Informed trading around stock split announcements: Evidence from the option market

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Abstract

Prior research shows that splitting firms earn positive abnormal returns and that they experience an increase in stock return volatility. If they do, then the option market is an ideal venue to capitalize on this information. By examining option-implied volatility, we assess option traders' perceptions on return and volatility changes arising from stock splits. We find that they do expect higher volatility following splits. There is only weak evidence though of option traders anticipating an abnormal increase in stock prices. In further analysis where we examine cross-sectional variation in the option-implied volatility of splitting firms, we show that our option measures can predict both stock volatility levels and changes after the announcement. However, there is little evidence that they can predict the returns of splitting firms.

Key words: option traders, implied volatility, event study

JEL Classification: G11, G12, G13 and G14

1. Introduction

The option market is a venue for informed trading. Prior research has identified a number of reasons why informed investors may prefer to trade equity options rather than the underlying stock. Such reasons include higher leverage and ease of shorting (Black (1975)). An impressive amount of recent empirical work has demonstrated evidence of informed trading in options for both the cross-section of stocks and around firm specific events. Research that considers the cross-section of stocks includes Cremers and Weinbaum (2010), Roll, Schwartz and Subrahmanyam (2010), Xing, Zhang and Zhao (2010), Johnson and So (2012) and An, Ang, Bali and Cakici (2014). Earnings announcements are studied by Diavatopoulos et al. (2012), Jin, Livnat and Zhang (2012) and Atilgan (2014). Lastly, Hayunga and Lung (2014) and Lung and Xu (2014) consider analyst recommendations and Chan, Ge and Lin (2014) examine M&As.

We contribute to this literature by investigating informed trading in options around stock split announcements. There are two key reasons why stock splits are a particularly interesting event to examine in the context of informed trading. First, unlike for example earnings announcements, which are scheduled events, stock splits announcements are unanticipated events that the market should not be aware of in advance. This allows us to more cleanly analyze whether informed option investors are trading in anticipation of the impending event. Second, prior research shows that stocks experience changes in both the level of their returns and the volatility of their returns due to splits. This provides us with a novel opportunity to examine the expectations of option traders on both return and volatility changes arising from the same event.

The specific observations of prior research on return and volatility changes due to splits that inform our analysis are as follows. There is, on average, a strong positive reaction when firms announce splits (Grinblatt, Masulis and Titman (1984), Chern, Tandon, Yu and Webb (2008) and Lin, Singh and Yu (2009)). Positive return drift that lasts at least one year after the split announcement is observed (Ikenberry, Rankine and Stice (1996), Desai and Jain (1997) and Ikenberry and Ramnath (2002)). However, this drift is conditional on the period examined (Byun and Rozeff (2003)) and it is driven by the relatively short period between the split announcement date and the split effective date (Boehme and Danielsen (2007)). Stock volatility increases when splits are announced (Ohlson and Penman (1985)), which is a common occurrence for any unscheduled and meaningful corporate announcement. Finally, there is an increase in stock volatility after splits are effected (Ohlson and Penman (1985), Dravid (1987) and Koski (1998)).

We examine option-implied volatility around 1,780 stock split announcements for the period 1998 to 2012. We draw inference on option traders' perceptions on volatility changes when splits are announced and after they are effected, and on split announcement returns and longer-term return drift following announcements. We document a consistent increase in implied volatility for the most speculative short-dated options in the days preceding the split announcement. This is indicative of informed trading in options. More pointedly, it suggests that news about impending split announcements has leaked and that option investors are trading on this information. Implied volatility increases in both call and put options, which indicates that the trading is driven by an expected increase in stock volatility on and soon after the announcement. In contrast, if the increase in implied volatility was only observed in calls, this would imply a directional bet on positive announcement returns. After a large and expected increase in implied volatility on the announcement date, implied volatility increases again on the next day but only in long maturity options that expire after the effective date. This suggests that option traders expect that stock volatility will increase after splits are effected.

To examine option traders' expectations on return changes arising from splits, we employ the option-implied volatility spread (Cremers and Weinbaum (2010)) and skew (Xing, Zhang and Zhao (2010)). The spread and skew measure differences in implied volatility between suitably matched calls and puts. In the days preceding the announcement, there is little in our results to suggest that option investors are trading to exploit the well documented positive returns when splits are announced. Given that our earlier analysis is strongly suggestive of volatility trading prior to the announcement, we surmise that the announcement returns are not large enough to induce them to trade. After splits are announced, there is some evidence of option trading in anticipation of longer-term return drift, particularly in smaller stocks, but the findings are not compelling.

The analysis discussed thus far focuses on the perceptions of option investors on return and volatility changes due to splits. We also assess informed trading in options by examining whether various implied volatility measures can predict future stock returns and volatility. In cross-sectional regressions of abnormal stock volatility on daily changes in implied volatility prior to the announcement, we show that implied volatility changes significantly predict the level of stock volatility on the day after the announcement. Thus, not only do option traders seem to be trading in anticipation of volatility increases due to split announcements, they also demonstrate an ability to predict stock volatility levels after the announcement. More broadly, in addition to displaying a capacity to acquire information, option traders also appear to be processing information skillfully.

We next show that the change in implied volatility from the announcement day to the following day significantly predicts which splitters will have the largest change in stock volatility after splits are effected – where the effective date is on average 40 days after the announcement date. An informed traders' private informational advantage is likely to be low directly after major news announcements. Thus, we contend that this specific instance of informed trading highlights option traders' superior ability to process public information. Finally, we run similar regressions to Jin, Livnat and Zhang (2012) and Chan, Ge and Lin (2014) where we examine whether the implied volatility spread and skew predict short-run announcement returns and longer-term abnormal returns. We find little evidence that these option measures can predict the future returns of splitters.

Our paper makes several contributions to the literature. The prior research on informed trading in options around corporate events focuses on the predictability of option measures and in particular, predictability on future returns (for example, Jin, Livnat and Zhang (2012), Chan, Ge and Lin (2014) and Hayunga and Lung (2014)). We are the first to examine the expectations of option traders on both return and volatility changes due to an unscheduled corporate event. More broadly, once could argue that this is the first paper that explicitly focuses on option traders' perceptions of a corporate event. Another key contribution is that we develop tests that disentangle option traders' expectations on return and volatility changes, so that we can draw inference on each. When analyzing predictability, our novel contribution is to evaluate whether option measures can predict both the level and change of future stock volatility due to the event. By investigating both the perceptions of option traders and predictability in options trading, we assess both the acquisition and skillful processing of information. This allows us to present a more complete picture of informed trading in options.

We find that informed option traders demonstrate an ability to acquire and skillfully interpret information prior to the event. This contributes to the body of literature that documents informed trading in options prior to other corporate events (for example, Chan, Ge and Lin (2014) and Hayunga and Lung (2014)). We also complement research that shows pre-event informed trading by other market participants such as investment banks (Bodnaruk, Massa and Simonov (2009)), short sellers (Karpoff and Lou (2010)), institutional investors (Ivashina and Sun (2011)) and hedge funds (Massoud, Nandy, Saunders and Song (2011)). After the announcement, we show that informed option traders possess a superior ability to process public information. This builds on similar recent evidence with options on other corporate events (Jin, Livnat and Zhang (2012)) and with short sellers using broader news announcements (Engelberg, Reed and Ringgenberg (2012)).

In the context of prior research on splits, rather than focusing on the return distribution of splitting stocks as the majority of prior studies have done[1], we contribute to this literature by assessing the perceptions of informed option traders. Our tests are quite simple and given that they focus on the expectations of option investors, we believe that they are more forward looking than conventional event study tests, which rely on stock returns.

The rest of the paper proceeds as follows. Section 2 outlines the research design. Section 3 discusses data, sample selection and sample characteristics. Section 4 presents the findings of the perceptions analysis. Section 5 reports on the predictability analysis. Section 6 concludes.

2. Research design

The initial analysis considers option traders' perceptions on future return and volatility changes due to splits. To investigate their perceptions on stock volatility, we examine the implied volatility of call and put options separately. With future return changes, we analyze the implied volatility of call and put options together by examining the volatility spread and skew. Our event window is the [-5, +5] day period around the split announcement.

In these tests, we examine the daily change in implied volatility, and the volatility spread and skew. Given that volatility is persistent, implied volatility today is an appropriate proxy for

[1] There have been three published papers on stock splits and the option market, each of limited scale and scope. Reilly and Gustavson (1985) find that call option returns are positive prior to split announcements but negligible post announcement. French and Dubosfky (1986) observe that the implied volatility of call options increases after the effective date but that high bid-ask spreads would render a trading strategy based on this increase unprofitable. Sheikh (1989) also finds that call option-implied volatility increases when splits are effected but that this increase was not anticipated at the time of the announcement. These studies spanned the period 1976 to 1983 and Sheikh's (1989) sample was the largest with 83 stocks.

expected implied volatility tomorrow. If the volatility spread and skew are indicators of future stock returns, in the absence of new information, these measures should be constant through time. Thus, we assume that the expected daily change in implied volatility and the volatility spread (skew) is zero. Our approach is consistent with Bollen and Whaley (2004) and Garleanu, Pedersen and Poteshman (2009) who find that changes in implied volatility reflect the net buying pressure of option investors.

2.1 Testing perceptions on volatility

Ohlson and Penman (1985) document a temporary increase in stock volatility after the split announcement and a more permanent increase after splits are effected. In the days preceding the announcement, if informed option traders are speculating on a volatility spike when splits are announced, then it is likely that they will employ shorter maturity options to do so[2]. When firms announce splits, they will disclose on what date the split will be effected. If option traders expect stock volatility to change after the effective date, then post-announcement, the behavior of implied volatility should differ depending on whether the options expire before or after the effective date. Accordingly, we compute the implied volatility for options that expire before and after the effective date, separately. Furthermore, if option investors are trading in anticipation of a change in the volatility of the underlying stock, then they will likely select options that are the most sensitive to changes in stock volatility. That is, options with the highest vega. Thus, to obtain a single estimate of option-implied volatility for a given stock, we take the weighted average of all available implied volatilities where the weight is the option vega.

[2] Short-dated options are more exposed to changes in short-term volatility, as the mean-reversion in stock volatility results in the implied volatility of long-dated options being more stable. Moreover, the option gamma, which reflects jump risk(s), is greatest for short dated options.

To examine option traders' expectations on future stock volatility, we calculate the daily change in implied volatility for call and put options as follows:

$$\Delta IV_{it} = IV_{it} - IV_{it-1}. \quad (1)$$

ΔIV_{it} is the change in implied volatility for stock *i* on day *t* and IV_{it} is the weighted average of all implied volatilities for stock *i* on day *t* where the weight is the option vega. It is calculated as:

$$IV_{it} = \sum_{j=1}^{N_{i,t}} w_{j,t}^{i} IV_{j,t}^{i}, \quad (2)$$

where $N_{i,t}$ is the number of options traded for stock *i* on day *t* and $IV_{j,t}^{i}$ is the implied volatility of option *j* for stock *i* on day *t*. Thus, we study the daily movement in the aggregate implied volatility across all options for a given stock.

2.2 Testing perceptions on returns

Although option-implied volatility reflects the demand of option investors, it may not be a reliable predictor of future stock returns. An increase in option-implied volatility may simply be the result of an expected increase in the volatility of the underlying stock. Recent literature including Cremers and Weinbaum (2010) and Xing, Zhang and Zhao (2010) suggest that the behavior of implied volatilities of call and put options together, not in isolation, reflect informed trading and predict returns in the equity market. Specifically, Cremers and Weinbaum (2010) argue that if informed investors are optimistic about the underlying stock, then they can either buy a call option or sell a put option. This should increase (decrease) the price of call (put) options, which in turn induces a higher implied volatility inverted from call options relative to put options. They refer to this as the volatility spread.

The change in the volatility spread is calculated as follows:

$$\Delta VS_{it} = VS_{it} - VS_{it-1} . \tag{3}$$

Following Cremers and Weinbaum (2010), the volatility spread VS_{it} for firm *i* on day *t* is:

$$VS_{it} = IV_{i,t}^{calls} - IV_{i,t}^{puts} \quad = \quad \sum_{j=1}^{N_{i,t}} w_{j,t}^{i} \left(IV_{j,t}^{i,call} - IV_{j,t}^{i,put} \right), \tag{4}$$

where *j* represents each pair of call and put options matched on the same strike price and maturity date, and $N_{i,t}$ refers to the number of valid pairs of options on stock *i*. We eliminate option pairs when either the call or put has zero open interest or a bid price of zero. The volatility spread for a given firm is computed by taking the weighted average of all the available option pairs where the weight is the average open interest in the call and put options (Cremers and Weinbaum (2010)).

In addition to the volatility spread, we employ the volatility skew measure developed by Xing, Zhang and Zhao (2010). Unlike the volatility spread, which is designed to capture information in a wide range of options across different strike prices and time to maturities, the option-implied volatility skew specifically captures information in out-of-the-money put options. The volatility skew is calculated as the difference in implied volatility between out-of-the-money put options and at-the-money call options. Doran, Peterson and Tarrant (2007) and Xing, Zhang and Zhao (2010) show that an increase in demand for out-of-the-money put options relative to at-the-money call options predicts negative stock returns. Jin, Livnat and Zhang (2012) and Chan, Ge and Lin (2014) find that the volatility skew forecasts positive returns as well.

If option traders believe in the existence of positive abnormal returns subsequent to the split announcement, then we should observe a reduction in the volatility skew over the event window. The volatility skew is estimated as follows:

$$SKEW_{i,t} = IV_{i,t}^{OTMP} - IV_{i,t}^{ATMC} , \tag{5}$$

where $SKEW_{i,t}$ is the option-implied volatility skew for stock *i* on day *t*, $IV_{i,t}^{OTMP}$ is the implied volatility of out-of-the-money put options for stock *i* on day *t*, and $IV_{i,t}^{ATMC}$ is the implied volatility of at-the-money call options for stock *i* on day *t*. Following Jin, Livnat and Zhang (2012), we select out-of-the-money put options by first identifying options that have a delta within the range [-0.45, -0.15] and choose the one that has a delta closest to -0.3. At-the-money call options are those whose delta is closest to 0.5 given that delta is higher than 0.4 and less than 0.7. In this case, as only one call and put is chosen per day for each splitting firm, no weighting is required. Similar to the volatility spread, we examine the change in the volatility skew. That is,

$$\Delta SKEW_{it} = SKEW_{it} - SKEW_{it-1}. \tag{6}$$

2.3 Testing the predictive ability of option measures

For the predictability analysis, we run cross-sectional regressions of various option measures on future stock returns and volatility. We assess whether these option measures can predict stock volatility at the announcement and the change in volatility after the effective date. We also test whether they can predict the announcement returns and returns in the post-announcement period.

To examine whether option-implied volatility can predict stock volatility at the announcement, we run the following regression:

$$AbVol_i = Intercept + \beta \Delta IV_i + \varepsilon_i. \tag{7}$$

$AbVol_i$ is abnormal stock volatility and is estimated as the square of the daily returns on Day 0 or Day +1 minus the average squared returns over the [-60, -20] period. ΔIV_i is the daily change in implied volatility in the pre-announcement period, as defined in equation (1). In the absence of new information and given the persistence in volatility, the daily change in implied volatility should have no predictive power in a cross-sectional analysis. Thus, this regression allows us to test for informed option trading on stock volatility levels after the announcement.

The regression analyzing the predictability of changes in stock volatility after the effective date is:

$$\sigma_{post-effective,i} - \sigma_{pre-effective,i} = Intercept + \beta \Delta IV_i + \varepsilon_i. \tag{8}$$

The post-effective change in volatility is measured as the difference in the annualized standard deviation of the daily returns following the effective date ($\sigma_{post-effective}$) and the annualized standard deviation of the daily returns from the announcement date to the effective date ($\sigma_{pre-effective}$). The number of days for which the post-split volatility is calculated is equivalent to the number of days from the announcement date to the effective date. Given that the date on which the split is effected is announced at the same time the split is, we consider changes in implied volatility on the announcement date and the following few days. Thus, we are examining whether option traders skillfully process the information in the announcement on post-split changes in stock volatility.

As implied volatility is considered a forecast of stock volatility over the life of the option, it would be inappropriate to conduct the predictability analysis on stock volatility using the daily level of implied volatility. For our primary tests of the predictability of future returns though, we use the daily level of the volatility spread and skew. This is consistent with the main analyses undertaken by Jin, Livnat and Zhang (2012) and Chan, Ge and Lin (2014).

To examine whether our option measures can predict the announcement returns, we estimate the following regressions:

$$CAR(0,+1)_i = Intercept + \beta VS_i + \sum_{j=1}^{n} \gamma_j ControlVariables_{ij} + \varepsilon_i, \tag{9}$$

$$CAR(0,+1)_i = Intercept + \beta SKEW_i + \sum_{j=1}^{n} \gamma_j ControlVariables_{ij} + \varepsilon_i. \qquad (10)$$

CAR is the cumulative announcement abnormal return, VS_i and $SKEW_i$ are as defined in equations (4) and (5), and the control variables are described in Appendix 1. These regressions allows us to test whether the level of the spread and skew in the days preceding the announcement explain the announcement returns.

The final regressions we run consider the predictability of returns in the post-announcement period:

$$BHAR(+7,+60)_i = Intercept + \beta VS_i + \sum_{j=1}^{n} \gamma_j ControlVariables_{ij} + \varepsilon_i, \qquad (11)$$

$$BHAR(+7,+60)_i = Intercept + \beta SKEW_i + \sum_{j=1}^{n} \gamma_j ControlVariables_{ij} + \varepsilon_i. \qquad (12)$$

BHAR is the buy and hold abnormal return and the control variables are again listed in Appendix 1[3]. As with the regressions on the post-split change in volatility, we analyze the spread and skew on the announcement day and the following few days. In so doing, we assess option traders' ability to interpret the information in the split announcement on future return drift.

3. Data and sample characteristics

From the OptionMetrics Ivy database, equity option data are collected for the period January 1998 to December 2012. The dataset covers daily closing bid and ask quotes, open interest, volume, implied volatility and the Greeks for all exchange-listed call and put options on U.S. equities. Since options on individual stocks are American options, implied volatilities are calculated using the

[3] The expected return used to calculate both the CAR and BHAR is the daily equal weighted return of the matching size portfolio, where four size portfolios are formed based on NYSE rankings.

Cox-Ross-Rubinstein (1979) binomial tree model, taking into account discrete dividend payments and the possibility of early exercise using historical LIBOR as the interest rate. Specifically, different values of volatility are inserted into the model until the price of the option approximates to the midpoint of the option's best closing bid-ask prices.

The OptionMetrics data are merged with the CRSP files to identify all splitting stocks with a split factor greater than or equal to 25% that have written options. In the period 1998 to 2012, 1,780 stock splits on 1,109 firms meet this requirement. With regard to the option data, each option record must have information on the strike price, best closing bid and ask prices, volume, open interest and implied volatility during the period [-10, +10] where Day 0 is the split announcement date. To address the issues related to thinly traded options, we impose the following filters: (1) options with an absolute value of delta less than 0.02 and more than 0.98 are excluded; (2) options must have maturities that range between 10 to 100 days; (3) all options with a bid-ask spread that is greater than the bid-ask mid-point are removed. There are on average 22 (23) call (put) options available on each splitting firm.

3.1 Summary statistics on option liquidity and implied volatility

To draw an initial inference on how the option market behaves in a period outside the split announcement window, the average implied volatility, volume and open interest of call/put options across different levels of moneyness is examined for the 10 day period from [-60 to -50]. We measure the degree of moneyness of an option using the option delta, which represents the risk-neutral probability of the option being in-the-money at expiration. Table 1 reports the results.

[Insert Table 1 here]

There is a U-shaped volatility smile for both call and put options, as is typically observed. We also see that out-of-the-money and near-the-money options tend to have higher volume and open interest than in-the-money options. This is expected, as trading in the option market is typically motivated by speculation or hedging. Since out-of/near-the-money options are relatively cheaper, they offer investors a higher degree of leverage and a better means to achieve their objective. This in turn makes out-of-/near-the money options more popular amongst investors compared to in-the-money options. Finally, the median volume and open interest for both call and put options are much lower than their means and in some cases equal to zero. This indicates that trading activity in the option market is quite thin where a large fraction of the option trading volume and open interest reside in the contracts of only a few stocks.

3.2 Summary statistics for market capitalization groups

Easley, O'Hara and Srinivas (1998) argue that informed investors' decision to trade in the option market depends on leverage and the liquidity of the option market relative to the stock market. The advantage of a liquid market is that it offers lower trading costs and it allows informed investors to hide their information. Another relevant consideration for informed investors when deciding whether to trade options is the behavior of the market makers. When the market makers obtain news, which they deem to have a material price impact, they will adjust the bid and ask prices in a way that inhibits other informed traders from earning abnormal returns. Informed investors faced with this situation can do one of the following. If they believe that abnormal returns cannot be earned based on the current bid and ask prices, they will not trade. If they disagree with the market makers, they can trade in the opposite direction. Finally, if they agree with the market makers and they believe that abnormal returns can still be earned, their trades will drive the bid and ask prices in the same direction initiated by the market makers. In this context, a significant change in implied volatility or the volatility spread (skew) when option liquidity is low is more likely to reflect the perception of the market makers[4]. Contrastingly, when option liquidity is high, changes in these metrics are more likely to be driven by both the market makers and other informed option traders. Thus, we contend that a significant change in implied volatility or the volatility spread (skew) observed in liquid options is a stronger signal of informed investors' perceptions compared with illiquid options.

Option trading volume, open interest and bid-ask spreads are important elements of option liquidity, but no single attribute adequately describes liquidity. Therefore, a proxy is required that represents all three elements of option liquidity, and market cap is the proxy selected. The classification scheme employed forms four size portfolios, where the first three groups comprise firms that constitute the S&P 500, S&P 400 and S&P 600 indices while the last group includes firms that do not belong to these three indices. Together, the three S&P indices constitute the S&P 1500 index, accounting for approximately 85% of U.S. market capitalization. In unreported results, the average (median) market cap of stocks in the "other" portfolio is higher (lower) than for S&P 600 stocks. The reason for this is that although small firms dominate the "other" portfolio, this group also contains a number of Nasdaq 100 stocks that are not members of the S&P 1500 Index. By design, Nasdaq 100 firms have high market cap.

To evaluate whether market cap adequately captures option liquidity, an examination of option trading volume and open interest is performed using options on stocks associated with the four size portfolios, as previously identified. Table 2 documents the findings. Once again, we observe a U-shaped volatility smile across all four capitalization groups. As for option liquidity, there is a monotonic decline in the mean (median) option volume and open interest as one moves

[4] Illiquid options suggest a low level of trading activity from option investors. This does not necessarily imply a high degree of agreement between the market makers and other informed investors. The low trading activity may be due to minimal interest by investors in the stock and its options.

from the large cap S&P 500 group to the small cap S&P 600 group. This pattern is present in both call and put options, and at different moneyness levels. Option liquidity for stocks that belong to the “other” group, as measured by the mean (median) trading volume and open interest, is higher than in the S&P 600 index and marginally lower than in the S&P 400 index. The “other” portfolio contains a number of higher capitalized Nasdaq 100 stocks, which exhibit high option liquidity. This explains why the average liquidity of options for the “other” portfolio is higher than the S&P 600 portfolio and only slightly lower than the S&P 400 portfolio.

[Insert Table 2 here]

Overall, the results show that option liquidity is increasing in market cap, which supports the use of market cap as a proxy for the level of option liquidity. In addition, stocks that constitute the S&P 500 index not only exhibit the highest option liquidity compared to the other three size groups, the mean (median) option trading volume and open interest for firms in this group is more than triple that of the mid-cap S&P400 group. This is consistent with our earlier evidence that the liquidity in the option market is concentrated in the contracts on a small proportion of stocks. Another advantage of grouping stocks by market cap is that it allows us to assess the perceptions of option traders in stocks that have varying levels of informational efficiency. As well as being the most liquid, S&P500 stocks are also the most informationally efficient, so we are particularly interested in the findings for this group.

3.3 Summary statistics on the volatility spread and skew

Next, we examine the volatility spread and skew over a short period preceding the split announcement window. This forms the first reference point on which to base expectations on the behavior of the volatility spread and skew. Table 3 reports the output. Similar to Cremers and Weinbaum (2010) and Xing, Zhang and Zhao (2010), the mean and median volatility spread are negative while for the volatility skew, these values are positive. This indicates that the implied volatilities inverted from put options are relatively higher than those for call options, which reflects option investors' greater concern over downside risks. The findings for the different market cap groups are broadly consistent with the full sample. However, it is observed that the absolute value of the volatility spread and skew increases as market capitalization decreases. This implies that put options are more expensive in small firms compared to large firms. This is expected, as smaller firms are more likely to be subject to short-sale constraints, which leads to higher demand for put options.

[Insert Table 3 here]

We also note that the absolute value of the volatility spread is lower than the volatility skew. The volatility skew is designed to extract the information in out-of-the-money put options while the volatility spread captures the information in both call and put options. If the difference in implied volatility between call and put options is mainly driven by the put options, then the magnitude of the volatility spread and skew should be similar, they should just have the opposite sign. Thus, the lower absolute value of the volatility spread indicates that these spread differentials are a function of price pressure in both calls and puts.

Overall, the summary statistics indicate that trading activity in the option market is quite thin. Option liquidity does increase markedly though as one moves up through the market cap groups. Moreover, without the effect of new information, the volatility spread and skew are not centered on zero. Thus, to evaluate whether option traders expect positive abnormal returns following stock split announcements, we do not study the level of the volatility spread and skew, rather we examine the change in these two measures.

4. The perceptions of option traders

4.1 Perceptions on volatility

Table 4 reports implied volatility changes for both call and put options during the [-5, +5] event window. Short (long) maturity options are those that expire before (after) the effective date. Prior to the announcement, we observe significant increases in implied volatility in both short maturity calls and puts. Specifically, there are significant increases on days -3, -2 and -1 in calls and on days -2 and -1 in puts. There are also weakly significant increases on day -5 in calls and on day -4 in puts. In contrast, long maturity options only exhibit a significant increase on day -2. As these implied volatility increases are observed in both calls and puts but primarily in short maturity options, they imply that option traders expect that stock volatility will increase when splits are announced. Given that splits are unscheduled events that the market should not have foreknowledge of, these findings are strongly suggestive of information leakage prior to the announcement.

[Insert Table 4 here]

On the announcement day and as expected, there is a very large increase in implied volatility across all option groups. On day +1 though, there is a significant (small) reduction in implied volatility for short maturity puts (calls). In contrast, both long maturity calls and puts exhibit another significant increase in implied volatility on day +1. As this increase is observed in both calls and puts but only in long maturity options, it suggests that option traders expect that stock volatility will increase after the effective date. Given that these are post-announcement changes, they incorporate option traders' interpretation of the information in the event.

Table 5 presents the sub-sample analysis for the four market capitalization groups. The daily change in implied volatility is only reported over the [-2, +2] period in order to conserve space[5]. Across the four size groups, both the short maturity calls and puts consistently show a significantly positive change in implied volatility on either day -2 or day -1, or on both days. Thus, the pre-announcement increase in implied volatility documented in the full sample is also present in each of the four size groups. This is a particularly strong result, as it indicates that stock volatility is expected to increase across a broad cross-section of stocks, whose options will have varying degrees of liquidity. The increase in implied volatility in S&P500 stocks is especially telling, as it is more likely to be driven by completed trades rather than by market makers adjusting spreads to inhibit the informed from profiting.

[Insert Table 5 here]

Unsurprisingly, in all market cap and option groups, there is a large and significant increase in implied volatility on day 0. On the ensuing days though, the behavior of implied volatility varies across the size groups. Specifically, we only observe a significant increase in implied volatility after the announcement day for long maturity options in S&P 600 and "other" stocks. This suggests that the inference reached from the full sample that option traders expect an increase in volatility after the effective date manifests in smaller stocks. In un-tabulated results, the post-split change in stock volatility, as defined in section 2.3, is 10.3% p.a. for the full sample. It is 5.4%, 7.0%, 13.3% and 14.2% for S&P500, S&P400, S&P600 and "other" stocks, respectively. Thus, option traders' expectation of a post-split increase in stock volatility, particularly in smaller stocks, is in line with the actual increases observed.

If an informed investor wishes to trade on information they have acquired on an impending event, when should they start trading to exploit that information? They will probably consider how much trading they think they can get away with without showing their hand. They may trade by

[5] Outside of the [-2, +2] window, that is for days -5, -4, -3, +3, +4 and +5, the change in implied volatility is insignificant for all size groups.

stealth in smaller blocks (Anand and Chakravarty (2007)) over multiple days. It is also likely to depend on the extent of information they have on the impending event. For example, they may have foreknowledge of both the split announcement and when it will be made, perhaps they do not know the exact date of the announcement, or maybe they know that some sort of meaningful corporate announcement will be made in the near future. Regardless, it is unlikely that the significant increases observed in implied volatility prior to the announcement are driven solely by those with some form of inside information. Particularly given the illegality of this trading. At some point, the informed trading by those with some knowledge of the impending split will probably be detected by other informed traders. Once detected, market makers will likely adjust spreads and other informed investors will consider jumping on the bandwagon. Our results show that the critical mass in trading seems to occur a few days prior to the announcement, as this is when implied volatility starts to significantly increase[6].

This increase, which is detected in both short-dated calls and puts, indicates that option traders expect stock volatility to increase post-announcement. Looking more closely though, we see that the magnitude of the increase is larger in calls than puts. Specifically, in table 4, there is a 0.67%, 0.89% and 0.84% increase on days -3, -2 and -1 in calls compared with 0.19%, 0.50% and 0.67% for the corresponding days in puts. The greater buying pressure observed in calls could imply not only an expectation of volatility increases but also of positive abnormal returns on the announcement. In a similar fashion, table 4 shows that the implied volatility increase in long maturity calls is 0.64% on day +1 compared with 0.26% in puts. This could suggest that there is an

[6] It is possible that the observed implied volatility increases are not due to information leakage but are solely due to superior processing of public information by informed traders. We think that this is unlikely though. Further, market makers may adjust spreads as an informed reaction to suspicious trading or as part of their normal inventory management processes. Even in the latter case though, the change in spreads will still have been initiated by informed option trading.

expectation of both an increase in post-split volatility and of positive abnormal returns over the longer-term. Therefore, we need to more carefully analyze whether changes in option-implied volatility reflect a change in investors' perceptions on the volatility or returns of the underlying stock. This is especially pertinent given that An, Ang, Bali and Cakici (2014) find that changes in implied volatility predict future returns. This leads to our next tests, which examine the volatility spread and skew.

4.2 Perceptions on returns

To draw inference on option traders' perceptions on return changes due to splits, we analyze the change in the volatility spread and skew. Prior to the announcement, we are particularly interested in these changes in short maturity options. There are two reasons for this. First, if option investors are trading in anticipation of positive returns on the announcement, they are likely to employ shorter-dated options. Second, in the preceding analysis, there were numerous instances where implied volatility significantly increased in short maturity calls prior to day 0.

Table 6 shows that there are no significant changes in the volatility spread and skew prior to the announcement in short maturity options. In fact, there is only one weakly significant change observed prior to day 0 and this is on day -5 in long maturity options for the volatility spread. The sub-sample analysis for the market cap groups in table 7 broadly corroborates these findings. The only significant change documented is on day -1 for short maturity options in S&P400 stocks for the volatility spread[7]. Prima facie, this significantly positive change implies that option traders expect positive announcement returns in S&P400 stocks. However, it is not supported by a

[7] In the broader [-5, +5] window, there are a few significant changes in spreads and skews in various market cap groups. They do not affect the inferences reached in this section though.

concurrent reduction in the volatility skew. Although the skew does decrease on day -1, it does not do so significantly (t-stat of -1.55). Further, given that this is the only instance of a significant change prior to the announcement, we are wary of placing too much emphasis on this result. In sum, there is little evidence in the pre-announcement spread and skew changes to support the contention that option investors are trading in anticipation of positive announcement returns.

[Insert Tables 6 and 7 here]

Our earlier analysis of volatility perceptions is indicative of pre-announcement information leakage. Given this, a possible interpretation of our return perception findings is that the announcement returns are not large enough to induce option investors to trade. In un-tabulated results, the mean CAR(0, +1) of our split sample is 2.01% (t-stat is 13.68) and the median is 1.41%. Further, 68% of our sample had a positive CAR. Although the announcement return is clearly statistically significant, an average return of 2% may not be deemed large enough given the risk.

Turning our attention to the post-announcement period, table 6 shows that in long maturity options, there is a weakly significant decrease in the volatility skew on day 0 followed by a significant decrease on day +1. This decrease in the skew on day +1 is reinforced by a significant increase in the volatility spread on the same day. These findings suggest that option traders expect positive longer-term return drift following split announcements. When we look at the market cap groups in table 7 though, this inference becomes murky. The significant increase in the volatility spread in long maturity options on day +1 in the full sample appears to be driven by S&P500 stocks. The spread increase on day +1 is weakly significant for this group and insignificant in the other three size groups. However, there is a significant decrease in the spread on day 0 in long maturity options for S&P500 stocks. Given this conflict, one cannot argue that the expectation of positive return drift in the full sample is driven by S&P500 stocks. For the volatility skew, it is insignificant on day +1 in long maturity options in all size groups, in contrast to the full sample. There is a significant decrease in the skew on day 0 in long maturity options for the S&P 600 and "other" group, which conforms with the aggregate results. Thus, if the volatility skew findings point to an expectation of longer-term return drift, then this drift appears to be driven by smaller stocks. Overall, we find some evidence that option traders expect positive return drift over the longer-term, particularly in smaller stocks, but the results are far from conclusive.

4.3 Sensitivity analysis

When splits are announced, it is common for firms to announce other information simultaneously. As an example, for around 30 percent of our sample, stock splits and cash dividends are concurrently announced. Given this, we repeat the analysis for firms that do not have a simultaneous release of other information during the period [-10, +10]. Appendix A presents the findings. The results are very similar to the analogous output in tables 4 and 6. There is evidence of an increase in implied volatility in both call and put options prior to Day 0. Once the split is announced, the increase in implied volatility is stronger and more persistent for options that expire after the effective date. With regard to the volatility spread and skew, once again, we see a significantly positive (negative) change in the volatility spread (skew) on Day +1. In unreported results, we find that this significant change is mainly driven by stocks that belong to the S&P 600 index and the "other" group. In sum, our findings are robust to the simultaneous release of other information.

The statistical significance of the change in implied volatility, and the volatility spread (skew) is inferred based on the assumption that the expected daily change in these measures is zero. To verify this condition, we examine the distribution of these changes during the period [-100, -20]. Appendix B reports that the daily change in these measures is very small, particularly in comparison to the changes observed during the event window of [-5, +5]. Nevertheless, to ensure that our analysis is not influenced by cross-sectional variation in the expected change in implied volatility and the volatility spread (skew), for each firm, we select a benchmark. Specifically, the expected daily change is proxied using the average change in these measures during the period [-100, -20]. The abnormal change is then computed by subtracting the appropriate benchmark. The findings are presented in appendices C and D, which replicate tables 4 and 6 but with abnormal changes. In short, the behavior of the abnormal change in implied volatility and the volatility spread (skew) is very similar to the raw change in these metrics.

5. The predictive ability of option measures

In the analysis of option traders' perceptions on future stock volatility, we document numerous cases where implied volatility significantly increases in short maturity options prior to the announcement. We interpret this as evidence that option traders are acquiring and trading on private information prior to split announcements. We also conjecture that the significant increases observed are unlikely to be solely due to trading on leaked information and that they also probably entail a skillful reaction by other informed traders who are responding to the trading activity observed. However, we cannot isolate to what extent the trading is based on leaked information or skillful processing of public information. What we can say with a reasonable degree of certainty is that the implied volatility increases are strongly suggestive of trading on leaked information. To more directly address whether option traders are skillfully processing information (public or private), we analyze whether pre-event option trading predicts future changes in the return distribution of the underlying stocks.

Given that we have already documented informed trading using pre-announcement changes in implied volatility, we rely on these changes again in our analysis on the predictability of volatility. Specifically, we run cross-sectional regressions of stock volatility levels at the announcement on changes in implied volatility prior to the announcement. As with all the pre-announcement analyses, we focus on short maturity options. Our reasons for doing so are similar to before. If option investors are trading on stock volatility levels in the near future, they are likely to employ shorter-dated options to do so. Additionally, the significant changes in pre-announcement implied volatility are observed in short maturity options.

Table 8 shows that implied volatility changes in short maturity options prior to the announcement do not predict abnormal stock volatility on day 0. However, for stock volatility on day +1, there are significantly positive coefficients in short maturity options on day -2 in calls and on days -5, -3, -2 and -1 in puts. This indicates that pre-announcement implied volatility changes predict stock volatility levels on the day after the announcement. A possible reason for the lack of predictability on day 0 is noise associated with the announcement. Once this noise mitigates, the predictability appears on the following day. These predictability findings complement our earlier results quite nicely. Not only do we document significant increases in implied volatility prior to the announcement, we also show that implied volatility changes predict stock volatility levels after the announcement. More broadly, the perceptions analysis highlights option traders' capacity to acquire private information. Here we show that they also display an ability to process information skillfully.

[Insert Table 8]

In the volatility perceptions analysis, when we examined implied volatility changes after the announcement, we saw significant increases in both long maturity calls and puts on day +1. We interpreted this as evidence that option traders expect an increase in stock volatility after splits are effected. Now we consider whether changes in implied volatility after the announcement can predict the post-split change in stock volatility. Here we are interested in long maturity options.

This is because option traders will likely employ longer-dated options that expire after the effective date if they are trading on post-split stock volatility changes.

Table 9 shows that the coefficients on the change in implied volatility on day +1 in both long maturity calls and puts are significantly positive. There is also a weakly significant positive coefficient on day +5 in long maturity puts. These findings indicate that changes in implied volatility after the announcement predict the post-split change in stock volatility. Again, the regression findings on the predictability of volatility complement the perceptions analysis well. Previously, we documented significant increases in implied volatility on day +1 for both long maturity calls and puts. Now we show that the change in implied volatility for these option groups on day +1 predicts the change in stock volatility after splits are effected. The private informational advantage of option traders is likely to be low directly after the announcement. As such, our interpretation of these findings is that option traders are displaying skill in processing public information[8].

[Insert Table 9]

We now turn our attention to the predictability of future returns. First, we consider the predictability of the announcement returns. To do so, we run regressions of the CAR(0, +1) on the pre-announcement level of the volatility spread and skew. There are no significant coefficients on the spread or skew in Table 10. This implies that the pre-announcement spread and skew do not predict the announcement returns. In the perceptions analysis, we find little evidence that option

[8] In unreported results, we find that the regression output assessing the predictability of volatility is very similar when we constrain the sample to only include splitters that do not have a simultaneous release of other information. When we run the regressions on the four market cap groups, we find that the "other" portfolio tends to drive the significant coefficients reported in tables 8 and 9. The S&P500, S&P400 and S&P600 groups also contribute to the significant findings but to a lesser extent.

investors are trading to exploit the positive announcement returns. We add to this here by documenting that our option measures do not predict the announcement returns.

[Insert Table 10]

Chan, Ge and Lin (2014) contend that even though the average announcement returns of acquirers is close zero, there is large variation in these returns across acquirers. They find that the spread and skew do predict the announcement returns of acquiring firms. With splits, there is much less dispersion in the announcement returns. As discussed previously, the average (median) CAR is 2% (1.4%) and 68% of our sample has a positive CAR. Thus, a possible explanation of our findings is that option traders find it difficult to differentiate between the announcement returns of splitting firms.

Lastly, we consider whether spread and skew levels after the announcement can predict future return drift. Here we are assessing option traders' ability to interpret information in the split announcement on subsequent return drift. In Table 11, there is a significantly positive coefficient on the spread in short maturity options on day +1. There is also a weakly significant positive coefficient on the spread on day +4, again in short maturity options. These findings suggest that post-announcement option trading predicts return drift in the shorter-term. However, the significantly positive coefficients on the spread are not supported by significantly negative coefficients on the skew for the corresponding days. Overall, the evidence on whether post-announcement spread and skew levels predict future return drift is weak[9].

[Insert Table 11]

[9] For consistency with our earlier analyses and for completeness, we rerun the regressions on return predictability but using the daily change in the spread and skew rather than the level. Appendices E and F report the output. There is little in these results that would suggest that the change in spread and skew can predict either the announcement returns or longer-term return drift.

6. Conclusion

This study investigates informed option trading around stock split announcements. To do so, we assess the perceptions of option traders on future stock return and volatility changes due to splits. We also test whether option trading around the event predicts future changes in stock returns and volatility. By considering both perceptions and predictability, we provide a more comprehensive picture of informed trading in options.

We find that option trading activity prior to the announcement indicates that option investors anticipate an increase in stock volatility soon after the announcement. Given that splits are unscheduled events that the market should not have foreknowledge of, this is suggestive of information leakage prior to the announcement. Option trading after the announcement implies that option investors expect stock volatility to increase after splits are effected. There is little evidence though that option investors are trading in anticipation of positive announcement returns or return drift in the longer-term. As a whole, the perceptions analysis indicates that option trading around the event is largely motivated by expected changes in future stock volatility.

Next, we show that pre-event option trading predicts the level of stock volatility soon after the announcement. This highlights option traders' capacity to skillfully process information prior to the announcement. It also complements the perceptions analysis nicely where we show that option traders demonstrate an ability to acquire information on the impending event. Lastly, we find that option trading soon after the announcement predicts the change in stock volatility after splits are effected. Given that informed traders' private informational advantage is likely to be low soon after public announcements, we contend that this emphasizes option traders' skill in processing public information.

In sum, we show that option traders display a capacity to both acquire and skillfully process information prior to split announcements. We also show that they are adept at analyzing public information after the announcement. Collectively, we document strong evidence of informed trading in options around split announcements.

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Appendix 1: Description of the control variables

The CAR regressions (equations (9) and (10)) and the BHAR regressions (equations (11) and (12)) employ the following control variables:

Size: is the natural logarithm of the firm's market capitalization at the end of the month prior to the announcement date.

Analyst: is the number of analysts following the firm for the earnings quarter before the announcement date.

Book-to-market ratio: is the firm's book value of equity at the end of the fiscal year preceding the calendar year of the announcement date divided by the firm's market capitalization at the end of the month prior to the announcement date.

Price: is the natural logarithm of the stock's price 20 days prior to the announcement date.

Volume: is the average dollar trading volume of the stock during the period [-250, -11].

Run-up: is the BHAR [-250, -11].

Arbitrage risk: is the standard deviation of the residuals from a market model regression using the past 48 months of stock returns.

Market risk: is the R-square of the regression used to estimate arbitrage risk.

Split factor.

In addition, the BHAR (+7, +60) regressions also include the CAR (0, +1) as a control variable.

Table 1: Summary statistics on option liquidity and implied volatility

This table reports the liquidity and implied volatility for both call and put options at different levels of moneyness for the 10 day period [-60 to -50] where Day 0 is the split announcement date. The option's degree of moneyness is measured using option delta, which is the risk-neutral probability of the option being in-the-money at expiration. Panel A reports the mean/median volume (Vol), open interest (OI) and implied volatility (IV) for call options while panel B reports the same information for put options. The sample period is 1998-2012.

Panel A: Call options

Moneyness index	Option delta	Mean OI	Median OI	Mean Vol	Median Vol	Mean IV
Deep out-of-the-money	0.02<delta<=0.125	1480	287	91	2	0.5521
Out-of-the-money	0.125<delta<=0.375	940	151	114	5	0.5240
Near-the-money	0.375<delta<=0.625	825	139	117	7	0.5538
In-the-money	0.625<delta<=0.875	649	89	50	0	0.5601
Deep in-the-money	0.875<delta<=0.98	444	45	13	0	0.6462

Panel B: Put options

Moneyness index	Option delta	Mean OI	Median OI	Mean Vol	Median Vol	Mean IV
Deep out-of-the-money	-0.125<delta<=-0.02	1068	201	49	0	0.6716
Out-of-the-money	-0.375<delta<=-0.125	676	80	71	0	0.5853
Near-the-money	-0.625<delta<=-0.375	380	25	50	0	0.5682
In-the-money	-0.875<delta<=-0.625	213	6	17	0	0.5341
Deep in-the-money	-0.98<delta<=-0.875	161	0	6	0	0.5840

Table 2: Summary statistics for market cap groups

This table reports the liquidity and implied volatility for call and put options on stocks that belong to the S&P 500 (large cap stocks), S&P 400 (mid cap stocks) and S&P 600 indices (small cap stocks), and “other” stocks (stocks that are not part of any of these three indices). Panel A reports the mean/median volume (Vol), open interest (OI), and the average implied volatility (IV) for call options during the period [-60 to -50] where Day 0 is the split announcement date. Panel B reports the same information for put options.

Panel A: Call options

Index	Option delta	Mean OI	Median OI	Mean Vol	Median Vol	Mean IV
S&P 500	0.02<delta<=0.125	2625	638	151	12	0.3940
	0.125<delta<=0.375	2179	557	261	29	0.3802
	0.375<delta<=0.625	2077	594	293	34	0.3982
	0.625<delta<=0.875	1616	359	124	5	0.4149
	0.875<delta<=0.98	1001	165	29	0	0.5289
S&P400	0.02<delta<=0.125	801	264	56	0	0.5127
	0.125<delta<=0.375	532	134	61	2	0.4811
	0.375<delta<=0.625	522	142	70	5	0.5019
	0.625<delta<=0.875	403	88	25	0	0.5000
	0.875<delta<=0.98	222	30	6	0	0.6117
S&P 600	0.02<delta<=0.125	197	74	14	0	0.5972
	0.125<delta<=0.375	226	50	24	0	0.5115
	0.375<delta<=0.625	219	53	25	0	0.5140
	0.625<delta<=0.875	167	35	11	0	0.5206
	0.875<delta<=0.98	106	12	3	0	0.6209
Other	0.02<delta<=0.125	629	166	50	0	0.7787
	0.125<delta<=0.375	401	95	57	1	0.6962
	0.375<delta<=0.625	371	88	60	5	0.7140
	0.625<delta<=0.875	300	56	27	0	0.7249
	0.875<delta<=0.98	230	36	9	0	0.8054

Panel B: Put options

Index	Option delta	Mean OI	Median OI	Mean Vol	Median Vol	Mean IV
S&P 500	-0.125<delta<=-0.02	2219	751	93	3	0.5094
	-0.375<delta<=-0.125	1691	455	167	13	0.4247
	-0.625<delta<=-0.375	995	169	130	6	0.4075
	-0.875<delta<=-0.625	517	48	43	0	0.4010
	-0.98<delta<=-0.875	360	10	13	0	0.4455
S&P400	-0.125<delta<=-0.02	525	134	22	0	0.6101
	-0.375<delta<=-0.125	399	78	43	0	0.5247
	-0.625<delta<=-0.375	223	24	29	0	0.5109
	-0.875<delta<=-0.625	110	4	9	0	0.4794
	-0.98<delta<=-0.875	54	0	4	0	0.5281
S&P 600	-0.125<delta<=-0.02	288	59	12	0	0.6391
	-0.375<delta<=-0.125	168	30	18	0	0.5458
	-0.625<delta<=-0.375	94	10	10	0	0.5212
	-0.875<delta<=-0.625	60	0	4	0	0.5001
	-0.98<delta<=-0.875	22	0	1	0	0.6178
Other	-0.125<delta<=-0.02	397	105	27	0	0.8678
	-0.375<delta<=-0.125	271	42	37	0	0.7611
	-0.625<delta<=-0.375	156	11	23	0	0.7358
	-0.875<delta<=-0.625	102	1	8	0	0.7066
	-0.98<delta<=-0.875	85	0	3	0	0.7883

Table 3: Summary statistics on the volatility spread and skew

This table reports the distribution of the volatility spread and skew for the period [-60 to -50] where Day 0 is the split announcement date. Panel A reports the summary statistics for the full sample while Panel B reports the same information for each market capitalization group. The volatility spread is the weighted average of the difference in implied volatility across all valid call and put option pairs matched on the same strike price and maturity date. The weight is the average open interest of the call and put options. The volatility skew is the difference in implied volatility of out-of-the-money put and at-the-money call options. Out-of-the-money put options are those with delta closest to -0.3 and at-the-money call options are those with delta closest to 0.5.

Panel A: Full sample

		Volatility spread	Volatility skew
	Mean	-0.0174	0.0318
	25th percentile	-0.0294	0.0024
	Median	-0.0089	0.0214
	75th percentile	0.0035	0.0440
	Standard deviation	0.0556	0.0415

Panel B: Market capitalization groups

Index		Volatility spread	Volatility skew
S&P 500	Mean	-0.0084	0.0239
	25th percentile	-0.0175	0.0035
	Median	-0.0054	0.0184
	75th percentile	0.0039	0.0341
	Standard deviation	0.0353	0.0262
S&P 400	Mean	-0.0097	0.0293
	25th percentile	-0.0217	0.0035
	Median	-0.0059	0.0215
	75th percentile	0.0056	0.0419
	Standard deviation	0.0438	0.0351
S&P 600	Mean	-0.0132	0.0327
	25th percentile	-0.0258	0.0008
	Median	-0.0073	0.0226
	75th percentile	0.0059	0.0463
	Standard deviation	0.0497	0.0415
Other	Mean	-0.0258	0.0398
	25th percentile	-0.0465	0.0017
	Median	-0.0165	0.0265
	75th percentile	0.0019	0.0575
	Standard deviation	0.0633	0.0520

Table 4: Implied volatility changes around split announcements

This table reports the change in implied volatility for call and put options around the split announcement date. The event window is [-5, +5] where Day 0 is the announcement date. Short maturity options expire before the effective date while long maturity options expire after the effective date. The sample period is 1998-2012. Numbers in parentheses are the t-statistic of the means. *,** indicate significance at the 10% and 5% level, respectively.

	Call		**Put**	
Day	Short maturity	Long maturity	Short maturity	Long maturity
-5	0.0035*	0.0014	0.0021	0.0012*
	(1.75)	*(1.20)*	*(1.62)*	*(1.75)*
-4	-0.0002	-0.0002	0.0023*	0.0008
	(-0.08)	*(-0.17)*	*(1.70)*	*(1.03)*
-3	0.0067**	-0.0012	0.0019	-0.0013**
	(3.08)	*(-1.08)*	*(1.37)*	*(-2.01)*
-2	0.0089**	0.0025**	0.0050**	0.0020**
	(3.57)	*(2.69)*	*(3.52)*	*(3.00)*
-1	0.0084**	0.0015	0.0067**	-0.0004
	(3.54)	*(1.48)*	*(4.07)*	*(-0.61)*
0	0.0124**	0.0117**	0.0156**	0.0118**
	(4.51)	*(7.87)*	*(7.98)*	*(11.74)*
1	-0.0025	0.0064**	-0.0056**	0.0026**
	(-0.94)	*(4.57)*	*(-2.50)*	*(2.41)*
2	0.0030	-0.0004	0.0015	-0.0003
	(1.04)	*(-0.34)*	*(0.70)*	*(-0.40)*
3	0.0049	0.0000	0.0023	0.0012
	(1.63)	*(0.04)*	*(1.31)*	*(1.63)*
4	0.0014	-0.0009	0.0026	-0.0001
	(0.56)	*(-0.91)*	*(1.47)*	*(-0.14)*
5	0.0010	-0.0001	0.0016	0.0007
	(0.35)	*(-0.14)*	*(0.83)*	*(1.04)*

Table 5: Implied volatility changes in market cap groups

This table reports the change in implied volatility for call and put options on stocks that belong to the S&P 500, S&P 400 and S&P 600 indices, and the "other" group (stocks that do not constitute any of the three indices). The event window is [-2, +2] where Day 0 is the split announcement date. *, ** indicate significance at the 10% and 5% level, respectively.

		Call		**Put**	
Index	Day	Short maturity	Long maturity	Short maturity	Long maturity
S&P 500	-2	0.0068*	0.0009	0.0056**	0.0029*
		(1.91)	*(0.52)*	*(2.66)*	*(1.89)*
	-1	0.0012	0.0017	0.0049**	-0.0013
		(0.37)	*(1.14)*	*(2.48)*	*(-0.96)*
	0	0.0084**	0.0051**	0.0138**	0.0115**
		(2.39)	*(2.18)*	*(3.70)*	*(6.68)*
	1	-0.0058	0.0031	-0.0113**	-0.0018
		(-1.36)	*(1.37)*	*(-3.04)*	*(-1.08)*
	2	0.0016	-0.0005	-0.0004	-0.0019
		(0.34)	*(-0.24)*	*(-0.13)*	*(-1.12)*
S&P 400	-2	0.0021	0.0018	0.0053**	0.0011
		(0.50)	*(1.04)*	*(2.27)*	*(0.96)*
	-1	0.0094**	0.0020	0.0012	-0.0005
		(2.07)	*(0.82)*	*(0.45)*	*(-0.45)*
	0	0.0108**	0.0122**	0.0151**	0.0106**
		(2.66)	*(3.75)*	*(3.98)*	*(6.22)*
	1	-0.0006	0.0028	-0.0011	0.0022
		(-0.11)	*(1.05)*	*(-0.36)*	*(1.35)*
	2	-0.0031	-0.0014	0.0019	0.0003
		(-0.79)	*(-0.63)*	*(0.43)*	*(0.24)*
S&P 600	-2	0.0145**	0.0036*	0.0020	0.0010
		(2.80)	*(1.80)*	*(0.58)*	*(0.77)*
	-1	0.0051	0.0007	0.0095**	-0.0003
		(1.00)	*(0.34)*	*(2.68)*	*(-0.22)*
	0	0.0142**	0.0131**	0.0137**	0.0093**
		(2.54)	*(4.60)*	*(3.19)*	*(4.48)*
	1	0.0043	0.0075**	-0.0010	0.0021
		(0.76)	*(3.14)*	*(-0.20)*	*(1.23)*
	2	0.0014	0.0003	0.0084*	0.0043**
		(0.20)	*(0.13)*	*(1.87)*	*(3.14)*
Other	-2	0.0116*	0.0034*	0.0066**	0.0029**
		(1.94)	*(1.77)*	*(2.06)*	*(2.10)*
	-1	0.0164**	0.0017	0.0102**	0.0002
		(2.99)	*(0.85)*	*(2.52)*	*(0.15)*
	0	0.0159**	0.0151**	0.0189**	0.0146**
		(2.25)	*(4.88)*	*(5.00)*	*(6.79)*
	1	-0.0057	0.0104**	-0.0070	0.0062**
		(-1.04)	*(3.25)*	*(-1.34)*	*(2.40)*
	2	0.0099	-0.0002	-0.0024	-0.0031*
		(1.58)	*(-0.09)*	*(-0.52)*	*(-1.79)*

Table 6: Volatility spread and skew changes around split announcements

This table reports the change in the option-implied volatility spread and skew. The volatility spread is calculated as the weighted average difference in implied volatility between call and put options matched on the same strike price and maturity date. The weight is the average open interest of the call and put options. The volatility skew is the difference in implied volatility between out-of-the-money put options and at-the-money call options. An out-of-the-money put option is one whose delta is closest to -0.3 and an at-the-money call option is one whose delta is closest to 0.5. The event window is [-5, +5] where Day 0 is the announcement date. *, ** indicate significance at the 10% and 5% level, respectively.

	Volatility spread		**Volatility skew**	
Day	Short maturity	Long maturity	Short maturity	Long maturity
-5	0.0007	0.0023*	-0.0003	-0.0007
	(0.46)	*(1.83)*	*(-0.26)*	*(-0.90)*
-4	-0.0004	-0.0012	-0.0020	-0.0005
	(-0.25)	*(-1.22)*	*(-1.57)*	*(-0.83)*
-3	0.0002	-0.0003	0.0013	0.0001
	(0.14)	*(-0.35)*	*(1.18)*	*(0.11)*
-2	-0.0003	0.0007	-0.0003	-0.0007
	(-0.16)	*(0.71)*	*(-0.21)*	*(-1.04)*
-1	0.0023	0.0003	-0.0016	0.0007
	(1.49)	*(0.28)*	*(-1.44)*	*(1.07)*
0	-0.0015	0.0007	0.0002	-0.0014*
	(-0.78)	*(0.50)*	*(0.18)*	*(-1.71)*
1	0.0002	0.0031**	-0.0002	-0.0019**
	(0.11)	*(2.41)*	*(-0.13)*	*(-2.27)*
2	-0.0004	0.0002	0.0002	0.0003
	(-0.19)	*(0.18)*	*(0.14)*	*(0.40)*
3	-0.0007	-0.0011	0.0010	0.0004
	(-0.40)	*(-1.03)*	*(0.86)*	*(0.66)*
4	0.0002	-0.0007	-0.0011	0.0004
	(0.11)	*(-0.72)*	*(-0.84)*	*(0.70)*
5	-0.0035**	-0.0013	-0.0012	0.0009
	(-2.05)	*(-1.29)*	*(-1.09)*	*(1.35)*

Table 7: Volatility spread and skew changes in market cap groups

This table reports the change in the option-implied volatility spread and skew on stocks that belong the S&P 500, S&P 400 and S&P 600 indices, and the "other" group (stocks that do not constitute any of the three indices). The event window is [-2, +2] where Day 0 is the split announcement date. *, ** indicate significance at the 10% and 5% level, respectively.

		Volatility spread		**Volatility skew**	
Index	Day	Short maturity	Long maturity	Short maturity	Long maturity
S&P 500	-2	-0.0003	0.0001	-0.0009	-0.0015
		(-0.08)	*(0.04)*	*(-0.49)*	*(-1.43)*
	-1	-0.0009	-0.0005	-0.0008	0.0008
		(-0.44)	*(-0.32)*	*(-0.51)*	*(0.68)*
	0	-0.0021	-0.0044**	0.0016	0.0019
		(-0.77)	*(-2.06)*	*(0.68)*	*(1.21)*
	1	0.0019	0.0040*	-0.0022	-0.0027
		(0.57)	*(1.74)*	*(-0.79)*	*(-1.56)*
	2	0.0004	-0.0006	-0.0004	0.0003
		(0.14)	*(-0.28)*	*(-0.22)*	*(0.30)*
S&P 400	-2	-0.0015	0.0001	0.0031	-0.0010
		(-0.67)	*(0.10)*	*(1.04)*	*(-0.87)*
	-1	0.0090**	0.0014	-0.0041	0.0006
		(3.25)	*(0.73)*	*(-1.55)*	*(0.49)*
	0	-0.0025	-0.0005	-0.0008	0.0013
		(-0.70)	*(-0.22)*	*(-0.36)*	*(0.90)*
	1	-0.0035	0.0025	0.0023	-0.0019
		(-0.90)	*(1.13)*	*(0.74)*	*(-1.15)*
	2	-0.0005	-0.0009	-0.0022	0.0005
		(-0.17)	*(-0.50)*	*(-0.73)*	*(0.32)*
S&P 600	-2	-0.0008	0.0019	-0.0026	0.0001
		(-0.22)	*(1.02)*	*(-0.89)*	*(0.09)*
	-1	0.0032	0.0007	-0.0006	0.0002
		(0.87)	*(0.33)*	*(-0.21)*	*(0.10)*
	0	-0.0020	0.0018	-0.0045	-0.0059**
		(-0.53)	*(0.77)*	*(-1.50)*	*(-3.03)*
	1	0.0024	0.0038	0.0007	-0.0020
		(0.53)	*(1.44)*	*(0.18)*	*(-1.03)*
	2	-0.0068*	-0.0014	0.0035	0.0034**
		(-1.78)	*(-0.69)*	*(1.07)*	*(2.56)*
Other	-2	0.0010	0.0006	-0.0004	-0.0004
		(0.25)	*(0.32)*	*(-0.16)*	*(-0.32)*
	-1	-0.0001	-0.0002	-0.0015	0.0011
		(-0.03)	*(-0.09)*	*(-0.67)*	*(0.87)*
	0	0.0001	0.0044	0.0022	-0.0027*
		(0.02)	*(1.39)*	*(0.79)*	*(-1.91)*
	1	-0.0002	0.0023	-0.0002	-0.0012
		(-0.04)	*(0.85)*	*(-0.07)*	*(-0.83)*
	2	0.0032	0.0027	0.0006	-0.0019
		(0.74)	*(1.04)*	*(0.17)*	*(-1.36)*

Table 8: Regressions of announcement volatility on changes in implied volatility

This table reports the output from the cross-sectional regressions of abnormal daily stock volatility (AbVol) on the change in option-implied volatility (ΔIV) for the sample of splitting firms. Abnormal daily stock volatility is estimated as the square of the daily returns on Day 0 (Day +1) minus the average squared returns over the [-60, -20] period. ΔIV is defined as in equations (1) and (2). Panel A reports the coefficients on ΔIV and the associated t-statistics for call options while panel B reports the same information for put options. Intercepts have been suppressed to conserve space. Short maturity options expire before the effective date while long maturity options expire after the effective date. The sample period is 1998-2012. *,** indicate significance at the 10% and 5% level, respectively.

Panel A: Call options

	Short maturity		Long maturity	
Day	Day 0 AbVol	Day 1 AbVol	Day 0 AbVol	Day 1 AbVol
-5	0.0012	-0.0058	0.0237	0.0004
	(0.41)	*(-0.88)*	*(1.38)*	*(0.04)*
-4	0.0027	-0.0002	0.0037	-0.0067
	(1.43)	*(-0.03)*	*(0.47)*	*(-0.41)*
-3	0.0035	-0.0009	0.0082	0.0079
	(1.52)	*(-0.17)*	*(0.96)*	*(1.12)*
-2	-0.0016	0.0103**	0.0295	0.0241**
	(-0.69)	*(2.44)*	*(1.10)*	*(2.51)*
-1	0.0029	0.0077	0.0111	0.0053
	(1.37)	*(1.24)*	*(0.63)*	*(0.82)*

Panel B: Put options

	Short maturity		Long maturity	
Day	Day 0 AbVol	Day 1 AbVol	Day 0 AbVol	Day 1 AbVol
-5	0.0171	0.0209**	0.0270*	0.0472
	(1.35)	*(2.11)*	*(1.70)*	*(1.33)*
-4	0.0071	-0.0136	0.0347	-0.0193
	(1.61)	*(-1.04)*	*(1.22)*	*(-0.53)*
-3	0.0043	0.0179**	0.0078	0.0312
	(0.97)	*(2.43)*	*(0.43)*	*(1.49)*
-2	0.0137	0.0223**	0.0359	0.0202
	(1.21)	*(2.57)*	*(1.35)*	*(1.29)*
-1	0.0520	0.0228**	0.0463	0.0204
	(1.33)	*(2.11)*	*(0.78)*	*(1.07)*

Table 9: Regressions of the change in post-split volatility on changes in implied volatility

This table reports the output from the cross-sectional regressions of the change in volatility following the effective date on the change in option-implied volatility (ΔIV) during the announcement window. The post-effective change in volatility is measured as the difference in the annualized standard deviation of the returns following the effective date and the annualized standard deviation of the returns from the announcement date to the effective date. The number of days for which the post-split volatility is calculated is equivalent to the number of days from the announcement date to the effective date. The coefficients on ΔIV and the associated t-statistics are reported. Intercepts have been suppressed to conserve space. *,** indicate significance at the 10% and 5% level, respectively.

	Call		**Put**	
Day	Short Maturity	Long Maturity	Short Maturity	Long Maturity
0	0.0162	-0.2025	0.1168	0.0784
	(0.14)	*(-0.92)*	*(0.82)*	*(0.18)*
1	0.1823	0.8710**	0.2354	0.9017*
	(1.27)	*(2.64)*	*(1.26)*	*(1.89)*
2	0.0995	-0.2141	0.1693	0.9760
	(0.65)	*(-0.42)*	*(0.90)*	*(1.34)*
3	-0.2080	0.6059	-0.5247*	0.3033
	(-1.41)	*(1.47)*	*(-1.72)*	*(0.31)*
4	-0.0203	-0.4942	0.0230	-0.2966
	(-0.17)	*(-1.23)*	*(0.08)*	*(-0.50)*
5	0.0603	0.9762	-0.0629	2.5907*
	(0.53)	*(1.22)*	*(-0.37)*	*(1.73)*

Table 10: Regressions of announcement returns on the volatility spread and skew

This table reports the output from the cross-sectional regressions of the cumulative announcement abnormal returns (CAR) on the pre-announcement level of the option volatility spread and skew. The abnormal return is estimated as the return of the splitting firm minus the return of a size portfolio that the firm belongs to on a given day. The spread and skew are defined as in equations (4) and (5), respectively. The control variables in the regression are described in Appendix 1. The coefficients on the spread and skew, and the associated t-statistics are reported. Intercepts and coefficients on the control variables are suppressed to conserve space. *,** indicate significance at the 10% and 5% level, respectively.

	Volatility spread		**Volatility skew**	
Day	Short Maturity	Long Maturity	Short Maturity	Long Maturity
-5	-0.0626	-0.1068	0.0481	0.0251
	(-1.12)	*(-0.99)*	*(0.52)*	*(0.18)*
-4	0.0060	-0.1500	-0.1215	0.0814
	(0.09)	*(-1.25)*	*(-1.05)*	*(0.52)*
-3	-0.0406	-0.0936	-0.1267	-0.0544
	(-0.80)	*(-0.86)*	*(-1.13)*	*(-0.41)*
-2	0.0074	-0.0231	-0.1287	-0.0540
	(0.13)	*(-0.26)*	*(-1.24)*	*(-0.46)*
-1	0.0329	-0.0721	-0.0968	0.0199
	(0.59)	*(-0.88)*	*(-0.87)*	*(0.17)*

Table 11: Regressions of post-announcement returns on the volatility spread and skew

This table reports the output from the cross-sectional regressions of the buy and hold abnormal returns (BHAR) on the level of the option volatility spread and skew. The BHAR is estimated during the period [+7, +60] as the return of the splitting firm minus the return of a size portfolio that the firm belongs to on the announcement date. The control variables in the regression are described in Appendix 1. The coefficients on the spread and skew, and the associated t-statistics are reported. Intercepts and coefficients on the control variables are suppressed to conserve space. *,** indicate significance at the 10% and 5% level, respectively.

	Volatility spread		**Volatility skew**	
Day	Short Maturity	Long Maturity	Short Maturity	Long Maturity
0	0.2242	0.2996	-0.1959	0.1138
	(1.07)	*(1.32)*	*(-0.46)*	*(0.23)*
1	0.5218**	0.4424	-0.4219	-0.3162
	(2.05)	*(1.54)*	*(-1.27)*	*(-0.74)*
2	-0.0158	0.0418	-0.2536	-0.1058
	(-0.07)	*(0.14)*	*(-0.69)*	*(-0.20)*
3	0.1886	-0.0335	-0.0967	-0.0500
	(0.89)	*(-0.10)*	*(-0.33)*	*(-0.10)*
4	0.3996*	0.4536	-0.2773	-0.3166
	(1.79)	*(1.43)*	*(-0.70)*	*(-0.68)*
5	-0.2008	-0.0598	0.5075	-0.3286
	(-0.85)	*(-0.20)*	*(1.24)*	*(-0.81)*

Appendix A: Sensitivity to simultaneous information releases

This table reports the change in option-implied volatility, volatility spread and volatility skew for the subset of firms that do not have a simultaneous release of other information during the period [-10, +10] where Day 0 is the split announcement date. *, ** indicate significance at the 10% and 5% level, respectively. Panel A reports the change in option-implied volatility while Panel B reports the change in the option volatility spread and skew.

Panel A: Implied volatility changes around split announcements

	Call		Put	
Day	Short maturity	Long maturity	Short maturity	Long maturity
-5	0.0052*	0.0025	0.0020	0.0006
	(1.91)	*(1.65)*	*(1.16)*	*(0.65)*
-4	-0.0001	-0.0004	0.0029*	0.0010
	(-0.03)	*(-0.27)*	*(1.69)*	*(0.99)*
-3	0.0089**	-0.0010	0.0017	-0.0013
	(3.31)	*(-0.67)*	*(0.91)*	*(-1.55)*
-2	0.0120**	0.0039**	0.0055**	0.0033**
	(3.65)	*(3.23)*	*(3.01)*	*(3.40)*
-1	0.0075**	0.0011	0.0065**	-0.0003
	(2.38)	*(0.87)*	*(3.06)*	*(-0.36)*
0	0.0129**	0.0118**	0.0165**	0.0106**
	(3.44)	*(6.28)*	*(6.49)*	*(8.54)*
1	-0.0043	0.0070**	-0.0085**	0.0031**
	(-1.28)	*(3.92)*	*(-2.94)*	*(2.23)*
2	0.0034	-0.0004	0.0009	-0.0007
	(0.94)	*(-0.27)*	*(0.34)*	*(-0.67)*
3	0.0051	0.0010	0.0022	0.0019**
	(1.26)	*(0.59)*	*(0.91)*	*(1.98)*
4	0.0019	-0.0017	0.0029	0.0001
	(0.58)	*(-1.38)*	*(1.19)*	*(0.07)*
5	0.0057	0.0012	0.0048*	0.0007
	(1.47)	*(0.90)*	*(1.82)*	*(0.75)*

Panel B: Volatility spread and skew changes around split announcements

	Volatility spread		Volatility skew	
Day	Short maturity	Long maturity	Short maturity	Long maturity
-5	0.0010	0.0035**	-0.0006	-0.0012
	(0.60)	*(2.48)*	*(-0.50)*	*(-1.33)*
-4	-0.0009	-0.0010	-0.0016	-0.0006
	(-0.57)	*(-1.01)*	*(-1.29)*	*(-0.93)*
-3	0.0003	-0.0004	0.0016	0.0001
	(0.21)	*(-0.44)*	*(1.46)*	*(0.19)*
-2	-0.0001	0.0004	-0.0004	-0.0005
	(-0.05)	*(0.45)*	*(-0.35)*	*(-0.82)*
-1	0.0024	0.0004	-0.0014	0.0007
	(1.57)	*(0.42)*	*(-1.27)*	*(0.97)*
0	-0.0015	0.0009	0.0002	-0.0011
	(-0.76)	*(0.64)*	*(0.13)*	*(-1.40)*
1	0.0013	0.0031**	-0.0012	-0.0020**
	(0.65)	*(2.49)*	*(-0.82)*	*(-2.53)*
2	-0.0007	0.0002	0.0010	0.0004
	(-0.40)	*(0.21)*	*(0.80)*	*(0.66)*
3	-0.0008	-0.0010	0.0015	0.0003
	(-0.45)	*(-0.92)*	*(1.30)*	*(0.41)*
4	0.0004	-0.0009	-0.0021*	0.0006
	(0.26)	*(-0.88)*	*(-1.67)*	*(1.04)*
5	-0.0033**	-0.0005	-0.0011	0.0009
	(-1.97)	*(-0.50)*	*(-0.94)*	*(1.29)*

Appendix B: Summary statistics for the change in implied volatility, volatility spread and volatility skew

This table reports the mean, median, standard deviation, skewness and kurtosis of the change in option-implied volatility, volatility spread and volatility skew during the period [-100, -20] where Day 0 is the split announcement date. Numbers in parentheses are the t-statistic of the means.

	Δ*IV* Call	**Δ*IV* Put**	**Δ*VS***	**Δ*SKEW***
Mean	-0.000036	-0.000060	-0.000016	-0.000041
	(-0.24)	*(-0.57)*	*(-0.11)*	*(-0.35)*
Median	-0.000330	-0.000311	0.000046	0.000032
Standard Deviation	0.054	0.038	0.051	0.038
Skewness	-0.086	0.810	0.066	0.811
Kurtosis	64	102	128	146

Appendix C: Abnormal change in implied volatility around split announcements

This table reports the abnormal change in implied volatility for call and put options around the split announcement date. The abnormal change in implied volatility is the change in implied volatility during the event window less the expected change in implied volatility. The expected change in implied volatility is estimated using the average change in implied volatility during the period [-100, -20] where Day 0 is the announcement date. Short maturity options expire before the effective date while long maturity options expire after the effective date. The sample period is 1998-2012. Numbers in parentheses are the t-statistic of the means. *,** indicate significance at the 10% and 5% level, respectively.

	Call		**Put**	
Day	Short maturity	Long maturity	Short maturity	Long maturity
-5	0.0037*	0.0016	0.0019	0.0009
	(1.79)	*(1.31)*	*(1.46)*	*(1.34)*
-4	-0.0003	-0.0001	0.0025*	0.0012
	(-0.16)	*(-0.10)*	*(1.83)*	*(1.60)*
-3	0.0069**	-0.0008	0.0020	-0.0010
	(3.14)	*(-0.71)*	*(1.43)*	*(-1.51)*
-2	0.0090**	0.0027**	0.0052**	0.0023**
	(3.55)	*(2.76)*	*(3.65)*	*(3.34)*
-1	0.0081**	0.0018*	0.0062**	-0.0004
	(3.38)	*(1.69)*	*(3.79)*	*(-0.60)*
0	0.0124**	0.0115**	0.0152**	0.0116**
	(4.42)	*(7.53)*	*(7.76)*	*(11.41)*
1	-0.0016	0.0065**	-0.0056**	0.0025**
	(-0.61)	*(4.58)*	*(-2.49)*	*(2.35)*
2	0.0032	-0.0005	0.0016	-0.0003
	(1.10)	*(-0.40)*	*(0.78)*	*(-0.37)*
3	0.0041	0.0001	0.0023	0.0014*
	(1.40)	*(0.10)*	*(1.28)*	*(1.88)*
4	0.0011	-0.0009	0.0031*	0.0001
	(0.45)	*(-0.86)*	*(1.68)*	*(0.13)*
5	0.0020	0.0004	0.0016	0.0006
	(0.69)	*(0.35)*	*(0.81)*	*(0.95)*

Appendix D: Abnormal change in the volatility spread and skew around split announcements

This table reports the abnormal change in the option-implied volatility spread and skew. The abnormal change in the volatility spread (skew) is the change in the volatility spread (skew) during the event window less the expected change in these variables. The expected change in the volatility spread (skew) is estimated using the average change in the volatility spread (skew) during the period [-100, -20] where Day 0 is the announcement date. *,** indicate significance at the 10% and 5% level, respectively.

	Volatility spread		**Volatility skew**	
Day	Short maturity	Long maturity	Short maturity	Long maturity
-5	0.0008	0.0026**	-0.0003	-0.0008
	(0.49)	*(2.05)*	*(-0.29)*	*(-0.96)*
-4	-0.0008	-0.0009	-0.0015	-0.0005
	(-0.54)	*(-0.91)*	*(-1.21)*	*(-0.74)*
-3	0.0007	-0.0003	0.0012	0.0001
	(0.45)	*(-0.33)*	*(1.09)*	*(0.11)*
-2	-0.0002	0.0005	-0.0004	-0.0006
	(-0.09)	*(0.52)*	*(-0.30)*	*(-0.85)*
-1	0.0023	0.0004	-0.0013	0.0007
	(1.50)	*(0.44)*	*(-1.14)*	*(0.98)*
0	-0.0016	0.0007	0.0001	-0.0012
	(-0.80)	*(0.50)*	*(0.10)*	*(-1.43)*
1	0.0012	0.0032**	-0.0010	-0.0021**
	(0.59)	*(2.52)*	*(-0.68)*	*(-2.58)*
2	-0.0005	0.0000	0.0009	0.0006
	(-0.25)	*(0.03)*	*(0.71)*	*(0.89)*
3	-0.0009	-0.0010	0.0014	0.0003
	(-0.52)	*(-0.89)*	*(1.19)*	*(0.44)*
4	0.0006	-0.0008	-0.0019	0.0006
	(0.36)	*(-0.77)*	*(-1.44)*	*(0.92)*
5	-0.0033*	-0.0007	-0.0011	0.0009
	(-1.91)	*(-0.75)*	*(-0.98)*	*(1.38)*

Appendix E: Regressions of announcement returns on changes in the volatility spread and skew

This table reports the output from the cross-sectional regressions of the cumulative announcement abnormal returns (CAR) on the pre-announcement change in the option volatility spread and skew. The abnormal return is estimated as the return of the splitting firm minus the return of a size portfolio that the firm belongs to on a given day. The spread and skew are defined as in equations (3) and (4), and (5) and (6), respectively. The control variables in the regression are described in Appendix 1. The coefficients on the change in the spread and skew, and the associated t-statistics are reported. Intercepts and coefficients on the control variables are suppressed to conserve space. *,** indicate significance at the 10% and 5% level, respectively.

	Volatility spread		**Volatility skew**	
Day	Short Maturity	Long Maturity	Short Maturity	Long Maturity
-5	0.0217	0.0064	-0.0109	0.0103
	(0.47)	*(0.10)*	*(-0.14)*	*(0.11)*
-4	0.0564	-0.0579	-0.1422**	0.1109
	(1.40)	*(-0.79)*	*(-2.03)*	*(0.95)*
-3	-0.0417	0.0633	-0.0135	-0.2488*
	(-1.09)	*(0.96)*	*(-0.19)*	*(-1.86)*
-2	0.0370	0.0867	-0.0171	-0.0084
	(1.14)	*(1.19)*	*(-0.24)*	*(-0.08)*
-1	0.0201	-0.0504	0.0519	0.1226
	(0.50)	*(-0.78)*	*(0.72)*	*(1.06)*

Appendix F: Regressions of post-announcement returns on changes in the volatility spread and skew

This table reports the output from the cross-sectional regressions of the buy and hold abnormal returns (BHAR) on the change in the option volatility spread and skew. The BHAR is estimated during the period [+7, +60] as the return of the splitting firm minus the return of a size portfolio that the firm belongs to on the announcement date. The control variables in the regression are described in Appendix 1. The coefficients on the change in the spread and skew, and the associated t-statistics are reported. Intercepts and coefficients on the control variables are suppressed to conserve space. *,** indicate significance at the 10% and 5% level, respectively.

	Volatility spread		**Volatility skew**	
Day	Short Maturity	Long Maturity	Short Maturity	Long Maturity
0	0.1364	0.2265	0.0296	0.2050
	(0.75)	*(1.29)*	*(0.08)*	*(0.52)*
1	0.1338	-0.0053	-0.1470	-0.4079
	(0.75)	*(-0.02)*	*(-0.49)*	*(-1.01)*
2	-0.2998	-0.2756	0.1872	0.2928
	(-1.39)	*(-1.12)*	*(0.51)*	*(0.60)*
3	0.1387	-0.0674	0.1392	0.0877
	(0.60)	*(-0.25)*	*(0.39)*	*(0.16)*
4	0.2018	0.4792*	-0.1370	-0.3989
	(1.14)	*(1.82)*	*(-0.52)*	*(-0.92)*
5	-0.4531**	-0.4678*	1.0401**	-0.1078
	(-2.08)	*(-1.78)*	*(2.11)*	*(-0.23)*