Trading in option contracts before large price changes:
A comparative study of US and UK stocks

Abstract

Previous studies indicate that traders in possession of important information are more likely to transact in option contracts rather than the underlying asset. This paper examines stock option trading volume before significant price changes in the underlying stock for all S&P100 and FTSE 100 constituent stocks; large stock price changes imply that significant unanticipated related information has arrived in the market. Our findings indicate irregular option trading volume before for a significant amount of large price changes. For High Book to Market and High/Low Market Value stocks, abnormal post-shock returns are related to pre-event option trading volume. Both effects are much less pronounced in the UK market.

Keywords: Price shocks, informed trading, option markets, trading volume
JEL Classifications: G1, G12, G14

1. Introduction

Previous studies indicate that traders in possession of important information are more likely to transact in option contracts rather than the underlying asset due to lower transactions costs, higher leverage, and downside protection (Black, 1972; Lee and Cheong, 2001; Chakravarty, Gulen, and Mayhew, 2004; among others). Manaster and Rendleman (1982) also argue that it is likely that option prices contain information about equilibrium equity prices that is not promptly reflected in market prices. Irrespective of the exact option strategy employed by traders the increased trading will result to increased call and put trading volume before the information is released (Jayaraman, Frye, and Sabherwal, 2001; Cao, Griffin, and Chen, 2005; Arnold, Erwin, Nail, and Nixon, 2006). For example, empirical evidence indicates that before significant corporate events informed trading takes place in options markets: Jayaraman Frye, and Sabherwal (2001) examine US takeover deals and find significant option trading volume prior to the rumor of a takeover for the firms involved (for similar results see also Cao, Chen, and Griffin, 2005; Arnold, Erwin, Nail, and Nixon, 2006). Jayaraman et al. suggest that informed trading takes place prior to the announcement.

Abnormal option trading volume before Merger and Acquisition announcements is also evidenced for the UK market (Siougle, Spyrou, and Tsekrekos, 2011), an expected result since there is evidence to suggest positive abnormal returns on insider transactions in both the US and the UK (see Seyhun 1986; Lin and Howe, 1990;

Chang and Suk, 1998; Friederich, Gregory, Matatko, and Tonks, 2002; Gregory, Matatko, Tonks, 1997). Due to differences in regulation between the two markets, however, we may expect a different pattern as regards to trading by informed investors (Fidrmuc, Goergen, and Renneboog, 2006). Kyriacou, Luintel, and Mase (2008) argue that there is a disparity in informed trading between US and UK executives' option trades due to the number of differences between the two markets. These differences may stem from the proportion of executive remuneration linked to options, option market regulation, taxation differences on the profits from option trading, or from differences in shareholder practices between the two markets.[1]

This paper examines trading volume in individual stock option contracts before large stock price changes in the underlying stock and offers original comparative evidence on investor transactions in the US and UK markets. It is the first time, to the best of our knowledge, that this issue is examined in depth at the stock level for the US and the UK market. Large stock price changes imply that significant unanticipated related information has arrived in the market and investors react to this information. Previous studies on price shocks of this type concentrate on investor behavior *after* the event, with the results suggesting that stock market participants have the tendency to overreact to significant negative price changes and not react (or react mildly) to large positive price changes. For example, Brown, Harlow and Tinic (1988), Bremer and Sweeney (1991), Atkins and Dyl (1990), among others, find significant price reversals

[1] In the UK institutional and/or large share block shareholders do not seem to monitor their investments, exert little disciplining, and do not attempt to mitigate problems of asymmetric information (see Franks, Mayer, and Renneboog, 2001; Faccio and Lasfer, 2002).

after extreme negative price movements and that investors overreact especially in the case of price declines (see also Chan, 2003; Benou and Richie, 2003).

There is a gap in the relevant literature, however, as regards to traders transactions in option contracts *before* significant price changes. Spyrou (2011) discusses this gap in the literature and reports abnormal trading volume in index option contracts before many days with abnormally high or low index returns. This paper extends previous research in many ways. Firtsly, we concentrate on individual stock option contracts rather than stock indexes. This allows for an in-depth cross-section investigation of investor behavior instead of a time-series analysis of international indexes; in other words the origins of the price shocks need not be assumed to be solely market-wide events but can also be firm-specific significant events or announcements. Secondly, since we study a large number of stocks and a large number of shocks for each stock we end up with a much larger number of events to be investigated, which adds to the robustness of the results. Thirdly, for the empirical analysis we employ all S&P100 index and FTSE100 index constituent stocks and are thus able to compare investor behavior before significant events between two important international markets.[2] As the discussion above indicates, investor behavior between the US and the UK may differ. Fourthly, we examine different investment styles by splitting the sample stocks to High Book/Market (B/M) and Low B/M sorts ("value" and "growth" stocks) and

[2] The S&P 100 index is a subset of the S&P 500 index and includes 100 leading US stocks with exchange-listed options and an adjusted Market Capitalization of approximately 7,455.80$ billion, as of January 2012 (www.standardandpoors.com); the constituent stocks represent approximately 45% of the market capitalization of the US equity markets. The FTSE 100 includes UK stocks with the highest market capitalization, representing approximately 80% of the UK total equity market capitalization and is a subset of the FTSE 350 index (http://www.ftse.com).

Large Capitalisation and Smaller Capitalisation sorts ("big" and "smaller" stocks) to see whether investor behavior is consistent within different investment styles.[3] Fifthly, in order to test the robustness of the results, we employ three different periods before a significant price change (used to calculate "pre-event" volume) and three different benchmark periods (used to calculate "average" volume) for both positive and negative shocks and for both call and put options. Finally, we examine whether pre-event abnormal trading volume is related to post-shock abnormal stock returns.

To anticipate the results, for a large number of significant (positive and negative) price changes in the underlying stock we find abnormal (call and put) option trading volume *before* the event irrespective of the testing period and the investment style. This indicates irregular option trading activity before price shocks. An interesting finding is that this activity is less pronounced for the FTSE stocks. For example, in a notable case, when Low B/M S&P constituent stocks are examined we find that in approximately 50% of (positive and negative) events there is abnormal (call and put) option trading volume for the 30-day period before the event (Table 3, Panel B). When Low B/M FTSE constituent stocks are examined this number ranges between 9% and 25% (Table 4, Panel B). Furthermore, we find that High B/M and High/Low MV stock abnormal post-shock return is related to pre-event option trading volume for US stocks only.

[3] It can be argued that since these indexes contain, by definition, the largest stocks in the respective markets sorting stocks on market capitalization may add little to the analysis. This argument, however, is only partially correct since there may be a large dispersion in market values: for the US sample the average constituent stock has a market capitalizationof 74.56$ billion, the largest 417.15$ billion and the smallest 7.01$ billion (as of January 2012).

This finding has implications for regulatory authorities, economic theory, and market participants. Consider the case where the significant price movement is the result of the arrival of new significant fundamental information. The existence of irregular option trading volume before the large price change implies that some market participants may have privileged access to information. In a Financial Services Authority (FSA) paper, Dubow and Monteiro (2006) suggest that significant price movements prior to regulatory announcements on FTSE350 constituent firms may reveal insider trading; they use share price movements to measure market cleanliness and find that "the level of insider trading is very high with over 30% of significant announcements being preceded by informed price movements" (p.22). In a subsequent FSA paper, Monteiro, Zaman, and Leitterstorf (2007) widen this analysis to include equity trading volume and news announcements and find leakages of inside information that are higher than what would expect in a clean market. Our finding of lower irregular trading before significant price changes in the UK suggest that regulatory differences between the two markets may lead to different investor behavior. Consider now the case where price shocks are not due to fundamental-related information: Cutler, Poterba and Summers (1989) examine the largest market-wide price changes in the S&P500 index and report that economic fundamentals and new information fail to explain price fluctuations fully. In this case, our results imply that (some) investors may anticipate extreme price swings due to shifts in non-fundamental factors, such as noise trader sentiment and investor psychology. If that is the case noise trader sentiment may not be completely unpredictable by some market participants. The rest of the paper is organized as follows: section 2 discusses the data and methodology; section 3 presents results on option trading volume before price shocks; section 4 examines whether pre-event option volume is related to post-event stock returns; section 5 concludes the paper.

2. Data and Testing Methodology

The sample for the empirical analysis consists of all the S&P100 Index and FTSE100 constituent stocks that have option contracts available for the period between May 2008 and March 2011. The sample stocks are large cap companies in the US and the UK across multiple industry groups. Note that the primary criterion for index inclusion is the availability of individual stock options for each constituent (http://www.standardandpoors.com/indices/sp-100). The unconditional daily change for stock *i* on day *t* is computed as the first difference of the logarithmic price level. All price data and daily option trading volume data are collected from DataStream. Daily option trading volume is defined as the number of option contracts traded on each day (total cumulative volume for all individual option series).

2.1. Extreme events

Previous studies employ various definitions for extreme events or stock price shocks. For example, among previously employed measures are stock price drops of at least 10%, weekly price changes of more than 50%, the largest stock price change in a 300-day window, a monthly price change of 20%, a market return of more than 2%, the top (bottom) 10 percentile of computed abnormal daily returns, etc., (Bremer and Sweeney, 1991; Howe, 1986; Atkins and Dyl, 1990; Benou and Richie, 2007; Dennis and Strickland, 2002; Schnusenberg and Madura, 2001; among others). Lasfer et al. (2003) point out that the appropriate definition should account for the varying return volatility form asset to asset and use a rule that is based on the distance of a certain observation from the mean value. This approach also accounts for the time-variation in risk premia (Ball and Kothari, 1989; Chan, 1988). This paper employs a methodology similar to Lasfer et al. (2003) and Spyrou (2011) to identify an extreme event: a significant price shock occurs on a day where each stock's return is above (positive shock) or below (negative shock) three standard deviations the average daily stock return computed over the [-60 to -11] days before the given day. The window ends 10 trading days prior to the event day in order to avoid possible price lead-up preceding the shocks. The standard deviation for day t is also computed from the observations between day t-60 and day t-11. Positive and negative shocks are analyzed separately to unveil which strategy investors tend to utilize at each case. For example, a long (short) strategy is implied if call (put) option trading volume increases before a positive price shock; similarly a long (short) strategy is implied if put (call) option trading volume increases before a negative shock.

2.2. Abnormal option trading volume

If price shocks are anticipated by market participants and there is a link between option markets and informed trading we should observe abnormal option trading volume for the period preceding price shocks. To test this hypothesis we employ a comparison period approach, i.e. the pre-event option trading volume is compared to the trading volume of a benchmark period (see Jayaraman et al., 2001; Cao et al., 2005; Amin and Lee, 1997; Schachter, 1988; among others). Option trading volume is logarithmically transformed (Sanders and Zdanowicz, 1992) to account for the variation in the number of option contracts traded daily:

$$V_{i,t} = \ln\left(1 + \text{Number of call (put) contracts on stock } i \text{ traded on day } t\right) \tag{1}$$

The benchmark period trading volume is defined as the average trading volume for a 100-day period preceding the event and ending 41 days before the event (-141 to -41):

$$\overline{V}_{b,i} = \frac{1}{100}\sum_{t=-140}^{-41} V_{it} \tag{2}$$

The pre-event option trading volume, or testing period volume, is defined as the average trading volume of the two trading weeks (10 trading days) immediately preceding the day of the large price change:

$$\overline{V}_{p,i} = \frac{1}{10}\sum_{t=-10}^{0} V_{it} \tag{3}$$

The null hypothesis is H_0: $V_{p,i} = V_{b,i}$, i.e. that the pre-event volume is equal to the benchmark volume and the alternative hypothesis is H_1: $V_{p,i} \neq V_{b,i}$, i.e. that the pre-event volume is different to the benchmark volume. Rejection of the null implies abnormal trading volume before the price shock. Standard *t*-tests are used to evaluate the significance of difference in volume between benchmark and pre-event periods.

2.3. Robustness tests

In order to check the robustness of the results, two further benchmark periods (-161 to -41) and (-181 to -41) and two additional testing periods (-20 and -30 days relative to the event) are also employed in the study for both call and put option contracts. As a result, we obtain nine different combinations of pre-event and benchmark periods for each type of shock (positive – negative). Furthermore, the analysis for both call and put contracts, both types of shock, and the nine combinations of pre-event and benchmark periods is repeated with various sub-samples of stocks, based on investment style. More specifically, each year stocks are ranked according to their annual average Book to Market (BM) Value and their annual Average Market Capitalization (MV) and are assigned to six groups: High BM stocks or “value” stocks (stocks with the top 25% B/M Value), Medium BM stocks (stocks with the medium 50% B/M Value), Low BM stocks or “growth” stocks (stocks with the low 25% B/M Value), High MV stocks or “Large Cap” stocks (stocks with the top 25% MV), Medium MV stocks (stocks with the medium 50% MV), and Low MV stocks or “Small Cap” stocks (stocks with the low 25% MV). Finally, since for certain option volume series some null values are observed (that could be due to non-trading days) the above analysis for all specifications is repeated both with and without these observations; the results are qualitatively the same and thus we report the latter here (the rest are available upon request).

3. Abnormal trading volume before price shocks

3.1. All stocks

Tables 1 and 2 present the results for the US full sample (Table 1) and the UK full sample (Table 2) for positive and negative price shocks for call and put contracts. In Table 1, Panel A presents results for the case where a benchmark period of (-141 to -40) days is employed and Panel B for the case where a benchmark period of (-161 to -40) days is employed. The results for the (-181 to -40) benchmark period are qualitative the same and are not reported in the paper (available upon request). Panel A1 (B1), presents results for a pre-event period of 10 days, Panel A2 (B2), presents results for a pre-event period of 20 days, Panel A3 (B3), presents results for a pre-event period of 30 days. Within each sub-panel the first line presents the percentage of shocks for which the pre-event option trading volume is higher than the benchmark option trading volume ($V_{p,i} > V_{b,i}$), the second line presents the percentage of events where the null hypothesis of equality is rejected at the 5% level of significance, the third (fourth) line presents the mean benchmark (pre-event) option trading volume in logarithmic terms, the last line presents the average absolute *t*-statistic for the null hypothesis of equality between pre-event and benchmark volume. The following Tables 2 to 6 are arranged in the same manner.

The results for the US full sample in Table 1 for the (-141 to -41) benchmark period (Panel A) show that for positive shocks and for the 10 days before the price shock (Panel A1) in 69.78% (64.01%) of events the call (put) option trading volume before the shock is higher than the benchmark trading volume. For 35.16% (31.87%) of the price shocks the null hypothesis of equality between the pre-event and benchmark option trading volume is rejected for call (put) contracts at the 5% level of significance. The mean benchmark call volume is 7.23 and the mean pre-event call volume is 7.54; the mean benchmark put volume is 6.75 and the mean pre-event put volume is 6.95. The results are similar for negative shocks and the rest of the pre-event periods (Panels A2, A3) with a tendency to increase in magnitude as the pre-event period increases. For example, in Panel A3 for 46.15% (41.21%) of the positive price shocks the null hypothesis of equality between the pre-event and benchmark option trading volume is rejected for call (put) contracts at the 5% level of significance. This is also the case for the other two benchmark periods, i.e. the (-161 to -41) in Panel B and the unreported (-181 to -41) period.

The results for the UK full sample in Table 2 for the (-141 to -41) benchmark period (Panel A) show that for positive shocks and for the 10 days before the price shock (Panel A1) in 51.05% (53.41%) of events the call (put) option trading volume before the shock is higher than the benchmark trading volume. For 19.28% (23.23%) of the price shocks the null hypothesis of equality between the pre-event and benchmark option trading volume is rejected for call (put) contracts at the 5% level of significance. The mean benchmark call volume is 4.35 and the mean pre-event call volume is 4.40; the mean benchmark put volume is 6.21 and the mean pre-event put volume is 4.32. The results are similar for negative shocks and the rest of the pre-event periods (Panels A2, A3) with a tendency to increase in magnitude as the pre-event period increases. For example, in Panel A3 for 25.03% (26.47%) of the positive price shocks the null hypothesis of equality between the pre-event and benchmark option trading volume is rejected for call (put) contracts at the 5% level of significance. This is also the case for the other two benchmark periods, i.e. the (-161 to -41) in Panel B and the unreported (-181 to -41) period.

The picture that emerges from the full sample results so far is that for a large number of stock price shocks there is irregular option trading volume *before* the shock in both markets, althought this effect is more pronounced in the US. More specifically, the null hypothesis of trading volume equality between pre-event and benchmark period is rejected irresepective of the testing period specifications. For the US the number of shocks with irregular trading volume before the event ranges between 31.87% and 46.15%; for the UK the number of shocks with irregular trading volume before the event ranges between 18.89% and 29.46%.

3.2. Value vs Growth and Large vs Smaller stocks

Table 3 (4) reports the same results for the B/M sub-samples for the US (UK) market. In order to save space we only report results for the (-161 to -41) benchmark period and for only the 10-day and 30-day pre-event period. The unreported results are qualitatively similar to the reported and are available upon request. The results for the US sub-sample in Table 3 are similar to the findings for the full sample. For example, for High B/M stocks and for positive shocks (Panel A) in 76.25% (72.50%) of events the call (put) option trading volume before the shock is higher than the benchmark trading volume. For 50.00% (35.00%) of the price shocks the null hypothesis of equality between the pre-event and benchmark option trading volume is rejected for call (put) contracts at the 5% level of significance. The results are similar for Medium and Low B/M stocks, for negative shocks, and for the 30-day pre-event period (Panel B).

The results for the UK sub-sample in Table 4 are also similar to the findings for the full sample. For example, for High B/M stocks and for positive shocks (Panel A) in 51.56% (54.69%) of events the call (put) option trading volume before the shock is higher than the benchmark trading volume. For 29.69% (29.69%) of the price shocks the null hypothesis of equality between the pre-event and benchmark option trading volume is rejected for call (put) contracts at the 5% level of significance. The results are similar for Medium and Low B/M stocks, for negative shocks, and for the 30-day pre-event period (Panel B). This effect is less pronounced in the UK: for the US the number of shocks with irregular trading volume before the event ranges between 31.91% and 57.50% while for the UK the number of shocks with irregular trading volume before the event ranges between 9.09% and 29.69%.

Table 5 (6) reports the same results for the Market Value (MV) sub-samples for the US (UK) market. In order to save space we only report results for the (-161 to -41) benchmark period and for only the 10-day and 30-day pre-event period. The unreported results are qualitatively similar to the reported and are available upon request. The results for the US sub-sample in Table 5 are similar to the findings for the full sample and the B/M sub-sample. For example, for High MV stocks and for positive shocks (Panel A) in 78.75% (74.47%) of events the call (put) option trading volume before the shock is higher than the benchmark trading volume. For 36.17% (35.11%) of the price shocks the null hypothesis of equality between the pre-event and benchmark option trading volume is rejected for call (put) contracts at the 5% level of significance. The results are similar for Medium and Low MV stocks, for negative shocks, and for the 30-day pre-event period (Panel B). The results for the UK sub-sample in Table 6 indicate, as above, that this trading pattern is less pronounced in the UK: for the US the number of shocks with irregular trading volume before the event ranges between 30.59% and 51.58% while for the UK the number of shocks with irregular trading volume before the event ranges between 16.05% and 32.79%.

The findings so far indicate that for a large number of stock price shocks there is irregular option trading volume before the shock in both markets, althought the effect is more pronounced in the US. This is irresepective of whether we look at the full sample or sub-samples based on B/M and Market Value, of the pre-event and benchmark period specifications, of call and put contracts and of whether the shock is positive and negative.

4. Are post-shock returns related to pre-event option volume? US evidence

This section examines whether pre-event abnormal trading volume is related to post-shock abnormal stock returns. The idea is to examine whether (call and put) option trading volume before a significant (positive and negative) event affects the returns of the underluing stock after the event takes place. This is done by estimating a cross-sectional regression of post-shock Average Cumulative Abnormal Returns (*ACAR*s) on pre-event option volume:

$$ACAR_i = a + bV_{p,i} \tag{4}$$

In (4) $ACAR_i$ is the post-shock Average Cumulative Abnormal Return for stock *i*, for 0, 1, 2, 5, and 15 days subsequent to the shock, and $V_{p,i}$ is the option trading volume for 10, 20, 30 days prior to the event.

The results for the full sample are presented in Table 7; Panel A presents results for US stocks while Panel B for UK stocks. We report two pre-event periods (10-day and 30-day). The rest of the results are available upon request and are similar to the reported. Panels A1 and B1 report the slope coefficient and the *t*-statistic from (4) where the right-hand side variable is option trading volume 10 days prior to the shock, while Panels A2 and B2 report results where the right-hand side variable is option trading volume 30 days prior to the shock. The dependent variable is the abnormal stock return on the event day (*AAR*(0)), and the post event *ACAR*s for 1, 2, 5, and 10 days subsequent to the shock, denoted as *ACAR* (0 to +1),……, *ACAR* (0 to +10). From Table 7 we can see that pre-event option trading volume is not related to post-shock abnormal returns. The only statistically significant (at the 5%) and negative coefficient is for US stocks and refers to the relation of call volume and the ACAR(0,1) after positive shocks; that is, higher (lower) call option trading volume before positive shocks leads to lower (higher) abnormal US stock returns on the first day after the shock, on average. No relation is detected for UK stocks.

Table 8 presents the same results for High and Low B/M stocks for the US (Panel A) and the UK (Panel B) for a pre-event period of 10-days (the results for Medium B/M stocks and other pre-event periods are similar and available upon request). From Panel A it becomes apparent that for High B/M US stocks option trading volume before the event is positively related to post-shock abnormal stock returns for up to 10 days, on average. No effect is detected for Low B/M US stocks. For UK stocks (Panel B) we detect an effect only for Low B/M stocks: higher (lower) call and put option trading volume before positive shocks leads to lower (higher) abnormal Low B/M stock returns on the first day after the shock, on average. No effect is detected for High B/M UK stocks. Table 9 presents the same results for High and Low Market Value stocks for the US (Panel A) and the UK (Panel B) for a pre-event period of 10-days (the results for Medium Market Value stocks and other pre-event periods are similar and available upon request). The findings in Panel A indicate that for High MV stocks option trading volume before the event is positively related to post-shock abnormal stock returns for up to 10 days, on average. For Low MV stocks we detect a negative relation between returns and put volume only for both positive and negative shocks. No effect is detected for UK stocks (Panel B).

Overall the findings in this section indicate that for the full sample, on average, there is very weak evidence that option trading volume before the event affects post-event abnormal returns in the US and the UK. For the US stock sub-samples, however, the picture is different: for High B/M and High MV US stocks option trading volume before the event is positively related to post-shock abnormal stock returns for up to 10 days, on average; for Low MV US stocks we detect a negative relation between returns and put volume only for both positive and negative shocks.

6. Conclusion

The results of earlier studies indicate that investors in possession of important information are more likely to transact in option contracts rather than the underlying asset. Irrespective of the exact strategy the increased trading will result to increased call and put trading volume before the information is released. This paper examines trading volume in individual stock option contracts before large stock price changes in the underlying stock and offers original comparative evidence for the US and UK markets. It is the first time, to the best of our knowledge, that this issue is examined in depth at the stock level for the US and the UK market. Due to differences in regulation between the two markets we may expect a different pattern as regards to trading by informed investors. Large stock price changes imply that significant unanticipated related information has arrived in the market and investors react to this information. Previous studies on price shocks concentrate on investor behavior after the event; there is a gap in the literature as regards to investors transactions in option contracts before significant price changes.

We find that for a large number of significant (positive and negative) price changes in the underlying stock there is irregular (call and put) option trading volume *before* the event and irrespective of various robustness tests, such as different testing periods and the investment styles. This indicates irregular option trading activity before price shocks. We also find that this activity is less pronounced for the FTSE stocks. For example, while for US stocks we find that for approximately 30% to 50% of price shocks there is abnormal option trading volume, for UK stocks this percentage ranges between 9% and 30%. Furthermore, for High B/M and High/Low MV stocks in the US, we find that option trading volume before the event is related to post-shock abnormal stock returns for up to 10 days, on average. Here is very weak evidence that this is the case for the UK market. Overall, the findings indicate that there is irregular trading activity in options markets before large price changes in the underlying assets and that this activity affects stock returns after the event. The finding of a much lower irregular trading in the UK indicates that regulatory differences between the two markets may lead to different investor behavior.

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Table 1
Abnormal option trading volume before price shocks: US stocks (full sample)

Panel A: Benchmark period: 141 to 41 days					Panel B: Benchmark period: 161 to 41 days				
	Positive shocks		Negative shocks			Positive shocks		Negative shocks	
	Call	Put	Call	Put		Call	Put	Call	Put
	Panel A1: Pre-event period 10 days					Panel B1: Pre-event period 10 days			
% of: $V_p > V_b$	69.78%	64.01%	65.90%	63.39%	**% of: $V_p > V_b$**	72.14%	66.30%	66.54%	64.41%
Reject H_0 at 5%	35.16%	31.87%	35.84%	34.30%	**Reject H_0 at 5%**	38.72%	34.26%	37.52%	35.01%
Mean V_b	7.23	6.75	7.35	6.85	**Mean V_b**	7.22	6.73	7.34	6.83
Mean V_p	7.54	6.95	7.63	7.08	**Mean V_p**	7.56	6.98	7.63	7.08
Mean abs *t* stat	1.87	1.69	1.81	1.74	**Mean abs *t* stat**	1.95	1.78	1.83	1.78
	Panel A2: Pre-event period 20 days					Panel B2: Pre-event period 20 days			
% of: $V_p > V_b$	66.21%	58.24%	62.81%	54.91%	**% of: $V_p > V_b$**	68.80%	62.12%	64.02%	56.48%
Reject H_0 at 5%	40.38%	36.81%	36.8%	38.54%	**Reject H_0 at 5%**	43.73%	40.67%	38.68%	40.43%
Mean V_b	7.23	6.75	7.35	6.85	**Mean V_b**	7.22	6.73	7.34	6.83
Mean V_p	7.45	6.85	7.53	6.95	**Mean V_p**	7.48	6.88	7.54	6.95
Mean abs *t* stat	2.14	1.88	1.91	1.91	**Mean abs *t* stat**	2.25	2.02	1.99	1.98
	Panel A3: Pre-event period 30 days					Panel B3: Pre-event period 30 days			
% of: $V_p > V_b$	60.99%	52.75%	58.77%	50.10%	**% of: $V_p > V_b$**	64.62%	55.99%	60.35%	51.84%
Reject H_0 at 5%	46.15%	41.21%	39.69%	40.27%	**Reject H_0 at 5%**	48.75%	45.96%	40.43%	42.75%
Mean V_b	7.23	6.75	7.35	6.85	**Mean V_b**	7.22	6.73	7.34	6.83
Mean V_p	7.39	6.79	7.47	6.88	**Mean V_p**	7.42	6.82	7.48	6.88
Mean abs *t* stat	2.37	2.16	2.00	2.04	**Mean abs *t* stat**	2.50	2.29	2.10	2.12

Notes to Table 1: The null hypothesis (H_0) is that: [$V_b = V_p$], i.e. that the pre-event option volume is equal to the benchmark period volume. The percentage in the line denoted as "Reject H_0 at 5%" is the percentage of events for which the null is rejected at the 5% of significance. There are 364 (519) positive (negative) shocks in the sample. Mean Volume (V) is defined as [ln(1+number of call (put) contracts of index *i* traded on day *t*]. "Mean V_b" is the mean volume for the benchmark period across all events. "Mean V_p" is the mean volume for pre-event period across all events. "Mean abs *t* stat " is the absolute mean t-statistic for the (H_0).

Table 2
Abnormal option trading volume before price shocks: UK stocks (full sample)

Panel A: Benchmark period: 141 to 41 days				
	Positive shocks		Negative shocks	
	Call	Put	Call	Put
	Panel A1: Pre-event period 10 days			
% of: $V_p > V_b$	51.02%	53.41%	53.05%	53.86%
Reject H_0 at 5%	19.28%	23.23%	25.51%	18.89%
Mean V_b	4.35	4.21	8.56	4.39
Mean V_p	4.40	4.3	8.71	4.45
Mean abs *t* stat	1.24	1.32	1.4	1.25
	Panel A2: Pre-event period 20 days			
% of: $V_p > V_b$	52.57%	54.49%	53.41%	52.19%
Reject H_0 at 5%	25.15%	24.79%	29.46%	21.59%
Mean V_b	4.35	4.21	8.56	4.39
Mean V_p	4.39	4.29	8.68	4.41
Mean abs *t* stat	1.37	1.44	1.54	1.34
	Panel A3: Pre-event period 30 days			
% of: $V_p > V_b$	50.06%	54.13%	52.93%	51.03%
Reject H_0 at 5%	25.03%	26.47%	28.50%	23.39%
Mean V_b	4.35	4.21	8.56	4.39
Mean V_p	4.37	4.26	8.63	4.39
Mean abs *t* stat	1.4	1.43	1.54	1.38

Panel B: Benchmark period: 161 to 41 days				
	Positive shocks		Negative shocks	
	Call	Put	Call	Put
	Panel B1: Pre-event period 10 days			
% of: $V_p > V_b$	51.33%	53.62%	52.17%	54.53%
Reject H_0 at 5%	19.44%	24.52%	26.09%	18.26%
Mean V_b	4.35	4.21	8.56	4.39
Mean V_p	4.41	4.31	8.72	4.45
Mean abs *t* stat	1.25	1.33	1.41	1.26
	Panel B2: Pre-event period 20 days			
% of: $V_p > V_b$	51.81%	55.07	52.29%	51.55%
Reject H_0 at 5%	26.57%	25.97	30.19%	21.76%
Mean V_b	4.35	4.21	8.56	4.39
Mean V_p	4.39	4.29	8.69	4.42
Mean abs *t* stat	1.39	1.46	1.55	1.36
	Panel B3: Pre-event period 30 days			
% of: $V_p > V_b$	50.72%	55.31%	52.78	50.52%
Reject H_0 at 5%	26.09%	27.66%	30.68	25.39%
Mean V_b	4.35	4.21	8.56	4.39
Mean V_p	4.38	4.27	8.64	4.40
Mean abs *t* stat	1.44	1.47	1.57	1.41

Notes to Table 2: The null hypothesis (H_0) is that: [$V_b = V_p$], i.e. that the pre-event option volume is equal to the benchmark period volume. The percentage in the line denoted as "Reject H_0 at 5%" is the percentage of events for which the null is rejected at the 5% of significance. There are 835 (778) positive (negative) shocks in the sample. This is higher to the US full sample due to the longer sample period for the UK full sample. Mean Volume (V) is defined as [ln(1+number of call (put) contracts of index i traded on day t]. "Mean V_b" is the mean volume for the benchmark period across all events. "Mean V_p" is the mean volume for pre-event period across all events. "Mean abs *t* stat " is the absolute mean t-statistic for the (H_0).

Table 3
Abnormal option trading volume before price shocks: Book/Market Sort, Benchmark period (161 to 41) days, US stocks

		Panel A: Pre-event period 10 days				Panel B: Pre-event period 30 days			
		Positive shocks		Negative shocks		Positive shocks		Negative shocks	
		Call	Put	Call	Put	Call	Put	Call	Put
High B/M Stocks	% of: $V_p > V_b$	76.25%	72.50%	66.67%	64.86%	71.25%	56.25%	57.66%	53.15%
	Reject H_0 at 5%	50.00%	35.00%	39.64%	33.33%	57.50%	43.75%	39.64%	32.43%
	Mean V_b	7.39	6.90	7.54	7.03	7.39	6.90	7.54	7.03
	Mean V_p	7.81	7.17	7.84	7.31	7.65	7.00	7.68	7.07
	Mean abs *t* stat	2.07	1.77	1.86	1.70	2.69	2.23	2.00	1.82
Medium B/M Stocks	% of: $V_p > V_b$	73.62%	68.71%	67.19%	63.64%	64.42%	58.90%	61.66%	50.20%
	Reject H_0 at 5%	34.36%	33.13%	33.20%	32.41%	43.56%	46.63%	33.60%	41.11%
	Mean V_b	7.27	6.82	7.34	6.88	7.27	6.82	7.34	6.88
	Mean V_p	7.64	7.09	7.60	7.10	7.47	6.94	7.46	6.91
	Mean abs *t* stat	1.80	1.72	1.67	1.75	2.30	2.24	1.87	2.08
Low B/M Stocks	% of: $V_p > V_b$	65.96%	56.38%	64.06%	64.06%	57.45%	46.81%	59.38%	51.56%
	Reject H_0 at 5%	31.91%	31.91%	42.19%	38.28%	48.94%	46.81%	50.00%	51.56%
	Mean V_b	7.11	6.63	7.28	6.78	7.11	6.63	7.28	6.78
	Mean V_p	7.42	6.88	7.64	7.07	7.32	6.70	7.50	6.88
	Mean abs *t* stat	1.81	1.72	1.98	1.81	2.31	2.21	2.33	2.25

Notes to Table 3: The null hypothesis (H_0) is that: [$V_b = V_p$], i.e. that the pre-event option volume is equal to the benchmark period volume. The percentage in the line denoted as "Reject H_0 at 5%" is the percentage of events for which the null is rejected at the 5% of significance. There are 80 (111) positive (negative) shocks in the sample. Mean Volume (V) is defined as [ln(1+number of call (put) contracts of index i traded on day t]. "Mean V_b" is the mean volume for the benchmark period across all events. "Mean V_p" is the mean volume for pre-event period across all events. "Mean abs *t* stat " is the absolute mean t-statistic for the (H_0).

Table 4
Abnormal option trading volume before price shocks: Book/Market Sort, Benchmark period (161 to 41) days, UK stocks

		Panel A: Pre-event period 10 days				Panel B: Pre-event period 30 days			
		Positive shocks		Negative shocks		Positive shocks		Negative shocks	
		Call	Put	Call	Put	Call	Put	Call	Put
High B/M Stocks	% of: $V_p > V_b$	51.56%	54.69%	50.00%	53.93%	53.13%	46.88%	51.56%	49.44%
	Reject H_0 at 5%	29.69%	29.69%	32.81%	17.98%	29.69%	23.44%	29.69%	25.84%
	Mean V_b	3.21	3.34	6.55	3.21	3.21	3.34	6.55	3.21
	Mean V_p	3.28	3.48	6.76	3.36	3.12	3.27	6.39	3.2
	Mean abs *t* stat	1.34	1.44	1.51	1.18	1.63	1.59	1.74	1.54
Medium B/M Stocks	% of: $V_p > V_b$	58.33%	64.39%	63.64%	55.84%	59.09%	65.91%	64.39%	51.30%
	Reject H_0 at 5%	18.94%	18.94%	22.73%	18.83%	28.79%	33.33%	31.06%	24.03%
	Mean V_b	2.40	2.37	4.77	2.48	2.40	2.37	4.77	2.48
	Mean V_p	2.59	2.7	5.3	2.66	2.49	2.58	5.08	2.52
	Mean abs *t* stat	1.24	1.29	1.4	1.11	1.38	1.49	1.57	1.37
Low B/M Stocks	% of: $V_p > V_b$	56.82%	54.55%	54.55%	56.72%	43.18%	38.64%	43.18%	56.72%
	Reject H_0 at 5%	18.18%	15.91%	18.18%	14.93%	9.09%	11.36%	9.09%	25.37%
	Mean V_b	3.29	3.19	6.48	3.42	3.29	3.19	6.48	3.42
	Mean V_p	3.43	3.29	6.72	3.52	3.21	3.08	6.28	3.42
	Mean abs *t* stat	1.27	1.04	1.21	1.11	1.13	0.93	1.10	1.36

Notes to Table 4: The null hypothesis (H_0) is that: [$V_b = V_p$], i.e. that the pre-event option volume is equal to the benchmark period volume. The percentage in the line denoted as "Reject H_0 at 5%" is the percentage of events for which the null is rejected at the 5% of significance. There are 64 (89) positive (negative) shocks in the sample. Mean Volume (V) is defined as [ln(1+number of call (put) contracts of index *i* traded on day *t*]. "Mean V_b" is the mean volume for the benchmark period across all events. "Mean V_p" is the mean volume for pre-event period across all events. "Mean abs *t* stat " is the absolute mean t-statistic for the (H_0).

Table 5
Abnormal option trading volume before price shocks: Market Value Sort, Benchmark period (161 to 41) days, US stocks

		Panel A: Pre-event period 10 days				Panel B: Pre-event period 30 days			
		Positive shocks		Negative shocks		Positive shocks		Negative shocks	
		Call	Put	Call	Put	Call	Put	Call	Put
High Market Value Stocks	% of: $V_p > V_b$	78.72%	74.47%	66.67%	66.67%	62.77%	53.19%	59.12%	46.54%
	Reject H_0 at 5%	36.17%	35.11%	40.25%	39.62%	48.94%	52.13%	38.99%	47.17%
	Mean V_b	8.63	8.23	8.71	8.28	8.63	8.23	8.71	8.28
	Mean V_p	9.02	8.58	8.99	8.53	8.87	8.38	8.85	8.33
	Mean abs *t* stat	1.95	1.94	1.85	1.96	2.47	2.55	2.04	2.32
Medium Market Value Stocks	% of: $V_p > V_b$	70.59%	62.94%	64.46%	61.98%	63.53%	55.88%	58.26%	50.00%
	Reject H_0 at 5%	34.12%	30.59%	36.36%	33.88%	47.06%	44.12%	40.50%	44.21%
	Mean V_b	7.11	6.65	7.06	6.59	7.11	6.65	7.06	6.59
	Mean V_p	7.41	6.85	7.30	6.81	7.29	6.72	7.16	6.6
	Mean abs *t* stat	1.78	1.59	1.77	1.74	2.37	2.10	2.03	2.08
Low Market Value Stocks	% of: $V_p > V_b$	68.42%	64.21%	70.69%	66.38%	68.42%	58.95%	66.38%	62.93%
	Reject H_0 at 5%	48.42%	40.00%	36.21%	31.03%	51.58%	43.16%	42.24%	33.62%
	Mean V_b	6.03	5.40	6.02	5.35	6.03	5.40	6.02	5.35
	Mean V_p	6.38	5.64	6.46	5.68	6.20	5.46	6.26	5.49
	Mean abs *t* stat	2.23	1.96	1.92	1.61	2.75	2.38	2.35	1.94

Notes to Table 5: The null hypothesis (H_0) is that: [$V_b = V_p$], i.e. that the pre-event option volume is equal to the benchmark period volume. The percentage in the line denoted as "Reject H_0 at 5%" is the percentage of events for which the null is rejected at the 5% of significance. There are 94 (159) positive (negative) shocks in the sample. Mean Volume (V) is defined as [ln(1+number of call (put) contracts of index i traded on day t]. "Mean V_b" is the mean volume for the benchmark period across all events. "Mean V_p" is the mean volume for pre-event period across all events. "Mean abs *t* stat " is the absolute mean t-statistic for the (H_0).

Table 6
Abnormal option trading volume before price shocks: Market Value Sort, Benchmark period (161 to 41) days, UK stocks

		Panel A: Pre-event period 10 days				Panel B: Pre-event period 30 days			
		Positive shocks		Negative shocks		Positive shocks		Negative shocks	
		Call	Put	Call	Put	Call	Put	Call	Put
High Market Value Stocks	% of: $V_p > V_b$	70.91%	70.91%	70.91%	66.67%	72.73%	69.09%	69.09%	69.14%
	Reject H_0 at 5%	18.18%	18.18%	27.27%	16.05%	30.91%	29.09%	29.09%	30.86%
	Mean V_b	4.87	4.86	9.73	4.85	4.87	4.86	9.73	4.85
	Mean V_p	5.23	5.27	10.5	5.19	5.05	5.09	10.14	5.04
	Mean abs *t* stat	1.26	1.24	1.35	1.14	1.51	1.55	1.67	1.51
Medium Market Value Stocks	% of: $V_p > V_b$	53.44%	61.07%	58.78%	57.56%	49.62%	54.20%	58.02%	48.84%
	Reject H_0 at 5%	24.43%	23.66%	25.95%	17.44%	25.19%	29.77%	27.48%	18.60%
	Mean V_b	2.58	2.55	5.13	2.58	2.58	2.55	5.13	2.58
	Mean V_p	2.72	2.8	5.52	2.72	2.56	2.62	5.18	2.58
	Mean abs *t* stat	1.34	1.3	1.44	1.12	1.42	1.45	1.54	1.3
Low Market Value Stocks	% of: $V_p > V_b$	50.00%	48.28%	46.55%	36.07%	51.72%	50.00%	46.55%	40.98%
	Reject H_0 at 5%	22.41%	18.97%	20.69%	21.31%	22.41%	18.97%	24.14%	32.79%
	Mean V_b	1.48	1.53	3.00	1.43	1.48	1.53	3.00	1.43
	Mean V_p	1.49	1.62	3.11	1.38	1.45	1.53	2.98	1.26
	Mean abs *t* stat	1.21	1.31	1.37	1.18	1.33	1.25	1.41	1.62

Notes to Table 6:. The null hypothesis (H_0) is that: [$V_b = V_p$], i.e. that the pre-event option volume is equal to the benchmark period volume. The percentage in the line denoted as "Reject H_0 at 5%" is the percentage of events for which the null is rejected at the 5% of significance. There are 55 (81) positive (negative) shocks in the sample. Mean Volume (V) is defined as [ln(1+number of call (put) contracts of index i traded on day t]. "Mean V_b" is the mean volume for the benchmark period across all events. "Mean V_p" is the mean volume for pre-event period across all events. "Mean abs t stat " is the absolute mean t-statistic for the (H_0).

Table 7
Regressing post-announcement ACARs on pre-announcement option trading volume, all stocks

	Panel A: US stocks								
		Panel A1: Pre-event period 10 days				**Panel A2: Pre-event period 30 days**			
		Positive shocks		**Negative shocks**		**Positive shocks**		**Negative shocks**	
		Call	**Put**	**Call**	**Put**	**Call**	**Put**	**Call**	**Put**
AAR (0)	b	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	t-stat	-1.10	-0.74	1.20	1.13	-1.23	-0.56	1.48	1.28
ACAR (0,1)	b	-0.01*	0.00	0.00	0.00	-0.01*	0.00	0.00	0.00
	t-stat	-2.13	-1.78	1.38	1.71	-2.05	-1.50	1.59	1.61
ACAR (0, 5)	b	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
	t-stat	0.21	0.49	0.98	1.18	0.80	1.34	1.66	1.54
ACAR (0, 10)	b	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
	t-stat	0.42	0.72	0.91	1.58	1.02	1.54	1.72	1.85
	Panel B: UK stocks								
		Panel B1: Pre-event period 10 days				**Panel B2: Pre-event period 30 days**			
		Positive shocks		**Negative shocks**		**Positive shocks**		**Negative shocks**	
		Call	**Put**	**Call**	**Put**	**Call**	**Put**	**Call**	**Put**
AAR (0)	b	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00
	t-stat	0.20	0.39	-1.18	-1.49	1.14	0.91	1.73	1.29
ACAR (0,1)	b	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00
	t-stat	0.24	0.43	-1.84	-1.57	1.14	0.92	1.80	1.51
ACAR (0, 5)	b	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00
	t-stat	0.11	0.33	-0.99	-0.44	0.89	0.76	1.26	1.26
ACAR (0, 10)	b	0.00	0.00	0.00	0.00	0.00	0.01	-0.01	0.00
	t-stat	0.28	0.64	-0.03	0.28	0.30	0.53	-1.35	-1.14

Notes to Table 7: The results presented above refer to the slope coefficient from the following cross section regression: $ACAR_i = a + bV_{p,i}$, where $ACAR_i$ is the post-event *ACAR* as follows: *AAR* (0), *ACAR* (0 to +1), *ACAR* (0 to +5), *ACAR* (0 to +10), and $V_{p,i}$ is the pre-event option trading volume. * denotes significance at the 5% level.

Table 8
Regressing post-announcement ACARs on pre-announcement option trading volume, B/M sort, Pre-event period 10 days

		Panel A: US stocks							
		Panel A1: High B/M stocks				Panel A2: Low B/M stocks			
		Positive shocks		Negative shocks		Positive shocks		Negative shocks	
		Call	**Put**	**Call**	**Put**	**Call**	**Put**	**Call**	**Put**
AAR (0)	b	0.01*	0.01*	0.00	0.00	0.00	0.00	0.00	0.00
	t-stat	2.22	2.36	-0.23	-0.75	-0.61	-0.07	1.88	1.95
ACAR (0,1)	b	0.01*	0.01*	0.00	0.00	0.00	0.00	0.00	0.00
	t-stat	2.67	2.64	0.37	0.06	-0.15	0.21	1.26	1.45
ACAR (0, 5)	b	0.03*	0.03*	0.00	0.00	0.01	0.01	0.00	0.00
	t-stat	2.40	2.40	0.67	0.07	1.44	1.26	1.03	0.82
ACAR (0, 10)	b	0.03*	0.03*	0.01	0.00	0.01	0.01	0.00	0.00
	t-stat	2.23	2.32	0.70	0.40	1.76	1.65	0.47	0.53
		Panel B: UK stocks							
		Panel B1: High B/M stocks				**Panel B2: Low B/M stocks**			
		Positive shocks		**Negative shocks**		**Positive shocks**		**Negative shocks**	
		Call	**Put**	**Call**	**Put**	**Call**	**Put**	**Call**	**Put**
AAR (0)	b	0.00	0.00	0.00	0.00	-0.01*	-0.01*	0.00	0.00
	t-stat	0.31	-0.19	-0.24	0.10	-2.22	-2.76	1.13	1.16
ACAR (0,1)	b	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	0.00
	t-stat	0.47	0.01	0.01	0.41	-1.17	-1.36	0.14	0.06
ACAR (0, 5)	b	0.00	0.00	0.00	0.01	-0.01	-0.01	0.00	0.00
	t-stat	0.07	-0.28	0.29	1.07	-1.37	-1.37	-0.89	-0.88
ACAR (0, 10)	b	0.00	0.00	0.01	0.01	-0.01	-0.01	-0.01	0.00
	t-stat	0.33	-0.09	0.98	1.63	-1.42	-1.44	-1.25	-0.98

Notes to Table 8: The results presented above refer to the slope coefficient from the following cross section regression: $ACAR_i = a + bV_{p,i}$, where $ACAR_i$ is the post-event *ACAR* as follows: *AAR* (0), *ACAR* (0 to +1), *ACAR* (0 to +5), *ACAR* (0 to +10), and $V_{p,i}$ is the pre-event option trading volume. * denotes significance at the 5% level.

Table 9
Regressing post-announcement ACARs on pre-announcement option trading volume, MV sort, Pre-event period 10 days

		Panel A: US stocks							
		Panel A1: High MV stocks				Panel A2: Low MV stocks			
		Positive shocks		Negative shocks		Positive shocks		Negative shocks	
		Call	**Put**	**Call**	**Put**	**Call**	**Put**	**Call**	**Put**
AAR (0)	b	0.01*	0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00
	t-stat	2.97	3.36	-1.60	-1.68	-1.28	-1.54	0.05	0.24
ACAR (0,1)	b	0.01*	0.01	-0.01	0.00	-0.01	-0.01*	0.00	0.00
	t-stat	2.75	2.85	-1.41	-0.73	-1.29	-1.99	-0.08	0.07
ACAR (0, 5)	b	0.04*	0.04	-0.01	0.00	-0.02	-0.03*	-0.01	-0.02*
	t-stat	2.61	2.67	-1.44	-0.41	-1.41	-2.27	-0.81	-2.06
ACAR (0, 10)	b	0.04*	0.05	-0.01	0.00	-0.02	-0.03*	-0.02	-0.03*
	t-stat	3.11	3.27	-0.88	0.03	-1.60	-2.34	-1.87	-2.57
		Panel B: UK stocks							
		Panel B1: High MV stocks				Panel B2: Low MV stocks			
		Positive shocks		Negative shocks		Positive shocks		Negative shocks	
		Call	**Put**	**Call**	**Put**	**Call**	**Put**	**Call**	**Put**
AAR (0)	b	0.00	0.00	0.00	0.00	0.00	-0.01	0.02	0.01
	t-stat	0.36	-0.30	0.14	-0.04	0.14	-0.43	0.90	0.24
ACAR (0,1)	b	0.00	0.00	0.00	0.00	-0.01	-0.01	0.02	0.01
	t-stat	-0.05	-0.61	-0.12	-0.24	-0.40	-0.29	0.98	0.25
ACAR (0, 5)	b	-0.01	-0.01	0.00	0.00	0.00	0.02	0.03	0.03
	t-stat	-0.92	-1.03	-0.07	0.26	0.01	0.65	1.30	0.88
ACAR (0, 10)	b	0.00	0.00	-0.01	-0.01	0.01	0.03	0.05*	0.07
	t-stat	-0.11	-0.17	-0.91	-0.45	0.15	0.81	1.95	1.92

Notes to Table 9: The results presented above refer to the slope coefficient from the following cross section regression: $ACAR_i = a + bV_{p,i}$, where $ACAR_i$ is the post-event *ACAR* as follows: *AAR* (0), *ACAR* (0 to +1), *ACAR* (0 to +5), *ACAR* (0 to +10), and $V_{p,i}$ is the pre-event option trading volume. * denotes significance at the 5% level.