stock liquidity, option liquidity, and information asymmetry

This table reports the summary statistics on the characteristics of the call–put implied volatility spread (*CPIV*). Investor sentiment is measured using Baker and Wurgler's (2006) sentiment index (*BW Sentiment*) and the University of Michigan consumer sentiment index (*UOM sentiment*), while stock liquidity is proxied by Pastor and Stambaugh's (2003) liquidity (*PS liquidity*) and's Amihud (2002) illiquidity (*Amihud illiquidity*) measures. Option liquidity is measured by *option volume* and *option bid-ask spread*, and the probability of informed trading is proxied by the *PIN* and the *ASY-INDEX*.

Variables	P10	P50	P90	Mean	S.D.
CPIV	–0.0446	–0.0065	0.0257	–0.0085	0.0412
BW Sentiment	–0.5600	–0.0200	0.4500	0.0611	0.4746
UOM Sentiment	66.3000	87.3000	104.6000	84.5660	13.4567
PS Liquidity	–0.1510	–0.0335	0.0603	–0.0347	0.0815
Amihud Illiquidity	0.0073	0.0183	0.0606	0.0285	0.0312
Option Volume	2.5000	74.5274	701.9444	273.3130	615.7315
Option Bid-Ask Spread	0.1025	0.2031	0.3958	0.2442	0.1991
PIN	0.0303	0.0805	0.1397	0.0835	0.0446
ASY-INDEX	12.0000	15.0000	18.0000	15.0825	2.6720

Table 3 Earnings announcement returns, sorted by call–put implied volatility spread

This table reports the two-day [0, 1] returns around earnings announcement periods sorted by quintiles of call–put implied volatility spread (CPIV) at day *t*–1. The stock returns are value-weighted based on market capitalization, whilst the option returns are calculated by the midpoint for all option contracts. The High–Low mean differences in the quintile returns are reported using Newey and West (1987) *t*-statistics. The first row in the table reports the *Mean CPIV* for the earnings announcements, sorted by *CPIV* quintiles measured at day *t*–1, while the variables in the portfolio returns rows report the two-day [0, 1] returns for each quintile.

Variables	CPIV Quintiles						t-value
	1 (Low)	2	3	4	5 (High)	High–Low	
Mean CPIV	–0.0576	–0.0214	–0.0078	0.0039	0.0340	–	
Portfolio Returns:							
Stock	0.0000	0.0001	–0.0005	–0.0002	0.0001	0.0001	0.08
ATMC	–0.0310	–0.0357	–0.0338	–0.0285	–0.0589	–0.0278	–1.71*
OTMC	0.0077	–0.0019	0.0013	0.0051	–0.0088	–0.0165	–1.86*
ATMP	–0.0797	–0.0376	–0.0500	–0.0445	–0.0430	0.0367	2.45**
OTMP	–0.0162	0.0041	0.0008	0.0017	0.0048	0.0210	2.42**

Table 4 Regression results on the effects of earnings announcements on return predictability

This table presents the results of the panel regressions on the effects of earnings announcements on call–put implied volatility spread (CPIV) returns, where the dependent variable is the two-day [*t*, *t*+1] returns for stocks and options on each date *t*. Market equity (*ME*), in billions, is defined as the number of shares outstanding multiplied by the common stock price at the end of month *t*–1. Book-to-market equity (*BM*) is calculated based on the book equity at the end of the prior fiscal year divided by market equity. Momentum (*MOM*) is calculated as the buy and hold stock return over months [*t*–12, *t*–1]. Implied volatility (*IV*) is computed as the moneyness-weighted mean of the implied volatilities of all options on the first day of the month of the CPIV measurement. The independent variables include day *t*–1 *CPIV*, which is calculated by following the method proposed in Cremers and Weinbaum (2010). *Dummy* takes the value of 1 if the day is an earnings announcement date, and zero otherwise. The *t*-statistics are based on robust standard errors clustered by firm. *** indicates significance at the 1% level; ** indicates significance at the 5% level; and * indicates significance at the 10% level.

Variables	*Stock*		*ATMC*		*OTMC*		*ATMP*		*OTMP*	
	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat
Intercept	0.0009	11.36***	0.0088	2.36**	0.0076	5.99***	–0.0025	–0.98	0.0046	5.05***
CPIV	0.0262	14.60***	–0.0680	–4.12***	–0.0380	–4.40***	0.1122	9.16***	0.0536	7.82***
Dummy	0.0003	0.56	–0.0447	–7.81***	–0.0061	–2.10**	–0.0445	–8.50***	–0.0031	–1.09
*CPIV*Dummy*	–0.0317	–2.67***	–0.3254	–2.68***	–0.1885	–2.66***	0.3322	3.12***	0.2358	4.01***
IV	–0.0002	–1.78*	–0.0156	–2.01**	–0.0052	–2.01**	–0.0096	–1.80*	–0.0029	–1.60
MOM	–0.0002	–2.94***	–0.0017	–2.92***	–0.0010	–3.10***	0.0029	5.28***	0.0009	2.72***
BM	–0.0437	–4.22***	–0.2433	–1.79*	–0.2665	–5.78***	0.5345	2.46**	0.2944	2.54**
ME	0.0008	0.59	0.1407	4.14***	0.0359	2.91***	0.1208	6.25***	0.0270	3.49***
Adj. R^2 (%)	0.14		0.11		0.05		0.12		0.04	

Table 5 Regression results on the effects of investor sentiment on return predictability

This table reports the results of the panel regression results on the effects of investor sentiment on call–put implied volatility spread (CPIV) returns, where the dependent variable is the two-day [*t*, *t*+1] returns for stocks and options on each date *t*. The independent variables include day *t*–1 *CPIV*, which is calculated by following the method proposed in Cremers and Weinbaum (2010). The *BW dummy* (*UOM dummy*) takes the value of 1 if BW Sentiment (UOM Sentiment) is ranked in the top 20 per cent; otherwise 0. Control variables include market equity, book-to-market equity, momentum, and implied volatility. Market equity (*ME*), in billions, is defined as the number of shares outstanding multiplied by the common stock price at the end of month *t*–1. Book-to-market equity (*BM*) is calculated based on the book equity at the end of the prior fiscal year divided by market equity. Momentum (*MOM*) is calculated as the buy and hold stock return over months [*t*–12, *t*–1]. Implied volatility (*IV)* is computed as the moneyness-weighted mean of the implied volatilities of all options on the first day of the month of the CPIV measurement. The *t*-statistics are based on robust standard errors clustered by firm. *** indicates significance at the 1% level; ** indicates significance at the 5% level; and * indicates significance at the 10% level.

Variables	*Stock*		*ATMC*		*OTMC*		*ATMP*		*OTMP*	
	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat
Panel A: BW Sentiment										
Intercept	0.0009	11.64***	0.0092	2.77***	0.0081	7.18***	–0.0039	–1.45	0.0044	4.68***
CPIV	0.0271	12.74***	–0.0611	–3.22***	–0.0328	–3.17***	0.1081	7.31***	0.0521	6.38***
BW dummy	–0.0005	–3.19***	–0.0114	–6.25***	–0.0050	–5.62***	0.0050	3.12***	0.0015	1.74*
*CPIV*BW dummy*	–0.0061	–1.65	–0.0654	–1.89*	–0.0391	–2.19**	0.0429	1.64	0.0226	1.50
Control Variables	Yes		Yes		Yes		Yes		Yes	
Adj. R^2 (%)	0.15		0.09		0.05		0.08		0.04	
Panel B: UOM Sentiment										
Intercept	0.0010	11.75***	0.0098	3.17***	0.0085	8.82***	–0.0049	–1.62	0.0039	3.47***
CPIV	0.0261	10.97***	–0.0509	–2.41**	–0.0403	–3.50***	0.1164	7.21***	0.0574	6.51***
UOM dummy	–0.0013	–8.05***	–0.0174	–9.70***	–0.0097	–10.99***	0.0163	9.87***	0.0071	8.23***
*CPIV*UOM dummy*	–0.0029	–0.84	–0.0847	–2.66***	–0.0174	–1.04	0.0278	1.11	0.0117	0.82
Control Variables	Yes		Yes		Yes		Yes		Yes	
Adj. R^2 (%)	0.17		0.12		0.09		0.12		0.07	

Table 6 The role of investor sentiment on the effects of earnings announcements

This table reports the panel regression results on the role of investor sentiment on call–put implied volatility spread (CPIV) earnings announcement returns, where the dependent variable is the two-day [0, 1] returns for stocks and options around earnings announcement date *t* (day 0). The firms are first of all divided into three groups based on their investor sentiment levels of low (<33%), mid (33-67%) and high (>67%) sentiment, with panel regressions then being run on these three groups. All of the variables are the same as those defined in Table 5, but only the coefficients on CPIV are reported in this table. The *t*-statistics are based on robust standard errors clustered by firm. *** indicates significance at the 1% level; ** indicates significance at the 5% level; and * indicates significance at the 10% level.

Variables	*Stock*		*ATMC*		*OTMC*		*ATMP*		*OTMP*	
	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat
Panel A: BW Sentiment										
High Sentiment	–0.0320	–1.50	–0.7129	–3.87***	–0.3891	–3.55***	0.4520	2.58**	0.3046	3.31***
Mid Sentiment	0.0068	0.39	–0.3046	–1.61	–0.1714	–1.53	0.4161	2.47**	0.2944	3.09***
Low Sentiment	0.0335	1.34	–0.0169	–0.07	–0.0326	–0.23	0.2353	1.17	0.1077	0.89
Panel B: UOM Sentiment										
High Sentiment	–0.0172	–0.91	–0.6886	–4.03***	–0.3394	–3.38***	0.4594	2.90***	0.3009	3.64***
Mid Sentiment	–0.0005	–0.03	–0.2139	–1.00	–0.1607	–1.30	0.3128	1.68*	0.2477	2.28**
Low Sentiment	0.0249	0.97	–0.0979	–0.42	–0.0963	–0.70	0.4616	2.16***	0.2174	1.79*

Table 7 Regression results on the effects of information asymmetry on return predictability

This table reports the panel regression results on the effects of information asymmetry on call–put implied volatility spread (CPIV) earnings announcement returns, where the dependent variable is the two-day [*t*, *t*+1] returns for stocks and options on each date *t*. The independent variables include day *t*–1 *CPIV*, which is calculated by following the method proposed in Cremers and Weinbaum (2010). The *ASY dummy* (*PIN dummy*) takes the value of 1 if the ASY Index (PIN) is ranked in the top 20 percent, and zero otherwise. Control variables include Market equity, Book-to-market equity, Momentum, and Implied volatility. Market equity (*ME*), in billions, is defined as the number of shares outstanding multiplied by the common stock price at the end of month *t*–1. Book-to-market equity (*BM*) is calculated based on the book equity at the end of the prior fiscal year divided by market equity. Momentum (*MOM*) is calculated as the buy and hold stock return over months [*t*–12, *t*–1]. Implied volatility (*IV)* is computed as the moneyness-weighted mean of the implied volatilities of all options on the first day of the month of the CPIV measurement. The *t*-statistics are based on robust standard errors clustered by firm. *** indicates significance at the 1% level; ** indicates significance at the 5% level; and * indicates significance at the 10% level.

Variables	*Stock*		*ATMC*		*OTMC*		*ATMP*		*OTMP*	
	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat
Panel A: ASY Index										
Intercept	0.0009	10.77***	0.0088	2.50**	0.0077	6.40***	–0.0022	–0.93	0.0050	5.98***
CPIV	0.0241	11.82***	–0.0980	–5.38***	–0.0569	–5.75***	0.1331	9.11***	0.0684	8.39***
ASY dummy	0.0001	0.79	–0.0077	–3.51***	–0.0023	–2.25**	–0.0099	–5.99***	–0.0042	–4.60***
*CPIV*ASY dummy*	0.0067	1.65	0.0868	2.44**	0.0598	3.32***	–0.0763	–3.09***	–0.0491	–3.43***
Control Variables	Yes		Yes		Yes		Yes		Yes	
Adj. R^2 (%)	0.14		0.09		0.05		0.09		0.05	
Panel B: PIN										
Intercept	0.0009	10.81***	0.0090	2.51**	0.0079	6.42***	–0.0026	–1.06	0.0048	5.47***
CPIV	0.0261	12.85***	–0.0665	–3.59***	–0.0389	–3.94***	0.1164	8.42***	0.0567	7.28***
PIN dummy	–0.0000	–0.11	–0.0098	–4.96***	–0.0037	–3.68***	–0.0068	–3.84***	–0.0028	–2.84***
*CPIV*PIN dummy*	–0.0027	–0.66	–0.0513	–1.38	–0.0177	–0.92	0.0011	0.04	0.0035	0.22
Control Variables	Yes		Yes		Yes		Yes		Yes	
Adj. R^2 (%)	0.14		0.08		0.04		0.08		0.04	

Table 8 The role of information asymmetry on the effects of earnings announcements

This table reports the panel regression results on the role of information asymmetry on call–put implied volatility spread (CPIV) earnings announcement returns, where the dependent variable is the two-day [0, 1] returns for stocks and options around earnings announcement date *t* (day 0). The firms are first of all divided into three groups based on their ASY-Index/PIN levels of low (<33%), mid (33-67%) and high (>67%), with panel regressions then being run on these three groups. All of the variables are the same as those defined in Table 5, but only the coefficients on CPIV are reported in this table. The *t*-statistics are based on robust standard errors clustered by firm. *** indicates significance at the 1% level; ** indicates significance at the 5% level; and * indicates significance at the 10% level.

Variables	*Stock*		*ATMC*		*OTMC*		*ATMP*		*OTMP*	
	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat
Panel A: ASY Index										
High ASY Index	0.0019	0.10	–0.1489	–0.82	–0.0827	–0.76	0.3669	2.86***	0.2155	2.59***
Mid ASY Index	0.0043	0.19	–0.3103	–1.53	–0.1697	–1.39	0.1169	0.59	0.1684	1.59
Low ASY Index	–0.0121	–0.62	–0.6810	–3.01***	–0.3989	–3.21***	0.7573	4.02***	0.4160	3.96***
Panel B: PIN										
High PIN	–0.0088	–0.32	–0.5921	–2.53**	–0.2825	–1.94*	0.3392	1.86*	0.2631	2.32**
Mid PIN	–0.0018	–0.13	–0.3014	–2.07**	–0.1950	–2.28**	0.4612	3.45***	0.2850	3.95***
Low PIN	0.0002	0.01	–0.5314	–1.50	–0.2827	–1.40	0.2874	0.92	0.1911	1.07

Table 9 Regression results on the effects of stock liquidity on return predictability

This table reports the panel regression results on the effects of stock liquidity on call–put implied volatility spread (CPIV) earnings announcement returns, where the dependent variable is the two-day [*t*, *t*+1] returns for stocks and options on each date *t*. The independent variables include day *t*–1 *CPIV*, which is calculated by following the method proposed in Cremers and Weinbaum (2010). The *PS dummy* (*Ami dummy*) takes the value of 1 if PS liquidity (Amihud illiquidity) is ranked in the top 20 percent, and zero otherwise. Control variables include market equity, book-to-market equity, momentum, and implied volatility. Market equity (*ME*), in billions, is defined as the number of shares outstanding multiplied by the common stock price at the end of month *t*–1. Book-to-market equity (*BM*) is calculated based on the book equity at the end of the prior fiscal year divided by market equity. Momentum (*MOM*) is calculated as the buy and hold stock return over months [*t*–12, *t*–1]. Implied volatility (*IV)* is computed as the moneyness-weighted mean of the implied volatilities of all options on the first day of the month of the CPIV measurement. The *t*-statistics are based on robust standard errors clustered by firm. *** indicates significance at the 1% level; ** indicates significance at the 5% level; and * indicates significance at the 10% level.

Variables	*Stock*		*ATMC*		*OTMC*		*ATMP*		*OTMP*	
	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat
Panel A: PS Liquidity										
Intercept	0.0016	19.60***	0.0161	4.80***	0.0120	11.11***	–0.0139	–4.63***	–0.0006	–0.55
CPIV	0.0245	12.97***	–0.0854	–4.84***	–0.0501	–5.25***	0.1138	7.87***	0.0576	7.20***
PS dummy	–0.0034	–25.35***	–0.0361	–25.40***	–0.0201	–27.42***	0.0475	32.08***	0.0233	29.55***
*CPIV*PS dummy*	0.0008	0.18	0.0062	0.17	0.0115	0.60	0.0542	2.04**	0.0208	1.41
Control Variables	Yes		Yes		Yes		Yes		Yes	
Adj. R^2 (%)	0.42		0.31		0.33		0.54		0.42	
Panel B: Amihud Illiquidity										
Intercept	0.0010	12.33***	0.0120	4.17***	0.0090	9.18***	–0.0026	–1.10	0.0045	4.98***
CPIV	0.0264	10.77***	–0.0659	–2.92***	–0.0328	–2.81***	0.0927	5.43***	0.0435	4.56***
Ami dummy	–0.0008	–5.92***	–0.0244	–15.03***	–0.0093	–11.68***	–0.0050	–3.45***	0.0003	0.34
*CPIV*Ami dummy*	–0.0028	–0.81	–0.0483	–1.64	–0.0317	–1.96*	0.0554	2.36**	0.0350	2.64***
Control Variables	Yes		Yes		Yes		Yes		Yes	
Adj. R^2 (%)	0.14		0.08		0.09		0.09		0.04	

Table 10 The role of stock liquidity on the effects of earnings announcements

This table reports the panel regression results on the role of stock liquidity on call–put implied volatility spread (CPIV) earnings announcement returns, where the dependent variable is the two-day [0, 1] returns for stocks and options around earnings announcement date *t* (day 0). The firms are first of all divided into three groups based on their stock liquidity levels, comprising of Pastor and Stambaugh's (2003) liquidity (PS liquidity) and Amihud's (2002) illiquidity measures, of low (<33%), mid (33-67%), and high (>67%), with panel regressions then being run on these three groups. All of the variables are the same as those defined in Table 5, but only the coefficients on CPIV are reported in this table. The *t*-statistics are based on robust standard errors clustered by firm. *** indicates significance at the 1% level; ** indicates significance at the 5% level; and * indicates significance at the 10% level.

Variables	*Stock*		*ATMC*		*OTMC*		*ATMP*		*OTMP*	
	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat
Panel A: PS Liquidity										
High Liquidity	0.0021	0.13	–0.4995	–3.16***	–0.2839	–3.04***	0.3765	2.38**	0.2824	3.43***
Mid Liquidity	0.0629	0.72	–0.1128	–0.17	0.0246	0.06	–0.3944	–0.63	–0.0877	–0.19
Low Liquidity	–0.0077	–0.45	–0.2862	–1.65*	–0.1723	–1.70*	0.4766	3.36***	0.2633	3.20***
Panel B: Amihud Illiquidity										
High Illiquidity	–0.0044	–0.18	–0.3909	–1.88*	–0.2038	–1.60	0.3420	2.02**	0.2133	2.05**
Mid Illiquidity	0.0066	0.47	–0.2575	–1.77*	–0.1788	–2.08**	0.4234	3.04***	0.2527	3.43***
Low Illiquidity	–0.0482	–1.14	–1.0614	–2.45**	–0.4960	–2.00**	0.5204	1.64	0.4592	2.28**

Table 11 Regression results on the effects of options liquidity on return predictability

This table reports the panel regression results on the effects of options liquidity on call–put implied volatility spread (CPIV) earnings announcement returns, where the dependent variable is the two-day [t, t+1] returns for stocks and options on each date t. The independent variables include day t–1 *CPIV*, which is calculated by following the method proposed in Cremers and Weinbaum (2010). The *BA dummy* (*Vol dummy*) takes the value of 1 if the bid-ask spread (option volume) is ranked in the bottom (top) 20 percent, and zero otherwise. Control variables include market equity, book-to-market equity, momentum, and implied volatility. Market equity (*ME*), in billions, is defined as the number of shares outstanding multiplied by the common stock price at the end of month t–1. Book-to-market equity (*BM*) is calculated based on the book equity at the end of the prior fiscal year divided by market equity. Momentum (*MOM*) is calculated as the buy and hold stock return over months [t–12, t–1]. Implied volatility (*IV)* is computed as the moneyness-weighted mean of the implied volatilities of all options on the first day of the month of the CPIV measurement. The t-statistics are based on robust standard errors clustered by firm. *** indicates significance at the 1% level; ** indicates significance at the 5% level; and * indicates significance at the 10% level.

Variables	*Stock*		*ATMC*		*OTMC*		*ATMP*		*OTMP*	
	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat
Panel A: Bid-Ask Spread										
Intercept	0.0009	10.89***	0.0074	1.98**	0.0072	5.69***	–0.0027	–1.09	–0.0049	–5.45***
CPIV	0.0244	13.03***	–0.0924	–5.32***	–0.0527	–5.83***	0.1270	9.80***	0.0636	9.00***
BA dummy	0.0002	1.24	0.0049	2.80***	0.0020	2.33**	–0.0044	–2.95***	–0.0024	–2.91***
*CPIV*BA dummy*	0.0083	1.79*	0.1345	3.51***	0.0798	3.59***	–0.0730	–2.11**	–0.0448	–2.26**
Control Variables	Yes		Yes		Yes		Yes		Yes	
Adj. R^2 (%)	0.14		0.08		0.05		0.08		0.04	
Panel B: Volume										
Intercept	0.0009	11.76***	0.0083	2.26**	0.0076	6.03***	–0.0036	–1.41	0.0044	4.77***
CPIV	0.0255	13.62***	–0.0822	–4.78***	–0.0460	–5.10***	0.1172	9.13***	0.0596	8.28***
Vol dummy	–0.0003	–1.79*	–0.0033	–1.45	–0.0011	–1.01	0.0031	1.63	0.0018	1.78*
*CPIV*Vol dummy*	0.0008	0.17	0.0575	1.39	0.0318	1.35	0.0034	0.09	–0.0132	–0.63
Control Variables	Yes		Yes		Yes		Yes		Yes	
Adj. R^2 (%)	0.14		0.08		0.04		0.08		0.04	

Table 12 The role of options liquidity on the effects of earnings announcements

This table reports the panel regression results on the role of options liquidity on call–put implied volatility spread (CPIV) earnings announcement returns, where the dependent variable is the two-day [0, 1] returns for stocks and options around earnings announcement date *t* (day 0). The firms are first of all divided into three groups based on their option liquidity/illiquidity levels of low (<33%), mid (33-67%), and high (>67%), with panel regressions then being run on these three groups. All of the variables are the same as those defined in Table 5, but only the coefficients on CPIV are reported in this table. The *t*-statistics are based on robust standard errors clustered by firm. *** indicates significance at the 1% level; ** indicates significance at the 5% level; and * indicates significance at the 10% level.

Variables	*Stock*		*ATMC*		*OTMC*		*ATMP*		*OTMP*	
	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat
Panel A: Bid-Ask Spread										
High Illiquidity	0.0136	0.87	–0.1326	–0.82	–0.1284	–1.35	0.2645	1.74*	0.2113	2.54**
Mid Illiquidity	–0.0017	–0.08	–0.4261	–1.72*	–0.1944	–1.37	0.3617	2.04**	0.1726	1.69*
Low Illiquidity	–0.0398	–1.49	–0.8947	–3.67***	–0.4782	–3.33***	0.8458	3.94***	0.5445	4.44***
Panel B: Volume										
High Liquidity	–0.0398	–1.49	–0.7132	–2.98***	–0.4344	–3.17***	0.9019	3.00***	0.5071	3.67***
Mid Liquidity	0.0256	1.37	0.0744	0.39	0.0310	0.27	0.1472	0.94	0.1074	1.13
Low Liquidity	–0.0055	–0.30	–0.5596	–3.17***	–0.3081	–3.00***	0.3891	2.62***	0.2711	3.11***