Informed Options Trading prior to M&A Announcements: Insider Trading?*

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Abstract

We document pervasive informed trading activity in equity options before M&A announcements. About 25% of takeovers have positive abnormal volumes. These volume patterns indicate that informed traders are likely using bullish directional strategies for the target and volatility strategies for the acquirer. We show that this abnormal activity cannot be explained by deal predictability, speculation, news and rumors, trading of corporate insiders, or leakage in the stock market. While the SEC litigates only about 7% of deals in our sample, the characteristics of illegal option trades before M&A announcements they prosecute closely resemble the documented patterns of unusual options activity.

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1 Introduction

The US Securities and Exchange Commission (SEC) alleged in 2013 that a brokerage account in Switzerland had been used for illegal insider trading the day prior to the leveraged buyout announcement of H.J. Heinz Inc. Although the evidence based on a purchase of 2,533 out-of-the-money (OTM) call options was overwhelming, one can assume that there are many more cases that go undetected, or where the evidence is not as clear-cut, in a legal/regulatory sense.[1] The prior literature has documented evidence of informed options activity ahead of mergers and acquisitions (M&A) announcements. However, even though these studies provide preliminary evidence of informed trading, they are not instructive about the prevalence of informed trading in the economy. More importantly, there is also little guidance in the literature on whether the documented informed activity can be accounted for by perfectly legal explanations, or whether it could potentially be illegal. We explore these issues in considerable detail in this paper.

The first objective of our study is to investigate and *quantify* the pervasiveness of informed trading in the context of M&A activity in the US. To this end, we conduct a forensic analysis of the trading volume, implied volatility, and bid-ask spreads of equity options over the 30 days preceding formal announcements of acquisitions, from January 1, 1996 through December 31, 2012. We examine *how* informed traders may trade differently in the options of target and acquirer companies, respectively, in order to yield abnormal returns, thereby emphasizing *where* informed investors trade in each case. The second objective of our study is to assess the likelihood that the informed trading is illegal by ruling out multiple legal explanations, and by relating the abnormal activity to SEC enforcement actions against illegal insider trading. Our analysis highlights "blind spots" that may be useful for regulators and prosecutors trying to detect insider trading activity. Our study provides detailed analyses and results that have not been reported before.

For target companies, we document evidence of a statistically significant average abnormal trading volume in equity options over the 30 days preceding M&A announcements. Approximately 25% of the cases in our sample have abnormal volumes that are statistically significant at the 5% level. The proportion of cases with abnormal volumes is relatively higher for call options than for put options. Stratifying the results by "moneyness," we find that there is significantly higher abnormal trading volume (both in average levels and frequencies) in OTM call options compared to at-the-

[1] See, for example, "Options Activity Questioned Again" in the *Wall Street Journal*, February 18, 2013.

money (ATM) and in-the-money (ITM) calls. We also find that ITM puts trade in abnormally larger volumes than ATM puts. This is evidence that informed traders may not only engage in OTM call transactions, but possibly also in ITM put transactions, or that the call trading generates arbitrage-based put trading activity.[2] An examination of the characteristics of cumulative abnormal volume shows that informed trading is more pervasive in cases of target firms receiving cash offers, and less so when the target is being taken private as a result of the deal. We consider synthetic options strategies and present a plethora of alternative tests which overwhelmingly confirm the evidence of informed investors trading directionally in anticipation of a future price jump in the target company' stock. We also find price and liquidity effects consistent with directional trading in the pre-announcement period, i.e., positive excess implied volatility, an attenuation of the slope of the term structure of implied volatility, and an increase in the percentage bid-ask spread for options on target firms from an average of 45% (35%) to 55% over the 30 (90) days preceding the announcement. This effect is significant for deep out-of-the-money (DOTM) and OTM call options, as well as short- to medium-dated options. For the most egregious cases, i.e., DOTM low-priced options, trading just prior to the announcement and expiring just after it, we show that the probability of the unusual volume arising out of chance is about three in a trillion. None of these patterns exist for comparable randomly chosen announcement dates, in terms of volume, prices or liquidity.

For acquirer firms, the average cumulative abnormal announcement return tends to be flat, with an increase in jump risk, up or down, suggesting more uncertainty in the stock prices of the acquiring firms. We therefore conjecture that informed investors would bet on an increase in jump risk and engage in "long-gamma"/"volatility" strategies. The evidence speaks in favor of this hypothesis as we find that there is a statistically significant increase in the trading volume on the acquirer ahead of the announcement of the acquisition that is greatest for ATM options and is non-random. In contrast to a bias towards trading in OTM call options for target companies, we find evidence of a greater symmetry in the rise of trading volume for calls and puts around ATM options. Higher abnormal volume is especially visible for stock-financed deals that have a greater uncertainty of deal completion and are therefore more exposed to "jump/volatility" trading strategies. Finally, we find an increase in the volume of ATM strike-matched call-put pairs ahead of the announcements, which is consistent with an increase in "long-gamma" trading strategies.

[2]It is shown in Internet Appendix Section A-I that a wide variety of strategies for exploiting private information about an acquisition result in the trading of OTM calls or ITM puts.

Is this informed activity in options ahead of M&A announcements illegal? To assess this likelihood, we examine a large number of alternative explanations and legal channels that could plausibly explain the abnormal trading volumes in options. In order to better distinguish informed from insider trading, we carefully differentiate between the legal status of *informed* and *insider* trading. We show that it is difficult to predict merger activity based on publicly observable information. The predictive models have low explanatory power ranging between 4% to 5%, with the average takeover propensity at 4%. Even if some individual investors may have superior skills in processing and connecting different pieces of information to infer the *occurrence* of a future takeover, it is difficult to conceive how they would be able to infer the correct *timing* of the announcement. While we focus our analysis on the thirty days preceding the announcement dates, most of the informed activity arises just days before the information gets publicly released.

Next, we show that the abnormal activity in options cannot be explained by speculation. We compare the options activity in the takeover sample to several control samples that are matched either on industry and firm characteristics, or on propensity scores. Similar findings of informed trading activity in options ahead of takeover announcements are absent from these control groups. In addition, our findings cannot be rationalized by news and rumors. We use RavenPack News Analytics, a database that is constructed from textual information in major newspaper outlets, public relation feeds, and over 19,000 other traditional and social media sites, to identify rumors and news about upcoming takeovers. We find no statistically significant difference in the average cumulative abnormal options trading volumes between the samples with and without news.

We further check whether the options trades originate from the accounts of corporate insiders. Corporate officers, directors, or large block-holders are legally required to disclose security transactions in their company's options. A systematic analysis of the derivative transactions and holdings information in the Thomson Reuters insider filings reveals that not a single options transaction was opened by registered insiders within the thirty pre-announcement days. Thus, the activity must originate from corporate outsiders, unless it is illegal. We also consider the possibility that astute options traders trade on information leakage in the stock market. However, past stock volume and return performance cannot explain the abnormal options activity. In addition, only 7% of all deals in our sample exhibit abnormal stock returns in the pre-announcement period, while about 44% of all deals exhibit excess implied volatility. Although 24% of all M&As have statistically significant

abnormal stock volume, a frequency that is similar to that in the options market, the economic magnitude is substantially smaller.

To better understand the nature of the informed options trading activity, we then study the cases in which the SEC conducted an investigation into illegal insider trading ahead of M&A announcements. We filter through more than 8,000 litigation records and hand collect information on the size, timing and type of trades, information we supplement with criminal records from the U.S. Department of Justice (DoJ). We find that the SEC is likely to examine cases in which the targets are large firms that experience substantial abnormal returns after the announcement, and in which the acquirers are headquartered outside the U.S. The characteristics of the litigation sample closely resemble the anomalous statistical evidence we find to be pervasive and non-random in a representative sample of M&A transactions. In particular, we consistently observe insider trades in short-dated and OTM call options on the target companies that are initiated, on average, 21 days before the announcement. Yet, the modest number of civil lawsuits for insider trading in options made by the SEC appears small in comparison to the pervasive statistical evidence we document. The SEC litigates about 7% of takeovers in our sample.

Have we proven evidence of illegal insider trading activity? Without supporting hard evidence by the Federal Bureau of Investigation, such as wire-taped phone conversations or other strong legal evidence, this is challenging to prove beyond reasonable doubt. Ultimately, only the jury will be able to judge the occurrence of trading on material non-public information and breach of fiduciary duty. This caveat does, however, not prevent us from concluding that the abnormal options activity raises a red flag and serious concerns about illicit activity in the options market.

Why do we focus on M&As? From an academic point of view, options trading around M&As is a particularly attractive laboratory for the testing of hypotheses pertaining to insider trading, for several reasons. First, M&A announcements are publicly unexpected events, in terms of their timing, and even their occurrence. Thus, on average, in the absence of unusual trading, we should not be able to distinguish options trading activity before an announcement from activity occurring on any randomly chosen date. In contrast to other corporate announcements, such as quarterly earnings announcements, M&As are likely the closest we can get to a truly unexpected event, with a substantial jump in the stock price, while still allowing us to construct a meaningful sample. Second, the nature of private information is clearly identified in the case of M&A announcements: a significant

rise in the target's stock price following the announcement in virtually all cases. This enables us to formulate clear hypotheses that one should fail to reject if informed trading is truly pervasive. Third, the richness of our options data, with detailed information relating to a large number of underlying stocks for multiple strike prices and expiration dates, is especially useful for formulating hypotheses about informed trading across several dimensions.

The structure of the paper is as follows. In Section 2, we provide a review of the relevant literature. We describe the data selection process and review the basic summary statistics in Section 3. We analyze the results for targets in the various subsections of Section 4, and discuss the results for acquirers in Section 5. Section 6 deals with the distinction between informed and insider trading. In Section 7, we provide an analysis of the SEC sample. We conclude in Section 8.

2 Literature Review and Contributions

We complement and extend the literature on informed trading on many dimensions. While previous research has highlighted abnormal activity ahead of M&A announcements on average, we explicitly quantify the likelihood of informed trading and examine deals case by case. We study the trading patterns in the equity options of *both* the target *and* the acquirer, emphasizing *how* insiders differentiate between *directional* strategies for targets and *non-directional/volatility* strategies for acquirers. We also emphasize *where* informed investors trade, in OTM calls (ATM calls and put) and cash (stock) deals for targets (acquirers). Second, although some of these earlier papers have investigated the informational content of option trading volumes for post-announcement stock returns, there has been little attempt to identify *illegal* insider trading, and *how* it can be detected using alternative *option strategies*. We explicitly consider synthetic option strategies that lead to long bullish or short bearish exposures for targets. For acquirers, we examine the replication of long strategies that benefit from an increase in volatility and short strategies that gain when volatility drops. In a major distinction from previous work, we rule out multiple legal channels that could explain the abnormal pre-announcement option volumes, including trading by high-level insiders, public rumors, or quantitative speculators who may predict takeovers based on publicly observable information. Finally, another novel and unique feature of our research is that we provide a detailed analysis of *all* SEC-prosecuted cases related to insider trading in options prior to M&A announcements during the

period of our study, and link them to our analysis of abnormal activity.

Our work relates to the theoretical literature studying when and how informed agents choose to trade in the options market in the presence of asymmetric information (Easley, O'Hara, and Srinivas, 1998), differences in opinion (Cao and Ou-Yang, 2009), short-sale constraints (Johnson and So, 2012), or margin requirements and wealth constraints (John, Koticha, Narayanan, and Subrahmanyam, 2003). More specifically, since our objective is to identify informed, or even insider, trading in the options market, ahead of unexpected public announcements, we also relate our work to the prior empirical literature on informed trading. In this spirit, Poteshman (2006) concludes that informed investors traded put options ahead of the 9/11 terrorist attack. Keown and Pinkerton (1981) confirm the leakage of information and excess *stock* returns earned through insider trading in the presence of merger announcements, but they do not investigate equity *option* activity. Meulbroek (1992) studies the characteristics of a sample of illegal insider trading cases prosecuted by the SEC from 1980 to 1989, but, does not focus on options trading either. Similarly, Guercio, Odders-White, and Ready (2015) study SEC prosecutions and argue that illegal insider trading has decreased in response to more aggressive enforcement. Also Ahern (2015) examines civil and criminal prosecutions made by the SEC and the DoJ, but he studies insider trading networks and does not examine security transactions. Cornell and Sirri (1992) provide a case study examination of illegal insider trading in *stocks* ahead of the 1982 takeover of Campbell Taggart by Anheuser-Busch, while Fishe and Robe (2004) find that trading by brokers, who illegally had advance access information to a newspaper column analysis covering a sample of 116 *stocks*, negatively impacted market depth. Acharya and Johnson (2010) show that a larger number of equity participants in leveraged buyout syndicates is associated with greater levels of suspicious stock and options activity. Chesney, Crameri, and Mancini (2011) develop statistical methods, using ex-post information, to detect informed option trades, confirming that informed trading tends to cluster before major informational events.[3]

Our research relates also closely to work that examines unusual options volume and price activity ahead of M&A announcements. Wang (2013) shows that unusual options volume and price activity ahead of M&As predicts SEC litigation. Frino, Satchell, Wong, and Zheng (2013) use SEC litigation reports to study the determinants of illegal insider trading, but they focus on *stocks*, not options. Our paper also speaks to the literature that investigates the informational content of option trading

[3]See Bhattacharya (2014) for a comprehensive literature review.

volumes ahead of M&As to predict the post-announcement abnormal stock returns. Cao, Chen, and Griffin (2005), for example, find evidence that, for the *target* companies in M&A transactions, the options market displaces the stock market for information-based trading during the periods immediately preceding takeover announcements, but not in normal times. Focusing on the *acquirer* firms, Chan, Ge, and Lin (2015) provide evidence that the one-day pre-event implied volatility spread (the implied volatility skew), a proxy for informed option trading, is positively (negatively) associated with acquirer cumulative abnormal returns. Using a much larger sample, we study unusual options activity in much greater depth and provide more granular evidence on the changes in the distribution of volume for different levels of option moneyness, ahead of announcements, which is worth examining in greater detail since the results presented in the literature are inconsistent across studies.[4] Podolski, Truong, and Veeraraghavan (2013) provide some indirect evidence that the option-to-stock volume ratio increases in the pre-takeover period, and increases relatively more for small deals that are less likely to be detected. Evidence of informed trading and the role of options markets in revealing information around M&A announcements in the UK is provided by Spyrou, Tsekrekos, and Siougle (2011). Finally, Dai, Massoud, Nandy, and Saunders (2011) argue that trading by hedge funds prior to M&As is informed, and Kedia and Zhou (2014) study the pre-announcement information content of corporate bond trading.

We are particularly interested in informed trading that may be generated by those who are outside the firm, i.e., corporate outsiders. Hence, we clearly differ from the large body of literature that attempts to decode informed trading by corporate *insiders* in *stocks* based on the Thomson Reuters insider filings. For example, Cohen, Malloy, and Pomorski (2012) separate trades into informed opportunistic and routine transactions, showing that only the former have predictive content for stock prices. Tamersoy, Xie, Lenkey, Routledge, Chau, and Navathe (2013) apply network analysis to identify temporal patterns in inside trades. Agrawal and Nasser (2012) argue in favor of widespread "passive" insider trading on targets, whereby registered insiders increase their net exposure by selling less stock ahead of the announcements. In general, these studies focus on stock trades only, and provide no evidence on option activity. Whether informed trading by corporate outsiders is illegal is impossible to answer without corroborative evidence on all trades, as we can only confirm evidence

[4]Poteshman (2006) focuses only on put options, Chesney, Crameri, and Mancini (2011) argue that there is more informed trading in put options, while Wang (2013) argues that there is higher abnormal volume for ATM call options. Barraclough, Robinson, Smith, and Whaley (2013) also document that the increase in trading volume in the pre-announcement period is most dramatic for target call options.

of *statistical* anomalies, rather than the *legality* of the transactions. We cannot rule out either that abnormal activity is the result of insider tips that have percolated down from corporate executives, as suggested by Ahern (2015). A parallel literature has developed in the law field, which discusses the fine line between legal and illegal insider trading.[5]

3 Data Selection and M&A Deal Characteristics

The data for our study come from three primary sources: the Thomson Reuters Securities Data Company Platinum Database (SDC), the Center for Research in Securities Prices (CRSP) Database and the OptionMetrics Database. We begin our sample selection with the full domestic M&A dataset for US targets from SDC Platinum over the time period from January 1996, the starting date for available option information in OptionMetrics, through December 2012. Our final sample consists of 1,859 transactions for which we were able to identify matching stock and option information for the target. These deals were undertaken by 1,279 unique acquirers on 1,669 unique targets.[6] For a subsample of 792 transactions, option information is available for both the target *and* the acquirer.

We restrict our sample to deals aimed at effecting a change of control, where the acquirer owned less than 50% of the target's stock before, and was seeking to own more than 50% of it after the transaction. Hence, our sample includes only M&As of majority interest, excluding all deals that were acquisitions of remaining or partial interest (minority stake purchases), acquisitions of assets, recapitalizations, buybacks/repurchases/self-tender and exchange offers. In addition, we exclude deals with pending or unknown status, i.e., we only include completed, tentative or withdrawn deals. Next, we require information to be available on the deal value, and eliminate deals with a transaction value below 1 million USD. Finally, we match the information from SDC with price and volume information in both CRSP and OptionMetrics. We require a minimum of 90 days of valid stock and option price and volume information on the target prior to, and including, the announcement date. We retain all options expiring after the announcement date. All matches between SDC and CRSP/OptionMetrics are manually checked for consistency based on the company name.

Panel A in Table 1 reports the basic deal characteristics for the full sample. Pure cash offers make up 48.6% of the sample, followed by hybrid financing offers with 22.3%, and share offers with

[5] We refer to Crimmins (2013) for a discussion of these legal details.

[6] Thus, 190 of the targets were involved in an unsuccessful merger or acquisition that was ultimately withdrawn. However, we include these cases in our sample, since the withdrawal occurred *after* the takeover announcement.

21.7%. 82.9% of all transactions are completed, and mergers are mostly within the same industry, with 53.4% of all deals being undertaken with a company in the same industry based on the two-digit SIC code. 90.2% of all deals are considered to be friendly and only 3.4% are hostile, while 11.6% of all transactions are challenged. For only 6.5% of the sample, do the contracts contain a collar structure, 76.5% of all deals involve a termination fee, and in only 3.5% of the transactions does the bidder already have a toehold in the target company. Panel B shows that the average deal size is 3.8 billion USD, with cash-only deals being, on average, smaller (2.2 billion USD) than stock-only transactions (5.4 billion USD). The average one-day offer premium, defined as the excess of the offer price relatively to the target's closing stock price, one day before the announcement date, is 31%. The statistics for the subsample for which we have option information on both the target and the acquirer are qualitatively similar.

4 Informed Options Activity Ahead of M&As - Targets

Our first objective is to quantify the likelihood of informed trading, while we will assess the likelihood of this informed trading being illegal in Section 6. Our analysis focuses on the trading activity in the options of both the target and the acquirer, for which we discuss information obtained from the trading volume of options in the main body of the paper. In Internet Appendix Section A-II, for completeness, we study how informed trading affects the prices and liquidity of options, and we overwhelmingly confirm the evidence of pre-announcement informed options trading volume. A distinctive feature of our analysis is the conjecture that informed investors trade differently in the options of target and acquirer firms. We emphasize that an informed trader would pursue directional strategies for the target, as the stock price almost always goes up after an announcement. On the other hand, for the acquirer, an informed trader would more likely pursue "volatility" trading strategies, as there is generally more uncertainty associated with the post-announcement direction of the stock price of the acquiring firm. The underlying assumption for all hypotheses is that informed traders are capital-constrained and would like to ensure that their private information is not revealed to the market prior to the trades, to minimize market impact.[7] We first state and justify

[7]The informed trader faces the trade-off between transacting in the more liquid stock, where his trades are less likely to be discovered, or in the options market that provides more leverage, but where the chance of a price impact is greater. As long as capital constraints are binding, informed investors will, at least partly, migrate to the options market (John, Koticha, Narayanan, and Subrahmanyam, 2003). Cao and Ou-Yang (2009) argue that speculative trading will occur

our hypotheses regarding the target firms. We discuss the hypotheses pertaining to the acquiring firms in Section 5.

- H1: *There is evidence of positive abnormal trading volume in the equity options of target firms prior to M&A announcements.*

If informed trading is present, but there is no leakage of information, informed traders should benefit relatively more from strategies that use options, due to the leverage they can obtain from them, if they are capital-constrained. A takeover announcement is generally associated with a stock price increase for the target, usually a significant one (Andrade, Mitchell, and Stafford, 2001). An informed trader who intends to trade is likely, given his capital constraints, to engage at least partly in leveraged trading strategies that will maximize his profits. The obvious venue for such activity is the options market, where we would expect to see significant abnormal trading volumes in options for the *target* firms in anticipation of major corporate takeover announcements. Given the importance of leverage, we can sharpen the above hypothesis as follows in Hypothesis H2:

- H2: *The ratios of the abnormal trading volumes in (a) OTM call options to ATM and ITM call options, and (b) ITM put options to ATM and OTM put options, written on the target firms, are higher prior to M&A announcements.*

In the presence of superior information, a trading strategy involving the purchase of OTM call options should generate a significantly higher abnormal return, as a consequence of the higher leverage ("more bang for the buck"). Hence, we expect a relatively larger increase in abnormal trading volume for OTM calls relative to ATM and ITM calls. Moreover, an informed investor, taking advantage of his privileged knowledge of the future direction of the target's stock price evolution, is also likely to increase the trading volume through the sale of ITM puts, which will become less valuable once the announcement has been made, followed by an upward move in the stock price of the target. An alternative strategy, arising from put-call parity, would be to buy ITM puts coupled with the underlying stock, financed by borrowing (mimicking the strategy of buying OTM calls). A possible reason for engaging in such a strategy rather than the more obvious one of buying OTM calls could be the lack of liquidity in OTM calls: a large order may have a significant market impact and even

in the options market mainly around major informational events if investors disagree about the future values of stock prices.

reveal the information to the market. Thus, an abnormally high volume in ITM puts may result from either the strategy of mimicking the purchase of OTM calls or the strategy of taking a synthetic long position in the stock (buying a call and selling a put with the same strike price). An informed trader may possibly engage in more complicated trading strategies to hide his intentions. We provide a detailed analysis of synthetic replications of directional trading strategies that should result in abnormal volumes of OTM calls and/or ITM puts in Internet Appendix Section A-I.[8] Interestingly, it turns out that, irrespective of which alternative strategy is applied, we should observe abnormal trading volume in OTM call and/or ITM put options.

In order to address Hypotheses H1 and H2, we conduct a forensic analysis of the trading volume in equity options written on *target* firms during the 30 days preceding M&A announcements. In a nutshell, we find that approximately 25% of all deals in our sample exhibit statistically significant abnormal options activity (at the 5% level) in the pre-announcement period. The magnitude of abnormal volume is greater for OTM call options than for ATM and ITM calls, and we show that the odds of abnormal volumes being greater in a sample with randomized announcement dates are at most one in a million (three in a trillion if we consider the most egregious cases).

4.1 Statistics of the Equity Options Trading Volumes

We first report the basic summary statistics for the option trading volumes of the target firms, stratified by time to expiration and moneyness, in Table 2.[9] We classify our sample into three groups in terms of time to expiration: less than or equal to 30 days, greater than 30 days but less than or equal to 60 days, and more than 60 days. In addition, we sort the observations into five groups of moneyness, where moneyness is defined as S/K, the ratio of the stock price S to the strike price K. DOTM corresponds to $S/K \in [0, 0.80]$ for calls ($[1.20, \infty)$ for puts), OTM corresponds to $S/K \in (0.80, 0.95)$ for calls ($[1.05, 1.20)$ for puts), ATM corresponds to $S/K \in (0.95, 1.05)$ for calls ($(0.95, 1.05)$ for puts), ITM corresponds to $S/K \in [1.05, 1.20)$ for calls ($(0.80, 0.95]$ for puts), and DITM corresponds to $S/K \in [1.20, \infty)$ for calls ($[0, 0.80]$ for puts). Panel A reports summary statistics for all options in the sample, while Panels B and C report the numbers separately for calls

[8] We also discuss replications of volatility trading strategies that should result in abnormal volumes of ATM calls and puts in relation to the results for the acquirers, which we examine more explicitly in Section 5.

[9] Given the high illiquidity of equity options, we report the summary statistics of trading volume by excluding zero-volume observations. More granular statistics on the quantiles of the distribution and aggregate volumes around announcements are available on request.

and puts, respectively. First, regardless of moneyness, the level of trading volume, as indicated by the mean volume statistics, is significantly higher for short and medium-dated options than for long-dated options. (For example, the average numbers of traded contracts in OTM options for target firms are 370 and 285 contracts, for maturities of less than 30 and 60 days respectively, while the number is 130 contracts for options with more than 60 days to maturity. This difference is more pronounced for call options than for put options.) Second, the highest average trading volume in calls tends to be associated with OTM contracts that expire more than thirty days in the future, while the highest average trading volume for puts is recorded for DITM options.

4.2 Identifying Abnormal Trading Volumes

Hypothesis H1 asserts that there is a positive abnormal trading volume in equity options written on the target prior to a public M&A announcement. We test this formally by applying the classical event study methodology to trading volumes. For each of the 1,859 deals in the sample, we obtain the aggregated option volume on the target's stock, as well as the aggregated volume traded in calls and puts. To compute the abnormal trading volume, we use, as a conservative benchmark for normal volume a market model for volume (*MMV* model), which accounts for the market volume in options, the Chicago Board of Options Exchange (CBOE) Volatility Index (VIX), as well as the contemporaneous return of the underlying stock and the market, proxied by the return on the S&P500 index. For the market volume in options, we use the median trading volume across all options, i.e., both calls and puts, in the OptionMetrics database. We verify all our results using an augmented MMV model, which includes lagged values of the dependent and all independent variables, the *MMV-L* model. As we are interested in the abnormal trading volume in anticipation of the event, we use, as the estimation window, the period starting 90 days before the announcement date and finishing 30 days before the announcement date. Our event window stretches from 30 days before to one day before the announcement date. To account for the possibility of clustered event dates, we correct all standard errors for cross-sectional dependence.

Table 3 shows that the average cumulative abnormal trading volume for the target firms is positive and statistically significant across both model specifications. The magnitude of the average cumulative abnormal volume over the 30 pre-event days is estimated to be 11,510 contracts for call options, using the MMV model. For put options on the target, the average cumulative abnormal

volume is also positive and highly statistically significant, but, over the 30 pre-event days, it is much smaller, at 1,243 contracts. The evolution of the average abnormal and cumulative abnormal trading volume for the targets is illustrated in the two upper panels in Figure 1. It is apparent that the average cumulative abnormal trading volume in put options is quantitatively less important than that in call options, which is primarily driving the results for the overall sample. The daily average abnormal volume for call options is positive and steadily increasing to a level of approximately 1,500 contracts the day before the announcement. Individually, the number of deals with positive abnormal trading volumes, at the 5% significance level, ranges from 467 to 543 for calls, and from 304 to 348 for puts, corresponding to approximately 25% and 16% of the entire sample, respectively.[10] These results confirm Hypothesis H1, that there are positive abnormal trading volumes in call and put equity options written on the targets prior to public M&A announcements.

We find that approximately one out of four deals exhibits statistically significant cumulative abnormal call options trading volume. How accurate is this number? Given that we test the statistical significance of each deal individually, we may suffer from a multiple hypothesis test bias.[11] In other words, among our sample of 1,859 deals, some test statistics may have rejected the null hypothesis simply out of luck. To explicitly account for false positives, we follow the methodology in Barras, Scaillet, and Wermers (2010) to adjust for false discoveries. The frequency of mergers with statistically significant abnormal call option volume is still 24%, even though we fail to adjust for false negatives, i.e., the fact that we fail to reject the null hypothesis simply by chance, which leads to a downward bias in the proportion of anomalous trading we observe. Given that the 25% number is obtained with the most conservative model using two-sided test statistics, we believe that our estimates are generally conservative.

In addition to the aggregated results, we stratify our sample by moneyness, and conduct an event study for each category. We find that there is significantly higher abnormal trading volume for the targets in OTM call options, compared to ATM and ITM calls, both in terms of volume levels and frequencies. Using the MMV model, for instance, Table 3 shows that the average cumulative

[10] Unreported results indicate that, at the 1% significance level, the number of deals with positive abnormal trading volumes in the entire sample ranges from 275 to 345 for calls, and from 179 to 203 for puts, corresponding to frequencies of 15% and 10%, respectively, based on the MMV-L model.

[11] For statistical inference, we follow Kothari and Warner (2007) and Campbell, Lo, and MacKinlay (1996). We note that our predictive volume models account for lagged values of both dependent and independent variables in order to purge out serial correlation in the residuals at the firm level. Moreover, we show in the paper that the documented effects for option volumes do not arise in samples matched on randomized announcement dates, on industry and firm characteristics, as well as on takeover propensity scores.

abnormal volume is 3,817 (1,775) contracts for OTM calls (puts) and 1,659 (1,034) contracts for ITM calls (puts), while it is 1,281 (494) for ATM calls (puts). These values correspond to 430 (383, 506) deals, or 23% (21%, 27%) of the sample for OTM (ATM, ITM) calls, and 458 (362, 405) deals or 25% (19%, 22%), for OTM (ATM, ITM) puts, respectively. In addition, while we find that the average cumulative abnormal volume is positive and statistically significant for both OTM and ITM calls and puts, it is only statistically significant at the 10% level for ATM put options for the MMV model. Figures 1c and 1d further show differences in the average and cumulative abnormal option volumes between cash and stock-financed takeovers. Consistent with the evidence of greater abnormal announcement returns for cash-financed deals (Andrade, Mitchell, and Stafford, 2001), the level of the cumulative abnormal options volume is greater for cash than for stock deals. In untabulated results, we find that the average cumulative abnormal options volume is 17,760 contracts for cash deals, and 3,336 contracts for stock deals, and the average cumulative abnormal volumes of both call and put options are consistently greater for cash-financed deals. These differences are, however, statistically significant at only the 10% significance level, using the MMV model with a natural log transformation of volume.

Panel B reports results from paired t-tests for the differences in means of the cumulative average abnormal volumes across different depths. Consistent with Hypothesis H2, these results emphasize that there is higher abnormal trading volume for OTM call options than for ATM or ITM calls. The differences in means, using the MMV model, for OTM calls relative to ATM and ITM calls, are 2,537 and 2,158, respectively, which are positive and statistically different from zero. On the other hand, the difference in means between ATM and ITM calls is slightly negative (-378), but not statistically different from zero. We do confirm that the average cumulative abnormal volume for ITM put options is higher than for ATM put options. This result provides some evidence that informed traders may not only engage in OTM call transactions but may also sell ITM puts.[12]

To summarize, our event study supports Hypotheses H1 and H2. In other words, there is ample evidence of positive abnormal volumes in equity options for the target firms in M&A transactions, prior to their announcement dates. In addition, we document that, for the targets, there is a significantly larger amount of abnormal trading volume in OTM call options than in ATM or ITM call options. There are also greater abnormal trading volumes in cash than in stock-financed takeovers.

[12]The expected cumulative abnormal volume for OTM put options is slightly higher than that for ITM put options. The difference of 742 contracts is, nevertheless, small, given that it is a cumulative measure taken over 30 days.

However, the evidence that informed traders may also engage in writing ITM put options is not as strong. One reason for this discrepancy may be that writing naked puts is a risky position, especially ITM puts: The failure of deal negotiations could lead to a sharp stock price drop, and selling naked puts requires large margins, which may be a binding constraint in the context of limited capital.

4.3 Implied Volatility, Liquidity, and Robustness Tests

We verify our results using a plethora of alternative tests and robustness checks for option volumes to ensure that our findings do not arise by pure chance. All additional tests overwhelmingly agree with the previous findings, yielding either similar or stronger results, both qualitatively and quantitatively. In order not to distract the reader from the second key objective of our analysis, i.e. the assessment of the likelihood that the observed informed trading activity is illegal, we discuss the details of these additional tests in Internet Appendix Section A-II, and only briefly describe them in this section. We first verify that all results hold for a natural log transformation of volume. Second, we show, using an approximation to the bivariate Kolmogorov-Smirnov test, that the three-dimensional volume-moneyness distribution shifts significantly in both time and depth over the 30 days preceding the announcement day, with an increase in the OTM call volume relative to ATM and ITM calls as we approach the event day. Third, we show that the frequency of trading increases in the pre-announcement period and that it is greater compared to a matched sample with random announcement dates. The odds that the trading frequency observed during the five-day pre-announcement period is as high in a sample of randomly chosen announcement dates is at best one in a million. Fourth, we study specific trades that are most susceptible to insider trading, and compare them to a matched random sample. We compare the statistics from these most egregious trades to those from a randomly selected sample and compute a probability of three in a trillion that the pre-announcement trading volume happened by chance.

As a complement to the volume results, we further conduct a forensic analysis of implied volatility, the summary statistic of the price behavior of options, over the 30 days preceding the M&A announcement date. We show that the pervasive evidence of informed trading on target companies is also reflected in positive excess implied volatility in the pre-event window. Though higher abnormal volumes in OTM call options for the targets need not affect option prices, it could be argued that higher volume "translates," on average, into an increase of the implied volatility prior to the

announcement day.[13] We also show that the percentage bid-ask spread for options on target firms rises from an average of 45% (35%) to 55% over the 30 (90) days preceding the announcement. This effect is significant for DOTM and OTM call options, as well as short- to medium-dated options. It can be explained as a "hedge" against risk of informed trading, manifested through an increase in options volume. Finally, informed trading has a greater impact on shorter-term equity option prices, and thus leads to an attenuation of the slope of the term structure of implied volatility for target firms. None of these effects on prices and liquidity arise in matched samples with randomized announcement dates.

4.4 Characteristics of Abnormal Volume

We have documented that abnormal trading volume in equity options ahead of M&A announcements is pervasive, non-random and most concentrated in OTM call options. This leaves open the question of whether certain target companies are more likely than others to exhibit unusual trading volumes. To answer this question, we regress the cumulative abnormal log trading volume in call and put options over the 30 pre-announcement days on a set of categorical variables reflecting M&A deal characteristics and several market activity variables. We test the following model:

$$\begin{aligned} CABVOL = \beta_0 + \beta_1 SIZE + \beta_2 CASH + \beta_3 TOE + \beta_4 PRIVATE + \beta_5 COLLAR \\ + \beta_6 TERM + \beta_7 FRIENDLY + \beta_8 US + \gamma_t + \varepsilon, \end{aligned} \tag{1}$$

where $CABVOL$ denotes the cumulative abnormal trading volume in call or put options respectively, which we scale for each target by the average predicted volume in the event window (i.e., the 30 pre-announcement days), using the coefficients estimated based on the MMV model in the estimation window.[14] All specifications contain year fixed effects γ_t, and standard errors are clustered by announcement day.

We investigate several M&A deal characteristics that may imply a higher likelihood of informed trading. Our strongest prior is that cumulative abnormal volume should be higher for cash-financed deals, given that cash-financed deals are known to have higher abnormal announcement returns

[13] This argument is related to prior work on the inelasticity of the option supply curve, along the lines analyzed theoretically by Garleanu, Pedersen, and Poteshman (2009) and empirically by Bollen and Whaley (2004) and Deuskar, Gupta, and Subrahmanyam (2011).

[14] We emphasize that this analysis is based on a natural log transformation of volume. Hence, scaled cumulative abnormal log volume is comparable across companies and interpretable as a percentage relative to predicted volume.

(Andrade, Mitchell, and Stafford, 2001) and are more likely to be completed (Fishman, 1989). Thus, we expect that an informed trader will benefit more from trading in such deals if he anticipates a higher abnormal return and is more certain that he will earn it. We test for this by including a dummy variable $CASH$ that takes the value one for purely cash-financed deals. In addition, traders with private information may prefer opening positions for larger companies, whose stocks (and therefore their options) tend to be more liquid and hence less likely to reveal unusual, informed trading. Thus, we expect cumulative abnormal volume to be higher for larger deals, measured by $SIZE$, a dummy variable that takes the value one if the deal is above the median transaction value, and zero otherwise. We also suspect that a bidder that has a toehold in the company (TOE) is more likely to gather information about a future takeover, and is hence more likely to trade based on his private information. Alternatively, an investor with privileged information from the bidder, with a toehold, may refrain from trading as he would be among the first suspects in any investigation. We also control for other deal characteristics, such as whether the target is taken private post-takeover ($PRIVATE$), whether the deal has a collar structure ($COLLAR$), whether it involves a termination fee upon the failure of deal negotiations ($TERM$), whether the deal attitude is considered to be friendly ($FRIENDLY$), and whether the bidder is a US-headquartered company (US).

The results for the benchmark regressions of cumulative abnormal volume in the target call options are reported in column (1) of Table 4. The two single most important predictors are cash-financed deals and the size of the target company. This evidence is consistent with our prior assumption that informed trading in call options on the target firm would be significantly higher for cash deals, which are anticipated to have higher abnormal announcement returns, and for larger, more liquid companies, for which it is easier to hide informed trading. Quantitatively, a target deal above the median transaction value has, on average, 3.32% greater cumulative abnormal call trading volume relative to its normal volume than a target below the median deal size.[15] Similarly, cash-financed deals have, on average, 6.37% greater cumulative abnormal volume than non-cash-financed deals. Given that the average cumulative abnormal volume is approximately 12,000 contracts, the typical cash-financed deal has about 764 more contracts traded during the 30 days before an announcement. The cash indicator is consistently robust across all specifications, with similar economic magnitudes.

If the bidder already has a toehold in the company, cumulative abnormal volume is about 5.6%

[15] We also proxy for the size of the company using a dummy variable $SALES$, which takes the value one if the target has more sales than the median. The results did not change.

smaller. The negative coefficient favors our second conjecture that equity stakeholders with a prior interest may make more of an attempt to keep their intentions secret, given that they would be suspects in the case of insider trading. Nevertheless, we point out that the coefficient of TOE loses its significance in other specifications with additional control variables.

Deals that embed a collar structure and a termination fee in their negotiations are also more likely to exhibit higher cumulative abnormal volume, by about 7.23% and 5.65%, on average. A collar structure implicitly defines a target price range for the takeover agreement. Moreover, a termination fee makes it more likely that a negotiation will be concluded. Thus, both variables are associated with greater certainty about the magnitude of the target's stock price increase, conditional on an announcement being made. This is consistent with a greater likelihood of informed trading in the presence of greater price certainty. All other variables are statistically insignificant. The adjusted R^2 of the regression, 6%, is reasonable given the likely idiosyncratic nature of the derived statistic, $CABVOL$, denoting the cumulative abnormal trading volume.

In line with Acharya and Johnson (2010), who argue that the presence of more syndicate loan participants leads to more insider trading in leveraged buyouts, we conjecture that the more advisors are involved in the deal negotiations, the higher is the probability of information leaking to the markets. The number of target and acquirer advisors is measured by $ADVISORS$. In unreported results, we find a positive coefficient, which is, however, not statistically significant. In column (2), we include the takeover price ($PRICE$), and control for the offer premium. The coefficient of the offer premium is negative, which could be associated with the fact that, percentage-wise, it is easier to offer greater markups for low-market-capitalization firms. Also, the offer price is negatively associated with a higher cumulative abnormal volume, although the effect is statistically indistinguishable from zero. A positive relationship between pre-announcement volume and the takeover premium may be expected if a true insider has near certainty about the details of the upcoming takeover. However, even if an insider has detailed information about the timing of an upcoming merger, there may be uncertainty about the upcoming price, which is often adjusted in the period immediately before the announcement. Moreover, it is plausible to argue that the smaller the premium, the greater is the number of options needed to maximize the insider profit.

We verify whether various market activity variables have an impact on the pre-announcement cumulative abnormal call volume. We include $TRUNUP$, the pre-announcement cumulative ab-

normal stock return for the target, $TANNRET$, the target's announcement-day abnormal return, $TTPRET1$, the target's post-announcement cumulative abnormal return, and $ARUNUP$, the abnormal stock return for the acquirer before the announcement day. $MKTVOL$ denotes the market volume on the day before the announcement day. These results are reported in columns (3) to (4). The pre-announcement run-up in the target's stock price is strongly positively related to the cumulative abnormal volume. On the other hand, the target's cumulative abnormal announcement return is negatively associated with the cumulative abnormal trading volume for call options. All other variables are statistically insignificant. The coefficients remain robust for large deals that are cash-financed, that have a collar structure, and that have a termination fee. In this final regression specification, the explanatory power increases to 14%. In unreported results, we repeat the analysis for cumulative abnormal volume in put options. While the results are qualitatively similar, the magnitudes of the coefficients are typically smaller. Overall, our interpretation of the evidence is that informed traders are more likely to trade on their private information when the anticipated abnormal stock price performance upon announcement is larger, and when they have the opportunity to hide their trades due to greater liquidity of the target companies.

5 Acquirer Firms

Though we report strongly unusual (directional) trading activity in options written on target companies, it is not clear, a priori, what we should expect regarding activity in stocks or options of the acquirer. The effect of a merger or acquisition on the acquirer's stock price is rather ambiguous. However, an informed trader could safely assume that the acquirer's stock price will move, possibly by a large amount, though he would not be certain in which direction, up or down. Thus, a sensible strategy would be to use options employing a non-directional "long-gamma/volatility" strategy like, for example, straddles.[16] As we did with the target firms, we first state and justify our hypotheses. In the presence of leverage constraints, we expect an informed trader to engage, at least partly, in leveraged trading strategies that will maximize his profits.

- H1-A: *There is evidence of positive abnormal trading volume in equity options written on the acquirer firms, prior to M&A announcements.*

[16] For non-directional strategies, we use the terms "volatility" and "long-gamma" interchangeably.

Chan, Ge, and Lin (2015) and Ordu and Schweizer (2015) document the predictive power of the option volume for the ex-post announcement returns of the acquirer. However, the question of *how* an informed investor would trade in equity options on the acquirer, and *what strategy* he would use, needs to be examined carefully. Given the uncertainty of the stock price evolution of the acquirer around the announcement date, with considerable cross-sectional variation in abnormal announcement returns (Savor and Lu, 2009), an informed investor trading in options on the acquirer would benefit most by engaging in strategies that benefited from large moves in the stock price (i.e., a jump) in either direction after the announcement. More specifically, the optimal strategy would be a zero-delta, long-gamma trade. The obvious strategy to use to implement a "long-gamma" strategy would be to buy ATM straddles. Hence, we expect a relatively larger increase in abnormal trading volume for ATM call and put options relative to OTM and ITM call and put options.

- H2-A: *Cumulative abnormal trading volumes in call and put options, written on the acquirer firms, are higher for ATM call and put options than for OTM and ITM call and put options prior to M&A announcements.*

The performance of a "long-gamma/volatility" strategy is a function of the uncertainty in the post-announcement move/jump in the underlying stock price. One conjecture is that this is likely to be particularly true for stock-financed deals compared with cash-financed deals. In stock-financed deals, there is more uncertainty about deal completion and, thus, about whether the acquirer's stock price will move up or down. This is justified by Fishman (1989), who argues that cash-financed takeovers have a lower chance of being rejected by the management of the target company and that they increase the speed of deal completion, which reduces the probability of competitive bids. In addition, Gilson and Black (2007) document that, in the United States, security registration and shareholder approval requirements lead to offer delays in the case of stock-financed mergers. Overall, this suggests that we should observe greater abnormal trading volume in M&As that are financed through stocks as opposed to cash.

- H3-A: *Cumulative abnormal trading volumes in call and put options, written on the acquirer firms, are higher for stock-financed than for cash-financed takeovers.*

In order to verify the hypotheses pertaining to the acquirer firms, we first provide a quick overview of the summary statistics on the option trading volume, stratified by time to expiration and money-

ness, in Table 2. Panel A reports statistics for all options in the sample, while Panels B and C report the numbers separately for calls and puts. Similar to the properties for the target firms, the mean trading volume is higher for short- and medium-dated options than for long-dated options.[17] On the other hand, the average trading volume is higher for options on the acquirer firms (547 contracts) than for those on the targets (283 contracts). Importantly, the distribution of volume as a function of moneyness exhibits a hump-shaped pattern for acquirers, irrespective of whether the options are short- or long-dated. Hence, trading volume tends to be highest for ATM options and decreases as the option moneyness, S/K, moves further ITM or OTM. In the entire universe, for instance, the average volume for ATM options is 1,084 contracts, while there are 497 and 398 contracts respectively, for OTM and ITM options, and 127 and 214 contracts respectively for DOTM and DITM options. This contrasts with the distribution for the targets, where the highest average trading volume tends to be associated with OTM options.

Panel A in Table 5 reports the results from an event study of abnormal volumes of options in the acquirer firms, using the MMV and MMV-L models and a natural log transformation of options volume. A first observation is that 203 deals exhibit statistically significant abnormal trading volumes in the options of the acquiring firms at the 5% statistical significance level, which corresponds to about 26% of the sample. Importantly, the frequency of deals with abnormal volumes is similar for calls (25%) and puts (24%), while the results for options written on the target firms are imbalanced in favor of OTM calls. Second, average cumulative abnormal trading volume is statistically significant at the 1% significance level, and corresponds to approximately 2,712 contracts, a number that is based on unreported results that use raw options volume.[18] Third, the level of abnormal trading volume is greatest for ATM options. For example, the average abnormal log volume using the MMV model is equal to 12 for ATM options, compared to 6 for OTM options and 9 for ITM options. The t-tests in Panel B for the differences in the average cumulative abnormal volumes across moneyness categories confirm that the average abnormal volume is greatest for ATM options. These findings confirm the conjectures made in Hypotheses H1-A and H2-A, i.e. that, prior to M&A announcements, there is positive abnormal trading volume in equity options written on the acquirer firms, which is greatest

[17] For example, the average numbers of traded contracts in OTM options, for acquirers, are 497 and 384 contracts for maturities of less than 30 and less than 60 days respectively, while the number is 193 contracts for options with more than 60 days to maturity. This difference is more pronounced for call options than for put options.

[18] All our results are robust against different model specifications of normal volume, and for both raw and a natural log transformation of options volume.

for ATM options.

We further test the conjecture that abnormal options trading volume is greater for stock-financed deals. The reason is that such deals are less likely to be completed, because stock-financed deals have a higher chance of being rejected by the management of the target company, are less likely to receive competitive bids, and face more administrative hurdles for reasons of security registration and shareholder approval. Figures A-4a and A-4b in the internet appendix plot the average abnormal and average cumulative abnormal log trading volumes for all options in M&A transactions that are either cash-financed (solid line) or stock-financed (dashed line), over the 30 days preceding the announcement date. In particular, the graph for cumulative abnormal trading volume emphasizes that the abnormal trading in the options of acquiring firms is determined primarily by takeover deals that are stock-financed. The difference is statistically significant for most specifications at either the 5% or 10% significance level.[19] This is consistent with the view that such deals bear more uncertainty about deal completion, which should be reflected in the acquirer company's stock price, and thus they are more prone to volatility trading strategies. This evidence confirms Hypothesis H3-A, stating that cumulative abnormal trading volumes in call and put options, written on the acquirer firms, are higher for stock-financed than for cash-financed takeovers.

We end the analysis of the acquirer firms by summarizing the results of several additional tests, reported in Internet Appendix Section A-III, that confirm the conjectures made in Hypotheses H1-A to H3-A. First, we measure the upper bound on the total volume of straddle trading strategies implemented in a given day and show that there is an increase in the straddle pairs (ATM strike-matched call-put pairs) and trading volumes of the acquirer firms, but not of the target firms. This trend is not observed on randomly drawn announcement dates, and is exclusively driven by ATM options. Second, we show that the call-to-stock and put-to-call volume ratios rise for targets, but that they stay flat for acquirers. Third, using the approximation to the bivariate Kolmogorov-Smirnov test for the options trading volumes on acquirer firms, we show that there is a statistically significant shift in the volume surface. This shift appears symmetric for calls and puts, and around ATM options, whereas the shift in the volume surface is more pronounced for call options and for OTM options in the case of target firms. Fourth, we present a modified strongly unusual trading sample for the acquirer and we compare its statistics with those from a sample comprising randomly selected

[19] These results are not reported, but are available upon request.

announcement dates. This test suggests that the abnormal volume in short-dated ATM options is not random, implying a probability of six in a billion that the trading volumes observed before the announcements happened by chance. Overall, our results confirm that there is a difference in *how* informed activity is reflected in the options of target and acquirer firms. While there appears to be *directional* trading for the former, the latter are exposed to *volatility* trading. We leave an analysis of this hypothesis using high-frequency micro-level data for future research.

6 Informed vs. Insider Trading

In the previous section, we provide substantial evidence of informed trading in the options market ahead of M&A announcements. Informed trading is often associated with insider trading, although it is conceptually quite distinct. As insider trading is a topic of intense public debate these days, this debate must be framed in the context of a clear and objective definition of informed versus insider trading. In addition, we emphasize that our evidence of informed trading is unusual, and also consistent with possible illicit activity. Nevertheless, there may be several reasons to believe that the abnormal activity that we document, in a statistical sense, is a natural result arising from rumors about upcoming tender offers, speculation because of industry-specific merger waves, or simply because of the superior ability of certain types of investors to forecast deal activity. We discuss these concerns in the following subsections.

6.1 A Legal Distinction of Insider Trading

In the United States, insider trading is regulated under the 1934 Securities Exchange Act ("Exchange Act") and the responsibility for enforcement lies with the SEC. More specifically, it is Section 10(b) of the Exchange Act and, in particular, Rule 10b-5, as well as Section 14(e) and Rule 14e-3 in the limited context of tender offers, that defines as illicit those trades that are based on material non-public information, and that are made in breach of fiduciary duty.[20]

Registered insiders – corporate officers, directors, or large block-holders with a stake of 10% or more in the company – are allowed to trade in their company's stock, or options written on it, but they are bound by rules relating to mandatory disclosure and timing, governed by Section

[20]For further details on insider trading regulations, see Morrison-Foerster (2013), Bainbridge (2007), Crimmins (2013).

16a of the Exchange Act. Thus, their trades may be of a legal or illegal nature, depending on the circumstances of trading and disclosure. Such "insiders" are bound by the "classical" theory implicit in the antifraud provisions in the Exchange Act, which holds them liable if they have traded based on non-public information from their company and if they have violated their fiduciary duty to the company and its shareholders.[21]

In addition, there are traders who are not directly connected with the company. Such agents may analyze multiple pieces of immaterial non-public information to infer a material "mosaic" conclusion, allowing them to make educated guesses with superior forecasting ability. Informed trading based on the so-called "mosaic theory" may not necessarily be illegal. However, such informed traders are restricted by the "misappropriation" theory implicit in the antifraud provisions in the Exchange Act, which prohibits trading based on information that is misappropriated from a third party to whom the investor owes a fiduciary duty. Nevertheless, a trade initiated by a "tippee," who has received material non-public information from a "tipper," may not be liable for conviction if the person did not know that the information was obtained in breach of fiduciary duty, at least that was the case prior to 2012.[22] The boundaries of illegal insider trading are thus, at best, blurry. Naturally, a regulatory system dependent on common law is evolving and path dependent. Allegedly, it appears that the ability and willingness to convict anyone for illicit insider trading practices is more of an art than a science, and may be influenced by, among other things, the aggressiveness of the prosecutors and the prevailing public mood.[23]

Until proven otherwise, an accused investor remains innocent, and hence we are unable to draw a clear and precise distinction between a trade that is speculative, informed and legal, and one that is illegal, as defined by Rule 10b-5 of the Exchange Act. What we can do is focus our microscope on certain trades, narrow down on the possibility that these are unusual/abnormal in a probabilistic sense, and flag them as suspicious and indicative of illicit activity. Thus, unless we discuss *actual* convicted criminal prosecutions or civil enforcement actions, we refrain from labeling any options

[21] A recent decision by the Second Circuit in United States v. Newman in December 2014 has raised the bar on identifying insider trading by ruling that (a) the trader knew that the information was confidential and illegal, and (b) that inside information was provided in exchange for something that benefited the provider.

[22] "In 2012, a decision by the Second U.S. Circuit Court of Appeals in SEC v. Obus arguably expanded tippee/tipper liability - at least in SEC civil enforcement actions - to encompass cases where neither the tipper nor the tippee has actual knowledge that the inside information was disclosed in breach of a duty of confidentiality" (Morrison-Foerster, 2013).

[23] The wave of prosecutions initiated by Rudolph Giuliani in the 1980s, and by Preet Bharara in recent years, both US Attorneys for the Southern District of New York, are indicative of such aggressiveness.

activity as illegal insider transactions, and we stick to the notion of informed trading, which is a less legally charged term. However, our definition of informed trading differs from the prior literature in some subtle dimensions. Cao, Chen, and Griffin (2005), for example, define trading to be informed if its direction foreshadows subsequent price movements. We, on the other hand, define trading to be informed if unusual options activity - characterized by abnormal volume, excessive implied volatility, and abnormal liquidity - is consistent with a directional trading strategy for the target, or a volatility strategy for the aquirer, and is higher relative to a control sample of randomly selected announcement dates. Thus, we use only pre-announcement information to draw an inference about informed trading, which must not arise in a randomly matched control sample. It is, in particular, the directional trading and the associated price effects that we exploit, for the targets, as consistently large price increases in the target's stock price consequent to takeover announcements demonstrate the clearly identified nature of private information. The magnitude of such abnormal announcement returns, about 16% on average, is evidence of unexpected and previously unknown news.

6.2 Takeover Predictability

Kosowski, Naik, and Teo (2007) document that hedge funds earn abnormal returns that cannot be explained by pure luck. The economic sources of such "hedge fund alpha" are, however, not uncontestably pinned down. Could it be that the positive abnormal performance of a certain class of hedge funds is rationally justified by a superior ability to predict M&A deal activity? We examine this question by looking at the ability of traders to predict merger activity through the lens of a takeover prediction model. More precisely, we estimate the likelihood that a firm will be a target in an M&A transaction using observable firm-specific and industry characteristics. We use the entire spectrum of completed takeover targets in the SDC Platinum database for which we can identify full firm-level information in Compustat over the period from 1995 to 2012. This generates a sample of 4,061 to 4,978 targets, depending on the specified model, with 101,306 firm-year observations for the most restrictive specification. Between 1,260 and 1,354 of these deals overlap with our option sample, and we therefore cover approximately 68% to 73% of the 1,859 deals that we studied in the previous section.[24] Depending on the specification, we have between 101,306 and 121,696 firm-year observations.

[24]Our sample is substantially larger than that of Billett and Xue (2007), who have 23,208 firm-year observations, and Cremers, Nair, and John (2009), who study a sample of 2,812 targets.

We estimate the ex-ante probability of a takeover using a logit regression framework. We define a target indicator variable MA that takes the value one if a firm was a target in a given calendar year, and zero otherwise. If a target was acquired, it drops from the sample in the year following its acquisition. In a second step, we attempt to predict the probability of treatment (i.e., a firm is a takeover target) using the previous year's balance sheet information. Formally, we run the regression

$$Prob(MA^i_{t+1} = 1) = \Phi\left(X^i_t \beta\right), \tag{2}$$

where $\Phi(\cdot)$ is the cumulative distribution function of the logistic distribution, and X^i_t is the vector of observable covariates that contains both firm-specific and industry characteristics. We include several variables that have previously been used in the literature to determine the probability of being acquired (Palepu, 1986; Ambrose and Megginson, 1992; Cremers, Nair, and John, 2009; Billett and Xue, 2007). We use the natural logarithm of total firm assets (Ln_Assets), the natural logarithm of employees (measured in thousands, $Ln\_Employees$) and a firm's market capitalization ($MarketEquity$) as proxies for firm size. We further incorporate variables relating to firm performance into our prediction model. Specifically, we use return on assets (ROA), return on equity (ROE), the total 12-month cumulative return over the previous calendar year ($CumRet$), and earnings per share (EPS). In addition, we incorporate several measures capturing the capital structure of the firm: $Leverage$, defined as total liabilities over total assets, total net property, plant, and equipment divided by total assets ($PPENT\_ratio$), retained earnings over total assets (RE_ratio), the market to book ratio (Q), capital expenditure divided by total assets ($CAPEX\_ratio$), and the dividend yield ($DivYield2$). All balance sheet variables are winsorized at the 99th percentile of the distribution.

Following the intuition that takeovers become more likely in the presence of large external blockholders (Shleifer and Vishny, 1986), we further include an indicator variable ($BLOCK$) that takes the value one if there exists at least one institutional shareholder that holds more than 5% of the company's stock. We extract the information on institutional ownership from the Thomson Reuters Institutional 13f holdings. To capture the clustering of mergers in industries over time, we also include a dummy variable ($WAVE$) that equals one if a takeover attempt occurred in the same industry in the previous year, based on the four-digit SIC code. We also include a proxy for the liq-

uidity of the stock, measured as the natural logarithm of the average trading volume in the previous calendar year (Log_Volume). Last, we include an indicator variable ($Option1$) that is equal to one if the company has option information in the OptionMetrics database.[25]

Table A-9 in the appendix provides the results of the maximum likelihood estimation from the takeover prediction model. Generally speaking, our results are qualitatively similar to those reported in earlier studies. For example, takeover probability increases in asset size, return on assets, and retained earnings, but it decreases in the market capitalization, leverage, earnings per share, return on equity, dividend yields, and cumulative market returns of the company over the previous calendar year. Moreover, a takeover indeed becomes more likely if there exists at least one large institutional shareholder, and if there was a takeover attempt in the same industry in the previous year. Finally, the probability of acquisition is also higher if a company's stock price is more liquid, but it is less likely if the firm has traded options. The pseudo R^2 of the logit regression, at between 4% and 5%, is modest but consistent with the results of previous takeover probability estimations (Cremers, Nair, and John, 2009). The distribution of takeover probabilities, reported in Figure A-9 of the internet appendix, also resembles the results in Billett and Xue (2007). The average (median) takeover propensity is 4% (3.6%), with an interquartile range of 2.89%, whereas the 5th and 95th percentiles are 0.62% and 8.71%, respectively.

The results of our takeover probability model are consistent with previous results in the literature. Yet, we generate only low takeover propensity scores, and the regression specifications have rather weak explanatory power. This suggests that, to some extent, it is difficult to correctly predict, using publicly observable information available to the econometrician, whether a company is subject to a future takeover threat. Even if we were to interpret the jointly low probability scores and R^2s as evidence that hedge funds have superior ability to process information (Solomo and Scholtes, 2015), it is much less conceivable that hedge funds could correctly predict the exact *timing* of a deal. Given that our examination of abnormal options activity is restricted to the short period preceding the announcement, and that most of the abnormal volume is generated a few days immediately before the event, our evidence is not likely to have arisen from a superior ability to legally predict mergers. Thus, it seems unlikely that the abnormal options volume we document can be traced back

[25] We cannot use the corporate governance measure of Gompers, Ishii, and Metrick (2003) or Bebchuk, Cohen, and Ferrell (2009) because of insufficient matching observations: the reduced sample would no longer be representative of the options sample.

to investors correctly predicting future announcement dates.

6.3 Speculation

Merger activity is procyclical and arrives in industry-specific waves (Andrade, Mitchell, and Stafford, 2001). Taking the example of H.J. Heinz Inc., it is possible that an astute investor may have observed other mergers in the food industry prior to the actual announcement on February 14, 2013, and simply placed a substantial speculative directional bet. In other words, the investor just got lucky! It is, thus, plausible that company-specific or industry characteristics make certain firms more prone to merger activity, causing them to endogenously attract more options trading. Such a selection bias would throw doubt on the validity of our results. In order to address this concern, we exploit the propensity scores from the takeover prediction model to construct several "takeover-propensity-matched" control samples. In other words, for each takeover deal in our sample, we look for a firm from the same industry (based on the one-digit SIC code) with traded options that has the closest propensity score. Alternatively, we match directly on a number of selected firm characteristics ($Assets$, $WAVE$, $BLOCK$, $Leverage$, Log_Volume, $Option1$) rather than on the univariate propensity score. We sample with replacement and use the Mahalanobis distance metric to evaluate the "closeness" of the match. Roberts and Whited (2012) explain how the propensity-score-matching technique allows one to construct "randomized" treatment and control groups, conditional on the observable covariates, whereby the outcome (say the abnormal volume) is independent of the treatment probability, i.e., the probability of being a takeover target. If we find that the average treatment effect on the treated (ATT), the average abnormal volume in the takeover sample, is significantly higher than the average treatment effect on the untreated (ATU), the average abnormal volume in the control sample, then it will be unlikely that our results were driven by a sample selection bias.

After successfully matching the treatment group with a comparable control group, we compute abnormal volume metrics, similarly to our earlier exercise. Note that, although we require firms eligible for the control groups to have traded options, not all of these firms have continuous option price and volume information available over the 90 days preceding the announcement dates. We, therefore, lose some additional control firms from our sample. In Table 6 we report the results for the sample that is matched directly on firm characteristics. Results for the sample matched based on the

propensity score are qualitatively and quantitatively similar, and are available upon request.[26] While the treatment group has 1,346 firms, the control group, using the first (and second) best match, has 1,059 (2,097) firms.

Similar to our initial analysis, we report results for aggregate options volume, and separately for the aggregate call and put volumes. We report results based on a market model, using the median aggregate options volume. In addition, we report two versions of a conditional benchmark model: the MMV model includes the median of the total daily trading volume across all options, the VIX index and the contemporaneous return on the S&P500 market index and the underlying stock; the MMV-L model complements the MMV model with lagged versions of the dependent and all independent variables. Panel A in Table 6 shows that our results remain largely unchanged. About 25% to 29% of all deals have positive abnormal options trading volume, with a higher frequency of unusual options activity for call than for put options. These results continue to obtain irrespective of the benchmark specification. The conservative conditional models suggest that the average cumulative abnormal options volume is in the range of 10,000 to 13,000 option contracts. These numbers generally have t-statistics above three (i.e., they are statistically significant at the 1% level).

Panel B reports the results for the control group using only the first best match. The frequency of deals with statistically significant cumulative abnormal volume at the 5% significance level is lower than in the treatment sample, ranging between 13% and 18% (12% and 13%, 8% and 10%) for aggregate (call, put) options volume. The average cumulative abnormal volume is significantly lower than for the treatment group, i.e., 2,633 option contracts in the most restrictive model, compared to 10,820 for the treatment sample. Importantly, none of the statistics is statistically significant at the 10% level. The results for the alternative control group using the two best matches remain qualitatively and quantitatively unchanged. In Panel D, we report the differences in average cumulative abnormal volumes between the treatment and control groups and the corresponding t-statistics. These difference-in-difference tests are akin to controlling for both the effects of firm characteristics and the effects of time. The difference in the average cumulative abnormal volume is 11,145 contracts for call options, and ranges between 8,186 and 14,303 contracts for the aggregated options volume.

[26] We also verify our results for robustness using (1) a natural log transformation of options volume, and (2) conditioning on the availability of a minimum of 200 days of valid option price and volume information in the matching year. The latter test increases the number of matching firms in the first-stage regression, which is desirable, while it is more restrictive in the regression specification. This provides us with 6 robustness regimes with 132 individual difference-in-difference tests (for each test, 11 models are tested for 2 control samples). These untabulated robustness tests, which are available upon request, are consistent with the reported evidence.

For put options, the difference tends to be considerably smaller, at 2,187 contracts, and it is not significant. In contrast, the difference is statistically significant at the 1% significance level for call options. This is also the case for the aggregated options volume, except in the conditional models, where the differences are significant at the 5% or 10% level.[27]

To summarize, we have verified that our results are robust to various versions of propensity-matched control samples. These tests suggest that the unusual options activity is significantly larger in the sample of firms that were takeover targets than in the sample of firms that closely resemble the takeover targets based on observable industry and firm characteristics, but effectively never went through a merger negotiation. The robustness of our results is presented in Figure 2, which reports the average abnormal volume and average cumulative abnormal volumes in both the treatment and the control group using the first best match. Clearly, the average abnormal options volume rises significantly ahead of the announcement for the takeover sample (dashed lines), while it fluctuates randomly for the control groups (solid lines). We interpret this as robust evidence that the unusual option activity we document is not merely the result of speculation or quantitative event prediction in the options market.

6.4 Buying the Rumor

Jarrell and Poulsen (1989) argue that the run-up in *stock* prices before a sample of 172 tender offers is mostly associated with observable and legal factors. Thus, the market is allegedly able to infer pending deals from information "heard on the street," hence run-ups in trading activity reflect the market's correct anticipation of future takeover activity, rather than illegal insider trading. We verify this concern using a comprehensive global news database that contains detailed real-time information on news and rumors about M&A activity.

More specifically, we use RavenPack News Analytics, a leading global news database used in quantitative and algorithmic trading, that extracts textual information from major publishers, such as Dow Jones Newswires, the Wall Street Journal, Barron's, regulatory and public relation feeds and over 19,000 other traditional and social media sites, and transforms it into a structured data feed that can be used in quantitative analysis such as ours.[28] The database has only existed since

[27] Note that the results for abnormal *call* options volume are statistically significant at the 1% level, even using the conservative conditional model. We have omitted these results for brevity, but they are available upon request.

[28] We are grateful to Bohui Zhang for pointing us towards this news database.

January 2000, and we have access to it for the period up to August 2012 only. This slightly reduces our M&A sample, which still remains larger than in *any* previous study. Previous finance studies that have used this information database include, among others, Kolasinski, Reed, and Ringgenberg (2013), Dang, Moshirian, and Zhang (2015), and Schroff, Verdi, and Yu (2014).

We rely on the information category "acquisitions-mergers." There are, in total, 88,103 observations for 6,913 different entities (CUSIP identifiers), coming from news sources classified as full articles, hot news flashes, news flashes, press releases, and tabular material. Detailed statistics are reported in Table A-10 of the appendix. The bulk of the information on tender offers comes from news flashes, which make up 60.39% of the sample. The two other important categories are full articles and press releases, representing 17.37% and 19.85% of the information, respectively, while hot news flashes and tabular material contribute only marginally to the structured information.

There may be multiple items of news related to the same merger on any given day. We are interested in two characteristics of the rumor. First, we want to know whether there was *any* rumor, and so we flag each deal with an indicator that equals one if the deal appears in the RavenPack News Analytics database during the pre-announcement period, and zero if not. Second, we are interested in the intensity of these news items. In this regard, RavenPack publishes two sentiment indicators that are meant to capture financial experts' views on whether there will be a short-term positive or negative, financial or economic impact. The two indicators are constructed using slightly different methodologies, but are meant to pick up the same type of information. These indicators take scores between 0 and 100, with a score above 50 reflecting a bullish sentiment, and a score below 50 suggesting a bearish short-term view about the stock. Given that different news stories may receive different sentiment scores on the same day, we calculate the average daily score for each indicator, the ESS (SI1) and the CSS (SI2). Thus, after eliminating duplicates entries, we retain, in total, 72,563 observations, with an average score of 56.33 for SI1 and 51.29 for SI2. The full score distributions of both sentiment indicators are summarized in Table A-11.

When we match the sentiment indicators with our database, we find a rumor or news story on 5,195 different deal-days, corresponding to 877 unique deals from our sample. Interestingly though, most of the news and rumor information appears on the announcement day itself, as can be seen in Table 7, which illustrates the total number of observations and unique deals in different sample windows. Rumors or news stories exist in the 30-day pre-announcement period for only 170 firms,

which corresponds to approximately 9% of our sample. It is fair to conjecture that these firms subject to rumors may be responsible for a substantial amount of the unusual trading activity we document ahead of the announcements, particularly as the average sentiment indicator suggests bullish short-term trading in these stocks. Thus, we investigate whether there is more abnormal volume in options for those firms that have rumors compared to a control group of targets without rumors.

First, it is important to emphasize a subtle point. While it is reasonable to conjecture that some investors may be accurate forecasters of the occurrence of corporate acquisitions in the future, it is less likely that they would be able to perfectly predict the *timing* of such announcements. Thus, since we examine abnormal trading activity only in a short period of a few days immediately preceding public announcements, such a hypothesis would effectively make it more difficult for us to detect abnormal activity involving informed trading, as we would measure such activity relative to a benchmark that already incorporates higher trading activity.

Figures 2c and 2d visually report the differences in average and average cumulative abnormal option trading volumes for the sub-samples with and without rumors in the 30-day pre-announcement period. These tests are based on a natural log transformation of volume. Clearly, the two sub-samples cannot be distinguished from each other statistically, as we have verified statistically, and the average abnormal trading volume is as unusual in the sub-sample with news "heard on the street," as in the sample without. The same results hold if we screen the sample for news and rumors in the 90-day pre-announcement period. The difference between the two groups turns out to be statistically insignificant.[29]

Finally, we investigate whether there is any relationship between the intensity of the sentiment indicators and the average (cumulative) abnormal volumes. We regress both average and average cumulative abnormal trading volumes on the sentiment indicator and a set of control variables for the 170 deals (239 observations) that we can associate with a rumor. Columns 1 and 2 of Table 8 suggest that rumors indeed lead to more trading. An increase in the sentiment indicator of one point is on average associated with 30 (231) more contracts in the (cumulative) abnormal total trading volume. This relationship is robust to the use of the natural log transformation, as can be seen in columns 5 and 6, where the coefficients continue to be statistically significant at the 1% level. We note that the positive relationship between a bullish sentiment and (cumulative) abnormal trading

[29]We have omitted these results for brevity, but we can provide them upon request.

volume exists for both call and put options. Columns 3 and 4 indicate that each additional point in the bullishness score is associated with 33 (21) additional contracts in the abnormal call (put) trading volume, on average. Our previous results on directional trading were typically robust for calls, but not for puts. Thus, these regression results suggest that news simply triggers speculative activity, which is not necessarily directional. We add the caution that this is based on only 170 deals, which represent about 9% of our sample. This is a magnitude short of the 25%, i.e., 465 deals, that were previously identified, in Section 4, as having positive and statistically significant average cumulative abnormal trading volumes.

To summarize, our results indicate that investors indeed "buy the rumor," as suggested by a positive association between positive abnormal trading volumes and a sentiment indicator providing short-term bullish views in the stock market. Nevertheless, news in the 30 pre-announcement days occurs for only 170 deals, representing only about 9% of our sample, while about 25% of all the deals in our sample have statistically significant positive cumulative abnormal trading volume at the 5% significance level. Also, we find that bullish signals lead to more abnormal trading in both calls and puts, while the strength of our previous findings of unusual options activity ahead of M&A announcements was *primarily* confined to calls. Thus, rumors and news trigger speculation and more trading activity overall, but not necessarily directional trading on the target. Finally, the tests based on a natural log transformation of volume show that there is no statistically significant difference in abnormal trading volume between the sub-samples with and without news. We conclude that rumors and news about upcoming merger activities are insufficient to fully explain the unusual amount of directional trading volume on targets ahead of announcements that we document.

6.5 Legal Insider Trading

Registered corporate insiders regularly have access to privileged information, as a result of which the SEC imposes on them the strict legal requirement that they must file whenever they trade in their company's securities and their derivatives.[30] While it is difficult to pin down the identity of every trader in the options market, it is possible to examine the trading activity of insiders, who may trade legally or illegally.

[30]More specifically, corporate insiders are defined broadly as those people having "access to non-public, material, insider information." They are required to file SEC Forms 3, 4 and 5, and under certain circumstances Form 144, whenever they trade or intend to trade in their company's securities.

Numerous studies examine legal insider stock-trading activity using the data in Table 1 of the Thomson Reuter insider filings. However, we are not aware of any prior study that systematically examines legal insider derivatives-trading activity, in particular trading in options, which can be obtained from information that is available in Table 2 of the insider filing data feeds. In our analysis, we screen all transactions recorded in Table 2, which "contains all Table 2 derivative transactions and holdings information filed on Forms 3, 4, and 5. The data in this file includes open market derivative transactions as well as information on the award, exercise, and expiration of stock options."[31] We drop all records that are flagged with the cleansing codes S or A, indicating inaccuracies in the data that are impossible to validate or are missing, and we retain information only from the most important Form 4 filings, which document a change in an insider's ownership position. We further retain only information for the 1,859 target stocks in our sample, dropping records if they occur more than 365 days prior to, or after the announcement date. We separately examine straight purchases and sales (transaction codes P and S), exercises (transaction codes M, C, O, and X), and awards (transaction codes A, N, T, I, G, W, and J) of different types of derivatives. A detailed description of each transaction code is provided in the internet appendix in Tables A-12 and A-13. In other words, we ignore option expirations and swap transactions. Regarding different derivative security types, we retain options, calls and puts (security titles OPTNS, CALL, and PUT), warrants (security title WT), employee stock options (security titles DIREO, DIRO, EMPO, ISO, and NONQ), and group derivative security types with option-embedded features, such as convertibles (security titles CVP, CVS, CVD, NTS, RGHTS, and DEFR). This filtered sample contains 3,430 observations related to 483 target companies, and is the basis for the more granular analysis we will perform next.

Examining the detailed statistics, which are reported in Table A-14 of the internet appendix, we come to the conclusion that there is *not a single* transaction, purchase or sale, of a derivative security within the 30 days preceding the announcement. While we do find some purchases of calls, puts, warrants, non-qualified stock options and convertible securities, these transactions are all restricted to a period outside the 30-day pre-announcement period. While this analysis does not enable to us to identify traders who trade in options ahead of the announcements, it does allow us to conclude that such trades are not coming from legal insiders, at least not directly. We cannot rule out the possibility that the unusual options volume we document may stem from tips originating with senior

[31] The advantage of the Thomson Reuters database is that they systematically clean all filings and verify the accuracy of the records.

executives at target companies or from former school ties (Cohen, Frazzini, and Malloy, 2010), especially given the evidence provided by Ahern (2015), that the average inside tip originates from corporate executives. However, a private tip would be illegal. Despite this caveat, we can conclude that the abnormal options volumes ahead of the announcements primarily come from corporate outsiders, and may or may not be illegal, but are certainly statistically unusual.

6.6 Leakage

Evidence in Roll, Schwartz, and Subrahmanyam (2010) and Johnson and So (2012) suggests that option volume tends to rise in response to positive stock returns. Thus, it is fair to conjecture that pre-announcement leakage or informed trading in stock markets causes the stock price to rise prior to the announcement, which may be responsible for the abnormal volume effects observed in the options market. We take several measures to rule out this concern. First, in all our previous tests, we systematically control for both contemporaneous and lagged stock returns of the target companies and the overall market. Yet, our conclusions of abnormal options activity in the pre-announcement period are not affected. Second, we conduct an event study for abnormal stock returns (detailed results are available in Table A-15 of the internet appendix), and we show that only 7% of all deals in our sample exhibit abnormal stock *returns* at the 5% statistical significance level. This is an order of magnitude short of the 25% that we find for options volumes. Third, although we do find that about 24% of all deals have abnormal stock *volumes* at the 5% level using the MMV-L model and a natural log transformation of volume (19% without a natural log transformation), the expected cumulative abnormal log volume for stocks is 1.64, which compares with 8.59 in the options market. Even though stock volume is not directly comparable to (unadjusted) options volume, the net effect from multiplying the options volume by the hedge ratio, i.e., the delta, and the 100 shares specified in the standard options contract, would make this difference even wider. This further shows that the magnitude of *abnormal* volumes in the options market is far greater than in the stock market. Finally, in Figure A-7 of the internet appendix, we provide a detailed analysis of the entire distribution of the option-to-stock volume ratios. The examination convincingly shows that there is a significant increase in the ratios of the call-to-stock and the call-to-put volumes, in particular at the right tail of the distribution, but only a modest increase in the ratio of the put-to-stock volume. Dividing the raw trading volume in stocks by 100 to make it comparable to the volume in options markets

(each option contract is based on 100 shares), we find that the average (median, 90th percentile) call-to-stock volume ratio increases from 7% to 11% (1% to 4%, 15% to 29%) in the pre-announcement period. Similarly, the call-to-put volume ratio increases from 16.83% to 30.72% at the 90th percentile of the distribution, while the put-to-stock volume only increases by a modest amount from 6% to 8% over the 30 pre-announcement days.

To conclude, the empirical evidence indicates that the unusually high abnormal option volumes we document are *not* driven by activity in the underlying stock market. Even if it were the result of leakage that would manifest itself in the stock market first, trading would have originated from an insider tip, which would be illegal.

6.7 Bottom Line

Abnormal options activity is pervasive ahead of M&A announcements, and reflected in approximately 25% of our sample. We have shown that it is difficult to predict the exact timing of merger announcements and that speculation is unlikely to be driving our results, as similar findings are absent from a propensity-matched control sample. In addition, the existence of rumors cannot rationalize that the leakage of information leads people to trade in the stock market, which is picked up by astute traders who then exploit their information in the options market. Some recent papers have argued that investment banks advising bidders take *equity* stakes in the target companies during the seven to one *quarters* before the announcement (**?**). However, using more granular high-frequency data on broker level transactions and connections, Griffin, Shu, and Topaloglu (2012) find that such institutional investors do not engage in trading on inside information during the two to twenty *days* before takeover announcements. Where does this leave us? It is certainly fair to conclude that there is massive evidence of informed trading. Is this proof of insider trading? We cannot answer in the affirmative since we are unable to prove rogue trading without evidence of civil or criminal conviction, which usually requires wire taps or other hard legal evidence, typically gathered with the help of the Federal Bureau of Investigation or other federal agencies. Yet, the different pieces of the puzzle suggest that it is highly likely that there is illicit activity taking place in the options market. In Section 7, we tie our statistical evidence to the civil litigations initiated by the SEC in order to improve our understanding of the suspect evidence that we have just uncovered.

7 SEC Litigation Reports

Up to this stage, we have presented *statistical* evidence of unusual options trading activity ahead of M&A announcements and ruled out multiple plausible *legal* explanations. We now verify whether there is any relationship between the unusual activity we document and the insider trading cases that we know, with the benefit of hindsight, to have been prosecuted. To do so, we scan more than 8,000 *actual* litigation releases concerning civil lawsuits brought by the SEC in federal court.[32] We extract all cases from the SEC files that encompass trading in stock options around M&A and takeover announcements, i.e., civil complaints against illegal insider trading in options, or, in both stocks and options. We complement missing information in the civil complaint files with additional information from the criminal complaint files, which we access through the Public Access to Court Electronic Records (PACER) from the U.S. Department of Justice (DoJ). A summary overview of the trades and their characteristics is reported in Table 9, and more detailed case-specific information is provided in Table A-16. We find that the characteristics from these case files closely reflect the highlighted statistical anomalies of unusual option volumes and prices that we find to be pervasive prior to M&A announcements.

7.1 The Characteristics of Insider Trading

In total, we identify 150 unique deals involving insider trading in options ahead of M&As that were announced between January 1990 and December 2013, with an average of about seven cases per year. Interestingly, the litigation files contain only five instances of insider trading involving options written on the *acquirer*, among which three are within the bounds of our sample period.[33] About one third of these cases (47 deals) cite insider trading in options only, while the remaining 103 cases involve illicit trading in both options and stocks. In addition, we find 258 M&A transactions investigated in civil litigations because of insider trading in stocks only. The large number of investigations for stock trades relative to those for option trades stands in contrast to our finding of pervasive abnormal call

[32] We are grateful to Kenneth Ahern for valuable discussions on this data. The litigation reports are publicly available on the SEC's website, https://www.sec.gov/litigation/litreleases.shtml.

[33] These three cases are the 1997 acquisition of Barnett Banks by the Nations Bank Corporation, the 2006 purchase of Maverick Tube Corporation by Tenaris, and the 2010 takeover of Dominion Resources by Consol Energy. The two cases outside our sample period are the 1995 acquisition of U.S. Shoe Corporation by Luxottica, and the 1995 takeover announcement of MetraHealth by United HealthCare.

option trading volumes that are much greater than for abnormal stock volumes.[34]

Out of the 150 SEC cases, 131 correspond to our sample period, which stretches from January 1, 1996 to December 31, 2012. Assuming that the publicly disclosed deals represent all litigated cases, we conclude that the SEC engaged in litigation in relation to about 7% of the 1,859 M&A deals included in our sample.[35] Several of the litigated cases do not appear in our sample, one reason being the aforementioned criteria for inclusion in our sample. On the other hand, some prominent cases of insider trading, such as the 2004 JPM Chase-Bank One merger, in which one investor was alleged to have bought deep out-of-the-money (DOTM) calls just (hours) before the announcement, do not appear in the SEC database. We have three potential explanations for these discrepancies. First, the SEC only reports *civil* litigations. If a case is deemed criminal, then the DoJ will handle it and it will usually not appear in the SEC records. We believe this reason to be an unlikely cause, given that a case typically does not come under criminal investigation without being investigated in the first instance by the SEC. Our intepretation is based on several discussions with securities law firms, and is also corroborated by Ahern (2015), who identifies only two cases among *all* (not just for M&As) the DoJ criminal complaints for insider trading that do not appear among the SEC civil litigation records.[36] Second, the SEC may refrain from divulging the details of a case to protect the identity of a whistleblower. In these instances, if the case is settled out of court, it will not appear in the public record. Third, the SEC will not even bother to litigate if there is little chance of indictment, which will depend on the availability of clear legal evidence of insider activity. Overall, in spite of these biases, 90 of the SEC litigation cases are covered by our study. In other words, our sample covers 60% of all litigated cases related to insider trading in equity options around M&A events, with the Type II error rate being 40%.[37]

We next describe the characteristics of the option trades that we are able to extract from the information in the SEC litigation reports.[38] 59.33% of all cases are cash-financed transactions.

[34]We emphasize the takeover of Nexen by CNOOC, which was involved in a SEC lawsuit because of insider trading in stocks, while the newspapers broadly discussed unusual option trades.

[35]The average yearly number of announcements in our sample is 109. Note that, while we also include incomplete and rumored deals, we only include transactions that imply a change in corporate control. We also exclude small deals with market values below 1 million USD and with insufficient options price and volume information.

[36]Actually, the working paper version of Ahern (2015) identifies three such cases, but one of them appeared recently as a civil complaint among the SEC litigation releases.

[37]To be precise about the definitions of Type I and Type II errors, we start with the null hypothesis that our sample covers all the cases litigated by the SEC. Thus, we define the Type I error to include cases that we identify as having originated from an insider, but that were not litigated by the SEC. Similarly, we define the Type II error to include cases litigated by the SEC that we fail to identify. By definition, these cases are not in our sample.

[38]Admittedly, the SEC has access to much more granular and detailed information on these cases, but we are not

Unreported statistics suggest that only 23.33% are purely stock-financed, while hybrid financing structures account for 12% of the litigation sample, and the financing structure is unknown for the remaining 5.33% of the sample. We would expect investors with private information to be less likely to trade on stock-financed announcements, as the announcement return is typically higher for cash deals. This is consistent with our finding of a greater cumulative abnormal call option volume for such transactions. The average profit reaped through "rogue trades" (in both options and stocks) during our sample period, is 1.084 million USD. As we conjectured earlier, for trades on the target companies, this profit arises from transactions that are almost exclusively purchases of OTM call options, at a single or multiple strike prices. The litigation reports reference put trades in only 6% of all cases. For 22 out of these 25 put trades, we can also identify the trading direction, which suggests that these were all sales of put options, consistent with the hypothesis that insiders would buy OTM calls and/or sell ITM puts. Also, as expected, Table 9 shows that the average ratio of the stock price to the strike price, in the case of call options purchased on the target, is 93%. Only 25 observations ($\approx$ 6%) have a moneyness ratio above 1.05, the cut-off level we defined for ATM options. Out of 25 put option trades on the targets, on the other hand, the average ratio of the stock price to the strike price is 97.29%, which is within our definition of ATM, but 12 of all these trades relate to sales of ITM put options with the average ratio of the stock price to the strike price above 105%. For transactions on the acquirer companies, 75% of all observations, i.e., 12 out of 16 trades for which we have information on the strike price, fall within the ATM moneyness range of 95% and 105%, which is also consistent with the earlier hypothesis that those insiders with private information on an upcoming deal, who wish to trade illegally, would likely trade ATM options on the acquirer company.

Furthermore, the insider trades are primarily executed in short-dated options, with an average time to expiration of 1.87 months. We note that there is a large variation in the timing of trades, the average inside trader transacting 21 days before the announcement date. However, the median trade occurs 11 days prior to the announcement. It takes the SEC, on average, 644 days to publicly announce its first litigation action in a given case. Thus, assuming that the litigation releases appear shortly after the actual initiation of investigations, it takes the SEC a bit less than two years, on

aware of any study that systematically analyzes this information, other than the early study by Meulbroek (1992) that focuses on stock trading, and for a much smaller number of cases than the present study includes. Ahern (2015) analyzes the same data, but he focuses on insider networks and does not report any information on inside trades.

average, to prosecute a rogue trade. The fines, including disgorged trading profits, prejudgment interest and civil penalty, if any, appear large enough to adequately recuperate illicit trading profits. The average fine is, at 1.889 million USD, a bit less than double the average rogue profit. This is, however, largely driven by cases related to 2007, which exhibit a ratio of the average fine to the average profit of about 4.39. Finally, the typical insider trade involves more than one person, and is often a network, as documented in detail by Ahern (2015). We find that the average number of defendants is four.

To summarize, the bulk of the prosecuted trades relate to target companies and are purchases of plain-vanilla short-dated OTM call options that are approximately 7% OTM, occur within the 21 days prior to the announcement, and are more frequently related to cash-financed deals. There is some evidence of sales of ITM put options on the target companies and purchases of ATM options on the acquirers. These characteristics closely resemble the anomalous statistical evidence we find to be so pervasive in a representative sample of M&A transactions: unusual and abnormal option trading volumes, in particular for OTM and short-dated call options.

7.2 The Determinants of Insider Trading Litigation

In this subsection, we examine the determinants of insider trading litigation, i.e., the specific characteristics of a case that tends to attract SEC action. We emphasize that we are unable to answer the question of whether certain characteristics reflect deals that are more prone to insider trading, or whether insider trading is more easily detected by the SEC because of certain company or market attributes. For example, the SEC may be more attentive during specific market conditions and to a certain type of company.[39] In fact, DeMarzo, Fishman, and Hagerty (1998) suggest that it may be optimal to prosecute insiders only after large price moves or after large volume transactions, and not to penalize small trades. Nevertheless, we believe that this descriptive evidence is informative about the nature of insider trading litigations.

To understand the characteristics of deals investigated by the SEC, we estimate a logit model for all M&A deals, classified as either litigated by the SEC or not. The identifying indicator variable *SEC*

[39]We suspect that the second assumption may be true. Given our discussions with a senior former official at the regulator, the SEC operates under severely constrained resources. It is, therefore, more likely to litigate cases that have a greater chance of resulting in a conviction and that have generated substantial illicit trading profits. In addition, the recent emphasis on this issue with the creation of a Whistleblower Office, suggests that there is time variation, in particular, a recent increase, in the intensity of litigation activity.

takes the value one if the deal has been litigated, and zero otherwise. We control for four different categories of explanatory variables in our estimation: (i) deal characteristics, (ii) financial variables, (iii) stock price information, and (iv) option volume and price information. For the variables relating to deal characteristics, we estimate the following logit model:

$$\begin{aligned} Pr\left(SEC=1\right) = F\left(\beta_0 + \beta_1 SIZE + \beta_2 CASH + \beta_3 CHALLENGE + \beta_4 COMPLETE \right. \\ \left. + \beta_5 TOE + \beta_6 PRIVATE + \beta_7 COLLAR + \beta_8 TERM + \beta_9 FRIENDLY + \beta_{10} US + \gamma_t\right), \end{aligned} \tag{3}$$

where $F\left(\cdot\right)$ defines the cumulative distribution of the logistic function, and all explanatory variables are categorical variables that take the value one if a condition is met, and zero otherwise. $SIZE$ takes the value one if the transaction is larger than the median M&A deal value. $CASH$ characterizes cash-financed takeovers. $CHALLENGE$ identifies deals that have been challenged by a second bidder. $COMPLETE$ identifies completed deals that were not withdrawn and did not fail. TOE indicates whether a bidder already had a toehold in the target company. $PRIVATE$ equals one if the acquirer privatized the target post-acquisition. $COLLAR$ identifies transactions with a collar structure. $TERM$ is one for deals that have a termination fee that applies if the takeover negotiations fail. $FRIENDLY$ refers to the deal attitude. US is one if the bidder is a US-based company. All specifications contain year fixed effects. We report the logit coefficients (and odds ratios in parentheses), using Firth's method for bias reduction in logistic regressions, in Table 10.

The evidence in column (1) suggests that the likelihood of SEC litigation is higher for larger and completed deals that are initiated by foreign bidders. Specifically, a transaction with a deal value greater than the median M&A deal value is 1.87 times more likely to be pursued. The log-odds ratio suggests that an acquisition undertaken by a foreign bidder is roughly twice as likely to be prosecuted as an M&A transaction initiated by a US-based bidder. Completed deals are positive predictors of options litigation, as a withdrawn or rumored deal is almost 3 times less likely to be investigated. The pseudo-R^2 of the regression is reasonable, with a value of 11%. We also investigate whether the total number of target and acquirer advisors matters in the prediction of litigation. Given that a greater number of parties involved in the transaction may increase the likelihood of leakage, one could expect to observe a positive effect. Unreported results suggest that there is a positive relationship between the number of advisors and the probability of litigation, but the effect is not statistically significant. We further test the importance for the probability of litigation of the

offer premium ($PREM1D$) and the offer price ($PRICE$). Column (2) indicates that both the offer premium and the offer price are positively related to the probability of SEC litigation, although the magnitudes of the odds ratios are just above one.

In addition to the deal characteristics and financial variables, we test whether we can predict the SEC litigations based on the stock price behavior of the parties involved in the transaction. Thus, in column (3), we estimate an augmented logit model and include $TRUNUP$, the target's pre-announcement cumulative abnormal stock return, $TANNRET$, the target's announcement-day abnormal return, $TTPRET1$, the target's post-announcement cumulative abnormal return, and $ARUNUP$, the acquirer's abnormal stock return before the announcement day. Of these variables, only the target's post-announcement cumulative abnormal return is highly statistically significant. The coefficient of 2.10 suggests that a target with a 1% higher cumulative abnormal post-announcement return is approximately 8 times more likely to be investigated. This corresponds to a marginal effect of 4.8%, keeping all other variables at their median levels. To complete our analysis, we also check whether the market environment in the period leading up to the announcement has predictive ability for the SEC litigations. Thus, in unreported regressions, we further augment the base model with $MKTVOL$, the market volume on the day before the announcement, and $ABNORMVOLC$, the target's total abnormal call trading volume during the 30 pre-announcement days. None of these variables exhibits statistical significance in explaining the SEC civil litigations. In all specifications, we note that the coefficients on $SIZE$, $COMPLETE$, and US remain statistically significant, with similar economic magnitudes.

In columns (4) to (6), we test whether there is any fundamental difference between those SEC cases that were pursued because of alleged insider trading in options and those that were investigated because of allegedly illicit trading in stocks. Thus, we repeat the regressions from columns (1) to (3), but we augment the dependent variable to include *all* litigated cases that involve insider trading around M&As, whether in stocks or options. Again, our previous conclusions remain largely unchanged. In addition, we do find some evidence that cash-financed deals are about 1.57 times more likely to be caught up in a civil lawsuit. However, this finding is not robust to the inclusion of market and trading activity measures.

It is likely that the SEC, being resource-constrained, pursues larger-sized firms that provide the biggest "bang for their buck" from a regulatory perspective, which may be efficient, given the

argument of DeMarzo, Fishman, and Hagerty (1998). Taken at face value, our results are consistent with this interpretation, given that SEC litigation is more likely for deals with large transaction values, higher bid prices and higher offer premiums. It is interesting to note that the odds of litigation are higher for deals that are initiated by foreign acquirers. Unfortunately, we cannot identify whether insiders prefer to trade ahead of transactions involving larger companies, as such companies typically have more liquid options markets, which would allow insiders to better hide their trades. Alternatively, the SEC may be more likely to go after large-scale deals because they are easier to detect and more broadly covered in the financial press. We interpret the higher odds ratios of litigation for deals initiated by foreign bidders as evidence that rogue traders focus on foreign jurisdictions in order to gain and exploit their private information. Overall, we find the number of civil litigations, initiated by the SEC because of illicit option trading ahead of M&As to be modest in light of the pervasiveness of unusual options trading that we documented earlier.

8 Conclusion

In light of recent allegations of insider trading based on unusual abnormal trading volumes in anticipation of major corporate acquisitions, we investigate the prevalence of informed option trading around such unexpected public announcements. We focus on equity options written on both target and acquirer firms, prior to M&A announcements in the US from 1996 until 2012. Our goal is twofold. First, we quantify the likelihood of informed trading by investigating options trading strategies, which should, *a priori*, lead to unusual abnormal trading volumes and returns in the presence of private information. Second, we assess the likelihood that informed trading is illegal, by examining whether various legal channels can explain the abnormal activity and by comparing the characteristics of informed activity in the data to those of illegal trades prosecuted by the regulators.

Our analysis of the trading volume, implied volatility and bid-ask spreads, over the 30 days preceding formal takeover announcements, suggests that informed trading is more pervasive than would be expected based on the actual number of SEC-prosecuted cases. We find statistically significant abnormal trading volumes in options for approximately 25% of takeovers in our sample, while the SEC litigates option traders for only 7% of takeovers. For *targets*, which almost always experience substantial positive abnormal announcement returns, the statistical evidence is consistent

with *directional* trading strategies, i.e., we see particularly pronounced effects for OTM calls. In contrast, for the *acquirer* companies, we also provide evidence of unusual options activity that is consistent with *volatility* trading strategies: greater abnormal trading volume in ATM options and for stock-financed deals that have greater risk of deal failure. We show that the magnitude of this unusual activity is unlikely to have arisen out of speculation, superior predictive ability based on publicly observable information, through trading accounts of registered insiders, or trading in the stock market. Finally, we describe the characteristics of SEC-litigated insider trades in options ahead of M&A announcements, and show that they closely resemble the statistical properties of the unusual pre-event options trading activity. While it is impossible, without further criminal evidence, to prove beyond reasonable doubt that this is undeniable evidence of *illegal* insider trading, this activity is clearly suspicious, given that in our sample, the odds of the abnormal volume arising out of chance are, at best, one in a million.

Guercio, Odders-White, and Ready (2015) argue that illegal insider trading in the stock market has decreased in response to more aggressive enforcement. Our work suggests that it may merely have moved to another location. This is thought provoking, especially if there appears to be substantial insider trading in many countries with less sophisticated markets than the U.S. (Griffin, Hirschey, and Kelly, 2011), which is the focus in our study. The distinction of *how* and *where* informed investors trade is not only of interest to economists studying the information structure of asset markets, market microstructure, and return patterns around M&A announcements. By shedding light on potential blind spots for the prosecution of rogue traders, these insights are of particular interest to regulators looking for insider trading.

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Table 1: Descriptive and Financial Overview of M&A Sample

Panel A provides an overview of the M&A deal characteristics for all US domestic M&As in the Thomson Reuters SDC Platinum database over the time period January 1996 through December 31, 2012, for which a matching stock, and option price information, were available for the target in, respectively, the CRSP master file and OptionMetrics based on the six-digit CUSIP. The sample excludes deals with an unknown or pending deal status, includes only those deals with available deal information, for which the deal value is above 1 million USD and in which an effective change of control was intended. In addition, we require valid price and volume information in both CRSP and OptionMetrics for the target for at least 90 days prior to and on the announcement day. We report the number of deals (No.) and the corresponding sample proportions (% of Tot.). In addition, we report how many of the deals are classified as completed, friendly, hostile, involving a target and acquirer in the same industry, challenged, or having a competing bidder, a collar structure, a termination fee or a bidder with a toehold in the target company. All characteristics are reported for the overall sample (column *Total*), as well as for different offer structures: cash-financed (*Cash Only*), stock-financed (*Shares*), a combination of cash and stock financing (*Hybrid*), other financing structures (*Other*), and unknown (*Unknown*). Panel B illustrates the financial statistics of the deals. We report the transaction value (*DVal*) in million USD and the offer premium. P1d (P1w, P4w) refers to the premium, one day (one week, four weeks) prior to the announcement date, in percentage terms. The deal value is the total value of the consideration paid by the acquirer, excluding fees and expenses. The dollar value includes the amount paid for all common stock, common stock equivalents, preferred stock, debt, options, assets, warrants, and stake purchases made within six months of the announcement date of the transaction. Any liabilities assumed are included in the value if they are publicly disclosed. Preferred stock is only included if it is being acquired as part of a 100% acquisition. If a portion of the consideration paid by the acquirer is common stock, the stock is valued using the closing price on the last full trading day prior to the announcement of the terms of the stock swap. If the exchange ratio of shares offered changes, the stock is valued based on its closing price on the last full trading date prior to the date of the exchange ratio change. For public-target 100% acquisitions, the number of shares at the date of announcement is used. The premium paid is defined as the ratio of the offer price to the target's closing stock price, one day (one week, four weeks) prior to the original announcement date, expressed as a percentage. Source: Thomson Reuters SDC Platinum.

Panel A: Deal Information

Offer Structure	**Cash Only**		**Hybrid**		**Other**		**Shares**		**Unknown**		**Total**	
Description	No.	% of Tot.	No.	% of Tot.	No.	% of Tot.	No.	% of Tot.	No.	% of Tot.	No.	% of Tot.
No. of Deals	903	48.6%	415	22.3%	80	4.3%	403	21.7%	58	3.1%	1,859	100.0%
Completed Deals	746	40.1%	357	19.2%	67	3.6%	339	18.2%	33	1.8%	1,542	82.9%
Friendly Deals	805	43.3%	379	20.4%	69	3.7%	382	20.5%	42	2.3%	1,677	90.2%
Hostile Deals	35	1.9%	14	0.8%	3	0.2%	7	0.4%	4	0.2%	63	3.4%
Same-Industry Deals	379	42.0%	280	67.5%	39	48.8%	268	66.5%	27	46.6%	993	53.4%
Challenged Deals	111	6.0%	55	3.0%	7	0.4%	32	1.7%	11	0.6%	216	11.6%
Competing Bidder	83	4.5%	32	1.7%	3	0.2%	20	1.1%	4	0.2%	142	7.6%
Collar Deal	4	0.2%	54	2.9%	3	0.2%	52	2.8%	7	0.4%	120	6.5%
Termination Fee	698	37.5%	352	18.9%	51	2.7%	292	15.7%	29	1.6%	1,422	76.5%
Bidder has a Toehold	42	2.3%	11	0.6%	2	0.1%	7	0.4%	3	0.2%	65	3.5%

Panel B: Deal Financials

Offer Structure	**Cash Only**		**Hybrid**		**Other**		**Shares**		**Unknown**		**Total**	
Description	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd
DVal (mil)	$2,242.0	$4,147.2	$5,880.9	$10,071.5	$5,074.2	$10,387.7	$5,429.8	$15,158.5	$1,635.7	$2,503.7	$3,848.4	$9,401.3
P1d	33.6%	31.7%	28.5%	27.5%	25.1%	40.5%	28.3%	39.5%	33.3%	29.6%	31.0%	33.1%
P1w	36.6%	31.0%	32.4%	29.1%	29.5%	42.5%	33.6%	61.5%	33.4%	29.8%	34.7%	39.8%
P4w	41.1%	35.6%	35.0%	32.4%	31.2%	46.1%	36.7%	45.3%	38.0%	33.6%	38.3%	37.7%

Table 2: Summary Statistics - Option Trading Volume (Without Zero-Volume Observations)

Table 2 presents basic summary statistics on option trading volumes, excluding zero-volume observations, stratified by time to expiration (TTE) and moneyness (Moneyness). We report the mean (*Mean*) and the standard deviation (*SD*). We classify the number of observations N into three groups of time to expiration: less than or equal to 30 days, greater than 30 but less than or equal to 60 days, and more than 60 days. We assign five groups for depth-in-moneyness, where depth-in-moneyness is defined as S/K, the ratio of the stock price S to the strike price K. Deep out-of-the-money (DOTM) corresponds to $S/K \in [0, 0.80]$ for calls ($[1.20, \infty)$ for puts), out-of-the-money (OTM) corresponds to $S/K \in (0.80, 0.95]$ for calls ($[1.05, 1.20)$ for puts), at-the-money (ATM) corresponds to $S/K \in (0.95, 1.05)$ for calls ($(0.95, 1.05)$ for puts), in-the-money (ITM) corresponds to $S/K \in [1.05, 1.20)$ for calls ($(0.80, 0.95]$ for puts), and deep in-the-money (DITM) corresponds to $S/K \in [1.20, \infty)$ for calls ($[0, 0.80]$ for puts). Panel A (B, C) contains information for all (call, put) options. Source: OptionMetrics.

	TTE = [0,30]		**TTE =]30,60]**		**TTE =]60,...]**		**TTE = [0,30]**		**TTE =]30,60]**		**TTE =]60,...]**	
	Target (N = 2,214,260)						**Acquirer (N = 3,582,394)**					
Panel A: All Options												
Moneyness	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
DOTM	246	1,973	163	863	117	1,035	127	594	141	838	112	774
OTM	370	1,990	285	1,201	130	847	497	1,497	384	1,388	193	1,072
ATM	273	1,291	184	855	131	845	1,084	3,038	551	1,666	208	927
ITM	356	6,214	190	3,244	99	923	398	5,209	236	3,488	106	678
DITM	275	3,264	208	5,288	83	1,105	214	3,286	334	12,543	80	1,774
Total	283	2,135	194	1,787	115	949	547	3,361	354	4,841	145	1,082
Panel B: Call Options												
Moneyness	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
DOTM	285	1,914	168	790	108	1,149	96	434	123	907	111	744
OTM	438	2,266	313	1,292	124	829	523	1,572	425	1,471	199	1,167
ATM	302	1,461	202	923	137	931	1,285	3,598	657	1,934	214	954
ITM	446	7,363	213	3,828	108	1,083	499	6,595	297	4,480	110	753
DITM	220	3,161	213	5,967	82	1,249	192	3,379	349	14,251	75	1,976
Total	311	2,564	212	2,197	114	1,040	603	4,143	412	6,386	147	1,231
Panel C: Put Options												
Moneyness	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
DOTM	220	2,010	159	915	129	855	145	672	152	795	114	802
OTM	306	1,689	253	1,084	141	880	468	1,410	332	1,277	181	871
ATM	234	1,003	155	739	120	680	855	2,210	424	1,263	200	885
ITM	139	976	136	836	84	580	249	1,670	145	700	101	555
DITM	485	3,627	192	1,264	87	669	294	2,915	281	1,989	94	735
Total	242	1,275	166	830	118	769	471	1,846	280	1,168	142	796

Table 3: Positive Abnormal Trading Volume - Target

Panel A reports the number (#) and frequency (freq.) of deals with statistically significant positive cumulative abnormal volume at the 5% significance level for the target companies, as well as the average cumulative abnormal volume ($E[CAV]$) and corresponding t-statistic ($t_{C\bar{A}V}$), computed using heteroscedasticity-robust standard errors. We use two different models to calculate abnormal volume: the MMV model, and the MMV-L model. For the MMV model, we account for the market volume in options, the Chicago Board of Options Exchange VIX Volatility Index, and the contemporaneous return of the underlying stock and the market, proxied by the return on the S&P 500 index. For the market volume in options, we use the median trading volume across all, respectively call and put, options in the OptionMetrics database. The MMV-L model augments the MMV model with lagged values of the dependent and all independent variables. All results are reported separately for call options, put options, and for the aggregate option volume. The estimation window starts 90 days before the announcement date and runs until 30 days before the announcement date. The event window stretches from 30 days before until one day before the announcement date. Panel B reports the results of t-tests for the differences in the average cumulative abnormal volumes across moneyness categories: out-of-the-money (OTM), in-the-money (ITM), and at-the-money (ATM). We report the difference in average cumulative abnormal volume (Diff), the standard error (s.e.) and the p-value (p-val).

Panel A	MMV Model			MMV-L Model			MMV Model			MMV-L Model		
	All	Calls	Puts	All	Calls	Puts	All	Calls	Puts	All	Calls	Puts
	All Options - Target						**OTM Options - Target**					
Sign.t-stat 5% (#)	533	543	348	446	467	304	450	430	458	423	408	451
Sign.t-stat 5% (freq.)	0.29	0.29	0.19	0.24	0.25	0.16	0.24	0.23	0.25	0.23	0.22	0.24
$E[C\bar{A}V]$	12,636	11,510	1,243	10,385	8,946	1,559	5,743	3,817	1,775	5,071	3,380	1,417
$t_{C\bar{A}V}$	3.80	5.59	0.68	3.76	5.77	1.04	5.32	5.26	3.09	5.44	5.46	3.34
	ATM Options - Target						**ITM Options - Target**					
Sign.t-stat 5% (#)	384	383	362	341	343	362	426	506	405	393	482	396
Sign.t-stat 5% (freq.)	0.21	0.21	0.19	0.18	0.18	0.19	0.23	0.27	0.22	0.21	0.26	0.21
$E[C\bar{A}V]$	1,834	1,281	494	1,652	1,156	457	2,678	1,659	1,034	2,526	1,540	984
$t_{C\bar{A}V}$	2.35	2.57	1.62	2.84	2.65	1.98	4.88	6.64	2.41	4.71	6.40	2.42
Panel B	Diff	s.e.	p-val	Diff	s.e.	p-val	Diff	s.e.	p-val	Diff	s.e.	p-val
	All Options - Target						**Call Options - Target**					
OTM-ATM	3,909	886	0.00	3,419	722	0.00	2,537	658	0.00	2,224	531	0.00
OTM-ITM	3,065	767	0.00	2,544	669	0.00	2,158	664	0.00	1,840	561	0.00
ATM-ITM	-844	783	0.28	-874	632	0.17	-378	501	0.45	-384	444	0.39
	Put Options - Target											
OTM-ATM	1,282	533	0.02	960	450	0.03	–	–	–	–	–	–
OTM-ITM	742	386	0.05	433	367	0.24	–	–	–	–	–	–
ATM-ITM	-540	425	0.20	-527	429	0.22	–	–	–	–	–	–

Table 4: Cumulative Abnormal Volume Regressions - Call Options with Scaled Volume

Table 4 reports generalized least squares (GLS) regression results from the projection of cumulative abnormal call option log-volume ($CABVOL_C$) on a set of M&A characteristics and market activity measures. Cumulative abnormal volume is standardized by the average predicted volume during the event window. $SIZE$ quantifies the M&A deal value. $CASH$ is a categorical value taking the value one if the deal is a cash-financed takeover and zero otherwise, TOE has the value one if a bidder already has a toehold in the target company, $PRIVATE$ equals one if the acquirer privatizes the target post-acquisition, $COLLAR$ takes the value one for transactions with a collar structure, $TERM$ is one for deals that have a termination fee that applies if the takeover negotiations fail, $FRIENDLY$ has the value one if the deal attitude is considered to be friendly, and US is one if the bidder is a US-based company, and zero otherwise. $PREM1D$ refers to the premium of the offer price over the target closing stock price, one day prior to the original announcement date, expressed as a percentage. $PRICE$ denotes the price per common share paid by the acquirer in the transaction. $SALES$ denotes the target's net sales over the previous 12 months. The total number of target and acquirer advisors is indicated by $ADVISORS$. $TRUNUP$ denotes the pre-announcement cumulative abnormal stock return for the target, $TANNRET$ denotes the target's announcement abnormal return, $TTPRET1$ refers to the target's post-announcement cumulative abnormal return, and $ARUNUP$ is the abnormal stock return for the acquirer before the announcement day. $MKTVOL$ is the market volume on the day before the announcement day. Each regression contains year fixed effects (YEAR FE), and standard errors are clustered by announcement day. We report the number of observations (Observations) and the adjusted R-squared. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively. Source: Thomson Reuters SDC Platinum, CRSP, OptionMetrics.

	(1)	(2)	(3)	(4)
VARIABLES	$CABVOL_C$	$CABVOL_C$	$CABVOL_C$	$CABVOL_C$
SIZE	3.32**	3.15**	2.50*	2.44*
	(1.34)	(1.48)	(1.29)	(1.29)
CASH	6.37***	7.01***	5.63***	5.49***
	(1.53)	(1.54)	(1.53)	(1.54)
TOE	-5.58*	-5.21*	-3.43	-3.38
	(2.94)	(3.00)	(2.71)	(2.71)
PRIVATE	0.12	-0.07	0.10	0.06
	(1.97)	(1.98)	(1.91)	(1.91)
COLLAR	7.23**	6.96**	6.49**	6.47**
	(2.94)	(2.96)	(2.85)	(2.85)
TERM	5.65***	5.46***	4.65***	4.57**
	(1.83)	(1.87)	(1.80)	(1.80)
FRIENDLY	3.04	3.77	2.00	1.91
	(2.36)	(2.41)	(2.29)	(2.30)
US	-2.45	-2.47	-1.74	-1.71
	(1.91)	(1.93)	(1.88)	(1.88)
TRUNUP			23.93***	24.30***
			(2.86)	(2.88)
TANNRET			0.91	0.57
			(4.58)	(4.56)
TTPRET1			-8.03**	-7.84*
			(4.08)	(4.08)
ARUNUP			-4.92	-4.52
			(4.25)	(4.27)
PREM1D		-0.05**		
		(0.02)		
PRICE		-0.00		
		(0.02)		
MKTVOL				-3.85**
				(1.95)
Constant	-1.37	-0.28	-0.84	15.25*
	(2.79)	(2.90)	(2.81)	(8.66)
Observations	1,859	1,806	1,859	1,859
adj. R2	0.06	0.06	0.12	0.12

Table 5: Positive Abnormal Trading Volume - Acquirer

Panel A reports the number (#) and frequency (freq.) of deals with statistically significant positive cumulative abnormal volume at the 5% significance level for the acquirer firms, as well as the average cumulative abnormal volume ($E[CAV]$) and corresponding t-statistic ($t_{C\bar{A}V}$), computed using heteroscedasticity-robust standard errors. We use two different models to calculate abnormal volume: the MMV model, and the MMV-L model. For the MMV model, we account for the market volume in options, the Chicago Board of Options Exchange VIX Volatility Index, and the contemporaneous return of the underlying stock and the market, proxied by the return on the S&P 500 index. For the market volume in options, we use the median trading volume across all, respectively call and put, options in the OptionMetrics database. The MMV-L model augments the MMV model with lagged values of the dependent and all independent variables. All results are reported separately for call options, put options, and aggregated option volume. The estimation window starts 90 days before the announcement date and runs until 30 days before the announcement date. The event window stretches from 30 days before until one day before the announcement date. Panel B reports the results of t-tests for the differences in the average cumulative abnormal volumes across moneyness categories: out-of-the-money (OTM), in-the-money (ITM), and at-the-money (ATM). We report the difference in average cumulative abnormal volume (Diff), the standard error (s.e.) and the p-value (p-val).

Panel A	MMV Model			MMV Model with Lags			MMV Model			MMV Model with Lags		
	All	Calls	Puts	All	Calls	Puts	All	Calls	Puts	All	Calls	Puts
	All Options - Acquirer						**OTM Options - Acquirer**					
Sign.t-stat 5% (#)	203	200	194	170	172	170	177	162	172	169	152	174
Sign.t-stat 5% (freq.)	0.26	0.25	0.24	0.21	0.22	0.21	0.22	0.20	0.22	0.21	0.19	0.22
$E[C\bar{A}V]$	2	2	2	2	2	2	6	2	8	6	2	7
$t_{C\bar{A}V}$	2.84	2.62	3.21	3.22	3.13	3.58	8.10	1.54	8.54	7.68	2.73	8.27
	ATM Options - Acquirer						**ITM Options - Acquirer**					
Sign.t-stat 5% (#)	260	258	191	238	227	188	173	166	173	166	156	168
Sign.t-stat 5% (freq.)	0.33	0.33	0.24	0.30	0.29	0.24	0.22	0.21	0.22	0.21	0.20	0.21
$E[C\bar{A}V]$	12	12	11	10	10	10	9	9	4	9	8	4
$t_{C\bar{A}V}$	9.73	10.21	10.82	9.92	10.15	10.58	11.00	9.94	4.91	11.29	10.64	5.00
Panel B	Diff	s.e.	p-val	Diff	s.e.	p-val	Diff	s.e.	p-val	Diff	s.e.	p-val
	All Options - Acquirer						**Call Options - Acquirer**					
OTM-ATM	-5	1	0.00	-5	1	0.00	-10	1	0.00	-8	1	0.00
OTM-ITM	-3	1	0.00	-3	1	0.00	-7	1	0.00	-6	1	0.00
ATM-ITM	2	1	0.09	1	1	0.26	3	1	0.02	2	1	0.12
	Put Options - Acquirer											
OTM-ATM	-3	1	0.00	-3	1	0.00	–	–	–	–	–	–
OTM-ITM	3	1	0.01	3	1	0.01	–	–	–	–	–	–
ATM-ITM	7	1	0.00	6	1	0.00	–	–	–	–	–	–

Table 6: Positive Abnormal Trading Volume in Treatment and Control Groups

This table reports the number (#) and frequency (freq.) of deals with statistically significant positive cumulative abnormal volume at the 5% significance level, as well as the average cumulative abnormal volume ($E[CAV]$) and corresponding t-statistic ($t_{C\bar{A}V}$), computed using heteroscedasticity-robust standard errors. We use three different models to calculate abnormal volume. For the market model, we account for the market option volume, defined as the median of the total daily trading volume across all options (respectively calls or puts) in the OptionMetrics database. We also report results for two different conditional models: the MMV model accounts for the median of the total daily trading volume across all options, the VIX index and the contemporaneous return on the S&P500 market index and the underlying stock; the MMV-L model augments the MMV model with lagged variables of the dependent and all independent variables. All results are reported separately for call options, put options, and for the aggregate option volume, except the results for the conditional models, where we report the results for the aggregate options volume only. The estimation window starts 90 days before the announcement date and runs until 30 days before the announcement date. The event window stretches from 30 days before until one day before the announcement date. Panel A reports results for the treatment group, Panel B (C) for the control group using the first (and second) best match. Panel D reports the average cumulative abnormal options volume for the treated (μ_0 PS0), and the two control groups based on the best match (μ_1 PS1) and the two best matches (μ_2 PS2), as well as their differences and the corresponding t-statistic. The statistics reflect the average treatment effect on the treated (ATT), the average treatment effect on the untreated (ATU), and the average treatment effect (ATE). The number of observations in each panel is indicated by N. Source: Thomson Reuters SDC Platinum, CRSP, OptionMetrics, Compustat, Thomson Reuters 13f filings.

	Market Model (Median)			MMV Model	MMV-L Model
	All	Call	Put	All	All
Panel A: Treatment Group PS0 (N = 1,346)					
Sign.t-stat 5% (#)	344	369	188	397	337
Sign.t-stat 5% (freq.)	0.26	0.27	0.14	0.29	0.25
$E[CAV]$	17,198	13,315	4,032	13,243	10,820
$t_{C\bar{A}V}$	4.54	4.91	3.51	3.06	3.02
Panel B: Control Group PS1 - Best Match (N = 1,059)					
Sign.t-stat 5% (#)	135	131	91	188	137
Sign.t-stat 5% (freq.)	0.13	0.12	0.09	0.18	0.13
$E[CAV]$	2,895	1,169	1,845	2,023	2,633
$t_{C\bar{A}V}$	0.91	0.94	0.77	0.57	0.89
Panel C: Control Group PS2 - Two Best Matches (N = 2,097)					
Sign.t-stat 5% (#)	250	231	187	356	294
Sign.t-stat 5% (freq.)	0.12	0.11	0.09	0.17	0.14
$E[CAV]$	2,144	859	1,358	2,226	2,092
$t_{C\bar{A}V}$	1.1	1.01	0.94	1.03	1.23
Panel D: ATT, ATU, ATE					
μ_0 (PS0)	17,198	13,315	4,032	13,243	10,820
μ_1 (PS1)	2,895	1,169	1,845	2,023	2,633
μ_2 (PS2)	2,144	859	1,358	2,226	2,092
$\mu_0 - \mu_1$	14,303	12,145	2,187	11,220	8,186
$t-stat$	2.89	4.07	0.83	2.00	1.76
$\mu_0 - \mu_2$	15,054	12,455	2,674	11,017	8,728
$t-stat$	3.60	4.39	1.57	2.31	2.22

Table 7: Frequency and Intensity of News around M&A Announcements

Table 7 reports the frequency and intensity of news around M&A Announcements. The information is based on RavenPack News Analytics, which extracts textual information from major publishers, such as Dow Jones Newswires, the Wall Street Journal, Barron's, regulatory and public relation feeds and over 19,000 other traditional and social media sites, and transforms it into a structured data feed that can be used in quantitative analysis. Using the data from January 2000 to August 2012, we report the number of news and rumor items (*Obs*) and the corresponding number of takeover deals (*Deals*) recorded during different time windows around the announcement day. RavenPack publishes two sentiment indicators that are meant to capture financial experts' views on whether there will be a short-term positive or negative, financial or economic impact. These indicators take scores between 0 and 100, a score above 50 reflecting a bullish sentiment, and one below 50 a bearish short-term view about the stock. In each time window, we report both the mean (*SI1 mean*, *SI2 mean*) and median (*SI1 med*, *SI2 med*) values of the sentiment indicators. Source: Thomson Reuters SDC Platinum, CRSP, OptionMetrics, Compustat, RavenPack News Analytics.

Time Window	<-90	-90 to -31	-30 to -21	-20 to -11	-10 to -6	-5 to -1	0	1 to 5	>5	Total	-30 to -1	-90 to -1
Obs	1112	290	67	67	31	46	660	252	81	5,195	239	529
Deals	477	204	55	59	29	63	659	218	728	877	170	299
SI1 mean	56	57	63	60	65	70	73	64	66	64	65	61
SI1 med	49	49	63	62	66	76	76	62	66	66	66	60
SI2 mean	51	51	51	51	51	51	51	51	51	51	51	51
SI2 med	52	52	52	50	51	52	51	52	52	52	51	52

Table 8: Investor Sentiment and Abnormal Trading Volumes

This table reports the results from a regression of average abnormal trading volume (AAV) and average cumulative abnormal trading volume (CAAV), respectively, on lagged total options trading volume ($Volume_{t-1}$), median total options trading volume in the market and its lag ($MktVol\_median$), the VIX index and its lag (VIX), the return on the underlying stock and its lag (RET), the return on the S&P500 and its lag ($RET\_S\&P500$), and a constant. We run specifications for total trading volume, as well as for call and put volumes. All specifications have year fixed effects, and we report robust standard errors. Source: Thomson Reuters SDC Platinum, CRSP, OptionMetrics, Compustat, RavenPack News Analytics.

	(1)	(2)	(3)	(4)	(5)	(6)
	Vol.	Vol.	Vol.	Vol.	Log(1+Vol.)	Log(1+Vol.)
Type	All	All	Calls	Puts	All	All
VARIABLES	AAV	CAAV	AAV	AAV	AAV	CAAV
$SentimentIndicator_t$ 1	30.87***	231.26***	33.33***	21.15***	0.01***	0.04***
	(9.94)	(78.84)	(9.86)	(5.24)	(0.00)	(0.01)
$Volume_{t-1}$	0.00	0.04**	0.00	0.00	0.00	0.00**
	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)	(0.00)
$MktVol\_median_t$	-5.22	-79.71*	-9.41	-4.85	-0.00	-0.01*
	(5.71)	(47.72)	(5.74)	(3.41)	(0.00)	(0.01)
$MktVol\_median_{t-1}$	2.57	57.21	7.77	2.79	0.00	0.01
	(6.32)	(55.94)	(6.80)	(4.03)	(0.00)	(0.01)
VIX_t	29.29	201.48	38.75	54.61	-0.00	0.03
	(158.31)	(1,323.84)	(158.40)	(81.18)	(0.02)	(0.22)
VIX_{t-1}	-56.57	-183.07	-50.05	-56.93	0.00	-0.02
	(151.11)	(1,299.47)	(150.44)	(78.64)	(0.02)	(0.21)
RET_t	1,005.49	4,542.57	639.76	375.07	0.04	0.63
	(832.97)	(5,000.61)	(772.78)	(389.48)	(0.11)	(0.85)
RET_{-1t}	-2,840.36*	-7,668.63	-2,247.13	-1,410.14**	-0.23	-1.36
	(1,455.84)	(9,819.07)	(1,387.28)	(639.96)	(0.19)	(1.65)
$RET\_S\&P500_t$	12,234.44	115,838.86	19,681.47	16,460.95	2.62	20.53
	(19,623.04)	(152,693.29)	(19,458.51)	(10,450.74)	(2.89)	(25.39)
$RET\_S\&P500_{t-1}$	241.38	-45,979.66	-1,736.94	-1,822.15	-1.08	-12.00
	(10,140.38)	(77,013.88)	(10,278.20)	(6,381.57)	(1.56)	(13.65)
Constant	985.86	3,727.64	606.96	-348.66	-0.01	0.04
	(1,073.19)	(8,368.75)	(1,091.22)	(594.02)	(0.17)	(1.43)
Observations	239	239	239	239	239	239
R-squared(%)	14	17	16	19	15	18
Year FE	YES	YES	YES	YES	YES	YES
Industry FE	NO	NO	NO	NO	NO	NO
Rating FE	NO	NO	NO	NO	NO	NO
Standard Error	ROBUST	ROBUST	ROBUST	ROBUST	ROBUST	ROBUST
adj.R2(%)	4.89	8.09	7.95	10.86	6.57	9.69

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 9: SEC Litigation Reports

Table 9 provides summary statistics on a sub-sample of litigation releases concerning civil lawsuits brought by the Securities and Exchange Commission (SEC) in federal court. We extract and document all the litigations that encompass trading in stock options around M&A and takeover announcements. The column *SEC LRs* indicates the number of M&A deals in each calendar year (*Year*) that have been subject to litigation by the SEC. The column *Cash* indicates the number of litigated deals that are cash-financed (if the information is available). The column *ABS Sample* refers to our sample of M&A deals. The column *Illicit Profits* is the average number of illicit profits reaped in the litigated cases (from stocks and options) and the column *Fines* reports the average yearly fine imposed in the litigations (total amount including disgorged trading profits, prejudgment interest and civil penalty, if any). The column *Days to Lit.* denotes the average number of days between the announcement date and the first filed litigation report. The column *Moneyness* S/K provides information about the average moneyness of the prosecuted call option trades on the target. The column *Option Mat.* presents the average time to maturity (in months) of all options trades under litigation, and the column *Days to Ann.* reports the average number of days between the first unusual option trade and the announcement date. The last column, *Defend.*, shows the yearly average number of defendants. A * in the first column indicates years with M&As involved in a litigation for alleged illegal trading on the acquiring company. In total, there are only five cases involving the acquirer in a deal. The last two rows report the sample averages over the entire period for which we have information on SEC litigations, as well as over the shorter sample period, 1996 to 2012, that we cover in our analysis of unusual options trading. Source: Thomson Reuters SDC Platinum, Securities and Exchange Commission, Department of Justice, CRSP, Public Access to Court Electronic Records (PACER).

Year	**SEC LRs**	**Cash**	**ABS Sample**	**Illicit Profits**	**Fines**	**Days to Lit.**	**Moneyness** S/K	**Option Mat.**	**Days to Ann.**	**Defend.**
1990	1	0	.	650,000	.		.	.	.	17
1993	2	0	.	87,000	72,171	1,514	.	.	13	6
1994	5	2	.	156,690	281,480	883	0.88	1.00	4	3
1995*	4	2	.	400,319	650,060	1,026	0.93	2.78	26	14
1996	3	2	70	377,612	903,343	456	0.93	0.50	3	2
1997*	4	1	133	480,367	1,471,178	350	1.02	1.50	2	3
1998	8	3	175	1,443,723	648,023	369	0.89	1.20	8	8
1999	2	2	217	295,676	57,880	1,088	0.94	1.00	4	14
2000	8	4	164	221,340	192,995	915	1.09	1.00	4	2
2001	3	1	86	232,533	270,662	1,212	0.95	0.25	0	4
2002	1	0	36	250,000	61,714	933	.	.	72	4
2003	3	0	54	372,404	905,647	689	0.94	1.85	12	3
2004	2	2	72	1,242,665	1,743,741	438	0.98	1.38	3	.
2005	11	5	109	879,829	1,499,516	841	0.97	1.17	14	6
2006*	14	10	119	1,001,278	637,230	552	0.97	0.93	13	4
2007	24	17	159	1,396,619	6,132,891	874	0.90	1.83	25	3
2008	6	5	98	1,226,436	1,243,423	719	0.93	3.12	18	2
2009	6	3	74	2,684,571	827,898	634	0.89	2.63	43	2
2010*	20	15	93	604,633	1,993,138	489	0.94	1.33	17	2
2011	8	4	114	914,337	263,969	832	0.83	3.83	44	4
2012	7	6	86	2,762,365	352,327	211	0.93	1.11	15	7
2013	7	5	.	1,493,579	5,069,953	144	0.96	1.56	8	2
90-13	7	9	.	1,037,617	1,888,521	644	0.93	1.88	21	4
96-12	8	10	109	1,084,162	1,937,595	635	0.93	1.87	21	4

Table 10: SEC Predictability Regressions

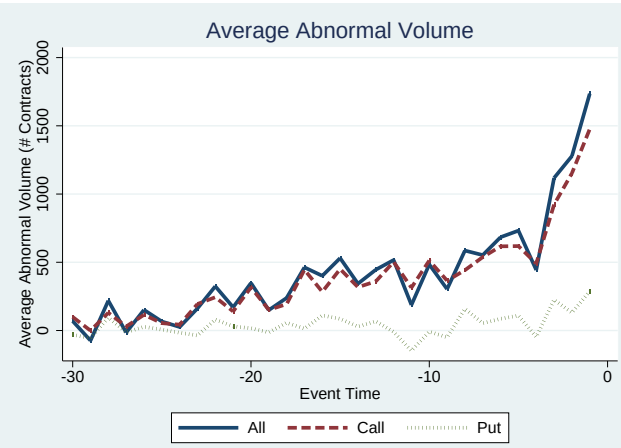
Table 10 reports logit coefficients from the logistic regressions (odds ratios in parentheses). The dependent variable SEC takes the value one if there was litigation in respect of the deal and zero otherwise. Columns (1) to (3) correspond to all SEC-litigated insider trading cases involving options; columns (4) to (6) correspond to those involving both options and stocks. The explanatory variables take the value one if a condition is met, and zero otherwise: $SIZE$ takes the value one for deals with a value greater than the median M&A deal value, $CASH$ for cash-financed takeovers, $CHALLENGE$ for challenged deals, $COMPLETE$ for completed transactions, TOE if a bidder already has a toehold in the target company, $PRIVATE$ if the acquirer privatized the target post-acquisition, $COLLAR$ for transactions with a collar structure, $TERM$ for deals with termination fees, $FRIENDLY$ if the deal attitude is considered to be friendly, and US if the bidder is a US-based company. $PREM1D$ refers to the premium of the offer price over the target's closing stock price one day prior to the original announcement date, expressed as a percentage. $PRICE$ denotes the price per common share paid by the acquirer. $TRUNUP$ denotes the target's pre-announcement cumulative abnormal stock return. $TANNRET$ denotes the target's announcement-day abnormal return. $TTPRET1$ indicates the target's post-announcement cumulative abnormal return. $ARUNUP$ is the acquirer's pre-announcement abnormal stock return. All specifications have year fixed effects (*Year FE*). We report the number of observations (*Observations*) and the pseudo R-squared (*ps.R-squared*). ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, based on Firth's method for bias reduction in logistic regressions. Source: Thomson Reuters SDC Platinum, CRSP, OptionMetrics, SEC, DoJ.

VARIABLES	(1) Logit (Odds Ratio)	(2) Logit (Odds Ratio)	(3) Logit (Odds Ratio)	(4) Logit (Odds Ratio)	(5) Logit (Odds Ratio)	(6) Logit (Odds Ratio)
SIZE	0.63***	0.44*	0.79***	0.57***	0.46**	0.70***
	(1.87)	(1.55)	(2.21)	(1.78)	(1.58)	(2.01)
CASH	0.15	0.10	0.02	0.45**	0.41*	0.25
	(1.17)	(1.10)	(1.02)	(1.57)	(1.51)	(1.29)
CHALLENGE	-0.64	-0.76	-0.57	-0.66*	-0.76*	-0.66*
	(0.53)	(0.47)	(0.56)	(0.52)	(0.47)	(0.52)
COMPLETE	1.05*	1.06*	1.07*	0.47	0.36	0.44
	(2.87)	(2.88)	(2.92)	(1.60)	(1.44)	(1.55)
TOE	-0.76	-0.74	-0.73	-0.67	-0.90	-0.62
	(0.47)	(0.48)	(0.48)	(0.51)	(0.41)	(0.54)
PRIVATE	0.20	0.27	0.30	-0.11	-0.04	0.05
	(1.22)	(1.31)	(1.35)	(0.90)	(0.96)	(1.05)
COLLAR	0.43	0.37	0.30	-0.24	-0.30	-0.37
	(1.53)	(1.45)	(1.35)	(0.79)	(0.74)	(0.69)
TERM	0.67	0.60	0.63	0.38	0.36	0.33
	(1.95)	(1.83)	(1.88)	(1.46)	(1.44)	(1.39)
FRIENDLY	-0.36	-0.36	-0.34	0.25	0.46	0.26
	(0.70)	(0.70)	(0.71)	(1.29)	(1.58)	(1.30)
US	-0.55**	-0.59**	-0.57**	-0.24	-0.30	-0.27
	(0.58)	(0.55)	(0.57)	(0.79)	(0.74)	(0.77)
PREM1D		0.01***			0.01***	
		(1.01)			(1.01)	
PRICE		0.01***			0.01**	
		(1.01)			(1.01)	
TRUNUP			-0.65			0.02
			(0.52)			(1.02)
TANNRET			-0.69			-1.02*
			(0.50)			(0.36)
TTPRET1			2.10***			2.38***
			(8.18)			(10.84)
ARUNUP			0.12			0.01
			(1.12)			(1.01)
Constant	-3.56***	-3.85***	-3.78***	-3.74***	-4.05***	-3.90***
	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Observations	1,859	1,807	1,859	1,859	1,807	1,859
ps.R-squared	0.11	0.12	0.13	0.11	0.12	0.13

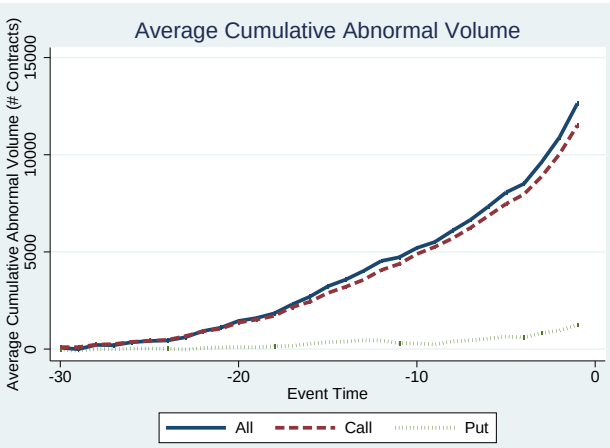
Figure 1: Abnormal Trading Volumes before Announcement Dates - Target

Figure (1a) plots the average abnormal trading volume for all equity options (solid line), call options (dashed line) and put options (dotted line), respectively, for the target companies, over the 30 pre-announcement days. Volume is defined as the number of option contracts. Figure (1b) reflects the average cumulative abnormal trading volume for all options (solid line), call options (dashed line) and put options (dotted line) over the same event period. Figures (1c) and (1d) plot the average abnormal and cumulative abnormal trading volume for all options in M&A transactions that are either cash-financed (solid line) or stock-financed (dashed line), over the 30 days preceding the announcement date. Source: OptionMetrics.

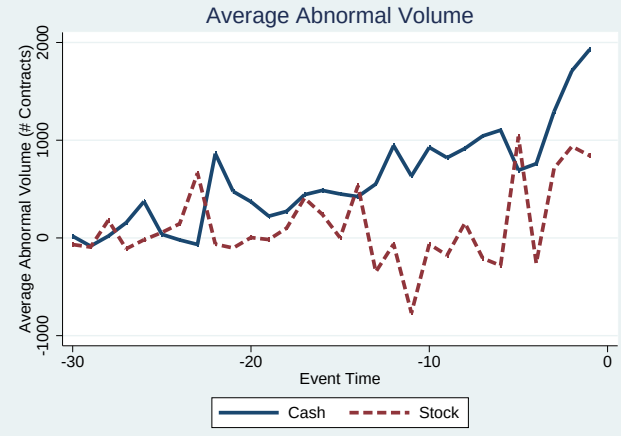
(a)



(b)



(c)



(d)

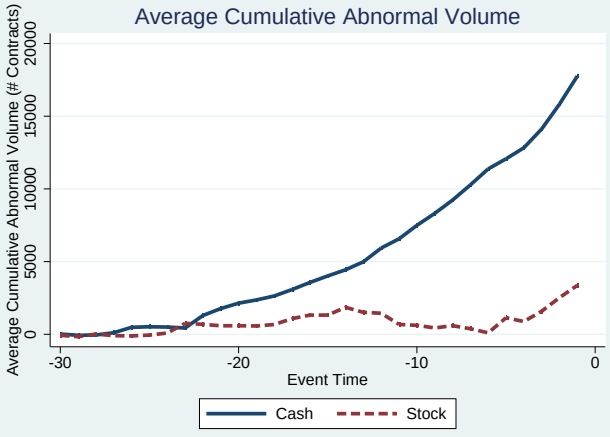
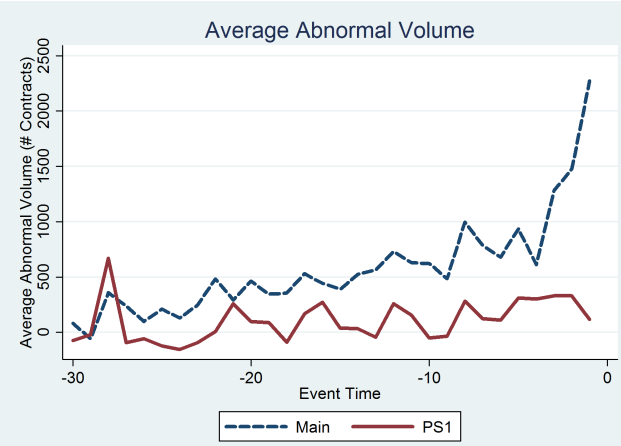


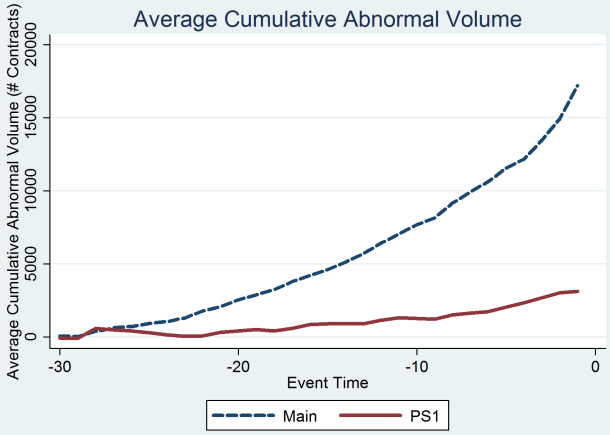
Figure 2: Abnormal Trading Volumes - Propensity-Matched Control Groups, News and Rumors

Figures (2a) and (2b) plot the average and average cumulative abnormal trading volume, respectively, for aggregate options volume in the treatment group (Main - dashed line) and the propensity-matched control group using the best match (PS1 - solid line), over the 30 days preceding the announcement date. Volume is defined as the number of option contracts. Figures (2c) and (2d) plot, respectively, the average and average cumulative abnormal trading volume for aggregate options volume in the sample with (No News – solid line) and without (News (30d) – dashed line) news or rumors about M&As in the 30 pre-announcement days. All results are based on a log-transformation of volume, defined as $logVolume = \ln(1 + Volume)$. Raw volume is defined as the number of option contracts. All graphs are based on the constant-mean volume model. Source: Thomson Reuters SDC Platinum, CRSP, OptionMetrics, Compustat, RavenPack News Analytics, Thomson Reuters 13f filings.

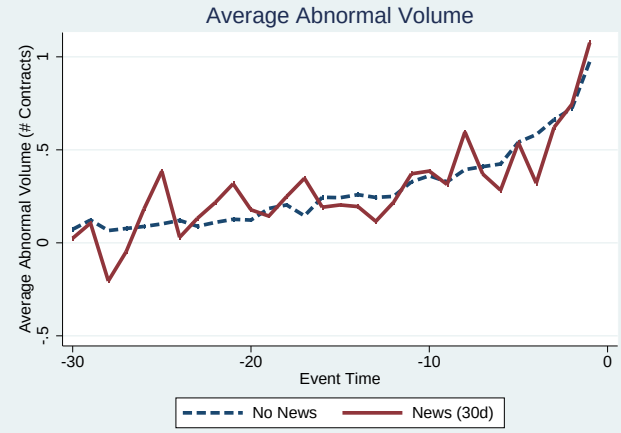
(a)



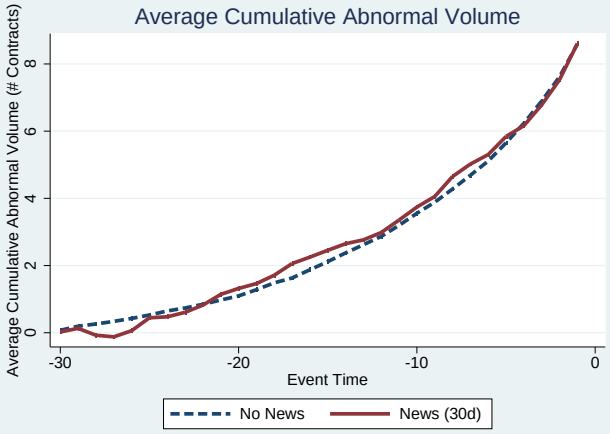
(b)



(c)



(d)



Internet Appendix: Not for Publication

Informed Options Trading ahead of M&A Announcements: Insider Trading?

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Abstract

We document pervasive informed trading activity in equity options before M&A announcements. About 25% of takeovers have positive abnormal volumes. The volume patterns indicate that informed traders are likely using bullish directional strategies for the target and volatility strategies for the acquirer. We provide evidence that this abnormal activity cannot be explained by merger predictability, speculation, news and rumors, trading of corporate insiders, or leakage in the stock market. The SEC litigates only about 7% of deals in our sample, and the characteristics of illegal option trades before M&A announcements closely resemble the documented patterns of unusual options activity.

A-I A Taxonomy of Insider Trading Strategies

To obtain a classification of potential insider trading strategies, we need to distinguish between insider trading strategies on the **target** and those on the **acquirer**. An investor trading illicitly, based on private information, would gain most from **bullish strategies** on the target company (or alternatively a replication of such a strategy carried out by **shorting bearish strategies**), and from strategies that are **long rising volatility** on the acquirer firms (or alternatively a replication of such a strategy by **shorting** strategies that benefit from **falling volatility**). Any replicating strategy that involves the underlying could also be created by investing in the futures contract on the underlying. In this section, we focus on options strategies and how they would impact options-to-stock volume ratios. We will not talk about the obvious strategy of investing directly in the stock only. The overall conclusion is that, irrespective of the strategy we consider, in the presence of insider information, there should be abnormal trading volumes in OTM call and/or ITM put options for target firms, and in ATM options for acquirer firms.

A-I.A Target

Insider trading on targets is only profitable for long bullish strategies. These strategies can be replicated by shorting bearish strategies. We discuss each possibility one by one.

A-I.A.1 Long Bullish Strategies

1. Long Call

The simplest way to exploit inside information using options is to buy plain vanilla and short-dated deep OTM call options on the underlying stock, given that they provide the biggest leverage to the investor.[1] This implies that we should observe abnormal trading volumes in call options prior to M&A announcements. The abnormal trading volume should be relatively higher for OTM options in comparison to ATM and ITM options. Moreover, the call-to-stock volume ratios should increase ahead of the announcements. The cost of such a strategy will be equal to the option premium.

2. Long Call Ratio Backspread

A call ratio backspread consists of selling a call option with strike K_1 and buying two call options with strike K_2, where $K_1 < K_2$. The advantage is that, by selling one call option for every two purchased, part of the strategy is self-financing. Similar to the simple long call strategy, the long call ratio backspread provides the most leverage if it is constructed using OTM options. Hence we would expect to see an abnormal trading volume in OTM call options in comparison to ATM and ITM options.[2] Moreover, the call-to-stock volume ratio should increase ahead of the announcement. The cost of this strategy will be equal to the option

[1] Of course, the options should not be too far OTM, since the stock may not move that much, even after the announcement.

[2] The implication also applies to the relative volumes of deeper OTM to less deeply OTM calls.

premium. (Note that this strategy could be replicated more cost efficiently by selling a put option with strike K_1, shorting the underlying, and buying two call options with strike K_2, where $K_1 < K_2$. Such a strategy would be more cost efficient as selling the ITM put and shorting the stock would bring in more money than selling the OTM call.)

3. Long Bull Call Spread

An insider might be certain about the direction in which the stock price was going to move, but could also reasonably assume that it was going to move by no more than a certain percentage. In that case, he could engage in a long bull call spread. Such a strategy is constructed by buying a call option with strike K_1 and selling a call option with strike K_2, where $K_1 < K_2$. Similarly to the long call ratio backspread, this strategy would be partly self-financing. If we were to assume that leverage was optimized and the call options were OTM, then we would expect abnormal trading volumes in call options ahead of takeover announcements. Such abnormal trading volumes should be relatively higher for OTM options than ATM and ITM options. Moreover, the call-to-stock volume ratio should increase ahead of announcements. (Note that this strategy could be replicated more cost efficiently by selling a put option with strike K_2, shorting the underlying, and buying one call option with strike K_1, where $K_1 < K_2$. Such a strategy would be more cost efficient for a financially constrained investor as selling the ITM put and shorting the stock would bring in more money than selling the OTM call.)

4. Long Bull Put Spread

A bull put spread can be implemented by buying a put option with strike K_1 and selling a put option with strike K_2, where $K_1 < K_2$. This would be most profitable if the investor transacted in ITM puts, thus creating the hypothesis that we ought to see an abnormal trading volume in ITM puts ahead of an announcement. Under this hypothesis, we should also see an increase in the put-to-stock trading volume ratio. The advantage of this strategy is that the purchase of an ITM put is financed with a relatively more ITM (and therefore more expensive) put. This strategy should therefore be entirely self-financing. (Note that this strategy can be replicated by buying a put option with strike K_1, selling a call option with strike K_2, where $K_1 < K_2$, and buying the underlying stock. In this case, we would also expect to see a higher abnormal trading volume in OTM call options and in ITM put options.)

A-I.A.2 Short Bearish Strategies

1. Long Put + Stock

According to put-call parity, a long call position can be replicated by a position in a put on the same underlying, with equal strike and equal time to maturity, combined with a position on the underlying stock. As the greatest leverage is obtained from OTM call options, this strategy can be replicated by buying ITM put options and matching them with the underlying stock. According to this hypothesis, we should observe abnormal trading volumes in both puts and stocks. Accordingly, the abnormal volume should be relatively higher for ITM put options than

for ATM and OTM puts. In addition, the put-to-stock volume ratio should not be significantly affected. This strategy, however, would be significantly less attractive for a capital-constrained investor, relative to a simple OTM call transaction, as the ITM puts are comparatively more expensive and the stock is fully funded. The cost of this strategy will be determined by the put premium and the stock price.

2. Short Put

If the investor is certain about the direction of the stock price movement, he can simply take advantage of his private information by selling ITM put options. When stock prices do shoot up after an announcement, the put options will expire worthless, whereas the writer of the options will have a profit equal to the put premium times the number of puts sold. This strategy could be replicated by taking a short position in matched-strike OTM call options together with a long position in the underlying stock (which would correspond to a covered call).

3. Sell Put Ratio Backspread

A short put ratio backspread is implemented by selling two puts with strike K_1 and buying one put option with strike K_2, where $K_1 < K_2$. While this strategy suggests that there would be a range of contingent outcomes from which the insider could benefit, the strategy is much riskier than others as he could lose money if the prices rise more than a certain amount. While we expect such a strategy to be an unlikely choice for insider trading, it would generate abnormal trading volumes in ITM put options. (A replication strategy with two short puts at K_1, long a call at K_2 and short the stock would produce different predictions for the option-to-stock trading volume ratio, and would also suggest an abnormal trading volume in OTM calls.)

4. Sell Bear Call Spread

The idea of selling a bear call spread is similar to the idea of selling ITM puts, except that the profit potential is diminished relative to simple ITM put options. This is thus another unlikely strategy, but a theoretically possible one. A short bear call spread is constructed by selling a call with strike K_2 and buying a call with strike K_1, where $K_1 < K_2$. In terms of expectations about trading volumes, such a strategy would raise the OTM call trading volume.

5. Sell Bear Put Spread

Finally, a short bear put spread is very similar to the short bear call spread, except that it is constructed using puts rather than calls. The composition contains a short position in a put option with strike K_2 and a long position in a put option with strike K_1. As this strategy is also similar to the idea of selling ITM puts, except that the profit potential is diminished relative to simple ITM put options, we again find such a strategy unlikely but theoretically feasible. In any case, the prediction is that we should expect to see an increase in the abnormal volume for ITM put options.

A-I.B Acquirer

In M&As, the outcome of the stock price evolution for the acquirer company is more uncertain than for the target company, which, on average, has a positive stock price evolution. On the other hand, the takeover announcement is typically associated with an increase in volatility. We therefore expect that an insider would trade on his private information by adopting long neutral price strategies that would benefit from a rise in volatility. Alternatively, he could adopt short neutral price strategies that would benefit from a fall in volatility.

A-I.B.1 Long Rising Volatility Strategies

1. Long Straddle

An insider, uncertain about the evolution of the stock price of the acquirer but certain about a rise in volatility, could take advantage of his private information through a long position in a straddle. A straddle is constructed by buying a call and put option on the same underlying and with the same strike price. Such a strategy benefits most from a rise in volatility if both options are purchased ATM. Thus, we would expect to see a relatively stronger increase in the trading volumes for pairs of calls and puts with the same strike and the same time to maturity (most likely short-dated options). This should result in a relatively higher abnormal trading volume for the acquirer in ATM options compared to ITM and OTM options, irrespective of whether we look at calls or puts. The cost of this strategy is determined by the prices of the ATM call and put options. In its simplest form, there should be an increase in both the call-to-stock and the put-to-stock trading volume ratios.

There are several ways to replicate this strategy. For example, it would be possible to buy two ATM calls and short the underlying stock. Alternatively, one could buy two ATM puts and add the underlying stock. The former strategy would be more desirable for capital-constrained investors as the purchase of ATM options could be financed through the short sale of the underlying stock. With respect to the latter replication, the trader would need to buy the put options *and* the underlying stock. In addition, in the case of a short sale of the underlying, the defensive argument that the trader was speculating may be more reasonable. Regardless, no matter which strategy we are looking at, we should expect to see an increase in abnormal trading volumes for ATM call and put options. In both cases, the ratio of calls/puts to the underlying stock is two, implying that we should see an increase in both the call-to-stock and the put-to-stock trading volume, just as in the case of the basic straddle strategy.

2. Long Strangle

A strangle is similar to a straddle, but it may be less costly to implement. It can be constructed by buying a call option with strike K_1 and a put option with a strike K_2, where $K_1 < K_2$. The optimal way to implement this strategy in the case of insider trading would be to buy near-the-money options. This means that both the options would be only weakly OTM. Hence, we can argue that we would expect to see an increase in abnormal trading volumes for ATM

options, if we were to define ATM through a delta range of between, for example, 45% and 55% (or a stock-to-strike ratio of between 95% and 105%).

There exist several variants of the strangle. One could buy a put option with strike K_1 and a call option with strike K_2, where $K_1 < K_2$. The outcome for the trading volume would be similar to the basic case. Alternatively, it is possible to buy one put at strike K_1, one put at strike K_2, and the stock. In this case, the put-to-stock ratio should increase, but not the call-to-stock ratio. However, one would expect to see an abnormal trading volume in ATM puts. It is also possible to replicate the strangle by buying one call at strike K_1, and one call at strike K_2, and shorting the stock. Likewise, the ratio of call-to-stock volumes should increase, and we would expect to see an abnormal trading volume for ATM calls.

3. Long Strap

An interesting alternative for an insider who was uncertain about the stock price outcome for the acquirer would be to take a long position in a strap. He would thereby benefit from a rise in volatility, but keep a higher profit potential should the stock price rise. A strap, if inside information existed, would be optimally constructed by buying two ATM calls and one ATM put. This would again lead to the prediction that there should be an abnormal trading volume in ATM options. In addition, there should be a relative increase in the ratio of the call-to-put trading volumes.

A variant to this strategy would be to buy three ATM calls and short the underlying. This would increase the trading volume in ATM call options, increase the ratio of call-to-put trading volumes, and increase the ratio of call-to-stock volumes.

4. Long Strip

A strip is essentially the mirror image of a strap. A long strip trading strategy benefits from a rise in the volatility of the underlying stock price, but its value increases relatively more if the stock price goes down. The strategy can be optimally constructed (in the presence of private information) by buying two ATM puts and one ATM call. This would also lead to the prediction of a positive abnormal trading volume in ATM options. In addition, there should be a relative increase in the ratio of the put-to-call trading volumes.

A variant to this strategy would be to buy three ATM puts and long the underlying. This would increase the trading volume in ATM put options, decrease the ratio of call-to-put trading volumes, and increase the ratio of put-to-stock volumes.

A-I.B.2 Short Falling Volatility Strategies

Strategies that benefit from falling volatility are implemented by taking the mirror image positions of those strategies that benefit from a rise in volatility. In other words, such strategies can be implemented by selling a straddle, a strangle, a strip or a strap. As an insider would need to go short in such positions, he would end up with the simple long straddles, strangles, strips and straps.

There is therefore no need to investigate any further strategies. We can simply refer to the strategies in section A-I.B.1.

A-I.C Conclusion

The insight from the exercise of classifying potential insider trading strategies for the acquirer and the target companies is the following: no matter which strategy we look at, the conclusion is that, in the presence of insider information, there should be abnormal trading volumes for the target companies in OTM call options and in ITM put options. Meanwhile, there should be abnormal trading volumes in ATM options written on the acquirers. Conditional on such findings, the ratios of call-to-stock, put-to-stock and call-to-put volumes may yield insights regarding which strategy has been implemented by the insider.

A-II Additional Results for Targets

A-II.A Shifts in the Option Trading Volume Density

The empirical section in the main text illustrated that the 30 days prior to M&A announcement dates should exhibit abnormal option volumes for target firms, particularly pronounced in respect to OTM call options. The question is whether there is a monotonic and statistically significant shift in the entire option trading volume *distribution* as the announcement date approaches. We formally test for a shift in the bivariate volume-moneyness distribution over time, in anticipation of the announcement dates.

Figure A-1 visually illustrates the shift in the volume distribution for calls and puts written on the target firms as we approach the announcement date. Each individual line reflects a local polynomial function fitted to the volume-moneyness pairs. It is striking to see how the volume distribution for call options shifts to the tails and increases the weights of the DITM and DOTM categories as we approach the announcement date. In addition, the volume keeps increasing, in particular in the event window $[-4, -1]$. The last event window $[0, 0]$ incorporates the announcement effect, whereby the overall average trading level is lifted upwards, and the distribution shifts to ITM call options and OTM puts, as would be expected as the merger has been announced. Another way to visualize the change in the distribution is shown in Figure A-2, although this graph is a univariate slice of the underlying bivariate distribution. The dashed blue line and the solid green line in each plot represent the 90th and 95th percentiles of the distribution, whereas the dotted red lines reflect the interquartile range. It is evident from the figure that the percentage increase in the percentiles of the volume distribution is very strong. For example, the interquartile range for target call options increases from a level below 50 contracts to approximately 2,000 contracts on the announcement day.

To summarize, there is a significant shift in both the mean and median trading volume for target firms in anticipation of M&A transactions. This shift is more pronounced for DOTM and OTM call options than for ITM and DITM options. This confirms Hypothesis H2 that there is a higher abnormal trading volume in DOTM call options than in ATM and ITM call options. In what follows,

we apply a formal statistical test of the shift in the volume distribution.

In order to test whether the bivariate volume-moneyness distribution shifts over time prior to the announcement date, we use a two-sample bivariate Kolmogorov-Smirnov (KS) test. The two-sample KS test is a non-parametric test of the equality of two continuous distribution functions. Essentially, the KS-statistic quantifies the distance between the two empirical cumulative distribution functions. While the test statistic is straightforward to compute in the univariate setting with distribution-free properties, the computation in the multivariate setting can become burdensome, particularly when the sample size is large. The reason for this is that, in the univariate setting, the empirical cumulative distribution function diverges only at its observed points, while it diverges at an infinite number of points in the multivariate setting. To see this, remember that, in a multivariate setting, there is more than one definition of a cumulative distribution function. In particular, in the bivariate setting, the four *regions* of interest are

$$H^{(1)}(x,y) = P[X \leq x, Y \leq y], \qquad H^{(1)}(x,y) = P[X \leq x, Y \geq y] \tag{A-2}$$

$$H^{(1)}(x,y) = P[X \geq x, Y \leq y], \qquad H^{(1)}(x,y) = P[X \geq x, Y \geq y], \tag{A-3}$$

and we need to evaluate the empirical cumulative distribution function in all possible regions. To reduce computational complexity, we rely on the Fasano and Franceschini (FF) generalization of the two-sample bivariate KS test. Define the two sample sizes $\{\left(x_j^1, y_j^1\right) : 1 \leq j \leq n\}$ and $\{\left(x_j^2, y_j^2\right) : 1 \leq j \leq m\}$, with their corresponding empirical cumulative distribution functions $H_n^{(k)}$ and $H_m^{(k)}$, for regions $k = 1, 2, 3, 4$. The FF test statistic (Fasano and Franceschini (1987)) is then defined as

$$Z_{n,m}^{'} = max\{T_{n,m}^{'(1)}, T_{n,m}^{'(2)}, T_{n,m}^{'(3)}, T_{n,m}^{'(4)}\}, \tag{A-4}$$

where

$$T_{n,m}^{'(k)} = sup_{(x,y)\in\mathcal{R}^2} \sqrt{\frac{nm}{n+m}} \left| H_n^{(k)}(x,y) - H_m^{(k)}(x,y) \right|. \tag{A-5}$$

Although the analytic distribution of the test statistic is unknown, its p-values can be estimated using an approximation, based on Press, Teukolsky, Vetterling, and Flannery (1992), to the FF Monte Carlo simulations.

Our prior is that the FF-statistic, which reflects the distance between the two bivariate empirical distribution functions (EDFs), should monotonically increase for the target firms as we get closer to the announcement date.[3] Essentially, the difference in EDFs should be larger between event windows $[-29, -25]$ and $[-24, -20]$, than between $[-29, -25]$ $[-19, -15]$, and so forth. In addition, the FF-statistics should increase relatively more for short-dated options, which mature closer to, but after, the announcement date. These predictions are clearly confirmed by the results in Table A-1. The FF test reveals statistically significant differences in the bivariate volume-moneyness distributions

[3]One can think of the FF-statistic as a variation of the KS-statistic in the multivariate setting. The FF-statistic is computationally less intensive in the multivariate case, but is consistent and does not compromise power for large sample sizes. See Greenberg (2008).

as we move closer to the announcement date. We compare the distributions in event-window blocks of five days. A glance at the table reveals that the test is statistically significant, at the 1% level, for almost all pair-wise comparisons. In addition, the magnitude of the statistic is monotonically increasing as we move from the left to the right, and as we move from the bottom to the top of the table.

Panels A and B in Table A-1 report the results for calls and puts, respectively. For example, the first row shows that the bivariate distribution shifts significantly from event window $[-29, -25]$ to $[-24, -20]$, with an FF-statistic of 0.0279. The test statistic increases to 0.1592 when we compare event windows $[-29, -25]$ and $[-4, -1]$, and to 0.4070 for event windows $[-29, -25]$ and $[0, 0]$. For short-dated options with a time to expiration of less than 30 days, the statistic for the difference in distributions for the shift from event window $[-29, -25]$ to $[-4, -1]$, *excluding the announcement effect*, has a value of 0.3388 (0.34) for call (put) options. This is *higher* than the announcement effect from event window $[-4, -1]$ to the announcement date. Changes in the bivariate distributions are statistically significant at the 1% level for almost all event windows. Overall, as expected, the largest test statistics seem to be associated with comparisons between the announcement date ($[0, 0]$) and the event window immediately preceding it ($[-4, -1]$).

These formal statistical tests provide evidence that the two-dimensional volume-moneyness distribution shifts significantly in both time and depth over the 30 days preceding the announcement day. Hence, the level of the volume distribution increases, with a higher frequency of trades occurring in both OTM calls and ITM puts. These findings support the results of the event study and strengthen our conclusions in favor of Hypotheses H1 and H2.

A-II.B Zero-Volume Runs

As emphasized earlier, liquidity is low in equity options. Given the significant number of zero-volume observations that characterize the data for equity options, we compare the proportions of non-zero trading volume between the pre-announcement period and any randomly chosen period to supplement our forensic analysis of the behavior of option volume. We also investigate proportions of non-zero trading volume conditional on there being no trading volume for the preceding one to five days. Each observation corresponds to an option series characterized by its issuer, the type (put-call), strike and maturity.

First, Panel A in Table A-2 reports the volume proportions for a randomly chosen date, which turns out to be March 5, 2003. On that day, OptionMetrics contains a total of 103,496 observations, of which 28,402 are classified as DOTM and 28,404 are classified as DITM according to our definition of depth as the ratio of the stock price to the strike price. As expected, trading volume is generally low. Only 15% of all options were traded, about 3% were traded with more than 100 contracts, and only 0.42% were traded with more than 1,000 option contracts. The stratified proportions reveal that the proportion of observations with non-zero trading volume is largest in the ATM category, followed by the OTM category. We compare these proportions first to those from our overall sample, in Panel B. The proportions are very similar to those observed on March 5, 2003. This is confirmatory evidence

that our sample is representative of a typical trading day. Panel C documents similar proportions for the five days preceding the announcement day.

These proportions are compared to a randomly chosen sample in Panel C, where for each M&A transaction we simulate a random pseudo-event date and look at the proportions of non-zero-volume observations in the five days leading up to the pseudo-event. Rather than reporting standard errors, we indicate how many standard deviations the proportion in the random sample lies from that actually observed.[4] The lowest difference between the proportions in the actual and random sample is four standard deviations. This value is obtained for the proportion of volumes above 1,000 contracts, for ATM options, conditional on there being no trading volume during the five preceding days. For all other comparisons, the difference corresponds to at least five standard deviations. A value of five standard deviations corresponds approximately to a chance of one in a million that the randomly observed proportion would be larger than on the pre-announcement event date. As any other comparison leads to even larger differences, we believe the odds of one in a million to be a conservative estimate.

A-II.C Strongly Unusual Trading Volume and Matched Random Sample

Our primary goal is to distinguish informed trading from random speculative bets. Hence, we are looking for unusual trading patterns that are *clearly* different from the patterns exhibited by randomly selected samples, since evidence of non-random trading would point to the existence of informed trading. We analyze extreme cases that are potentially the *most likely* to reflect informed trading. In this spirit, we define as strongly unusual trading (SUT) observations (defined as the trading volume for an option-day pair, i.e., the end-of-day volume for a given option on the target) meeting the following four criteria for individual options: (1) The daily best recorded bid is zero. This corresponds implicitly to DOTM options where the market-maker, through his zero bid, signals his unwillingness to buy, but is willing to sell at a non-zero ask price. (2) The option expires on or after the announcement day, but is the first one to expire thereafter (the so-called front month option). Obviously, an insider would buy options that were going to expire soon after the announcement: in order to get the biggest "bang for their buck," he would try to buy the cheapest ones, these being the ones most likely to end up ITM. Short-dated OTM options tend to be cheaper and provide the greatest leverage. (3) The option has strictly positive trading volume. Since many individual equity options, especially those that are OTM, have zero trading volume (although all options have quotes in the market-making system), we focus on those that have positive volume, since a zero-volume trade cannot be unusual, by definition. (4) Finally, the transaction takes place within the 30 days preceding the event date, defined as the 0 date (i.e., between event dates -29 and 0). An informed trader faces a trade-off in that he must leverage on his private information prior to the event, while avoiding trading too close to the event, as that may entail a higher risk of alerting other market

[4]Note that each option volume observation follows a Bernoulli variable taking the value 1 if volume is positive (respectively larger than 100, 500 or 1,000 contracts) and 0 otherwise. Assuming independence, the sum of all observations follows a binomial distribution. The standard error of proportion p obtained from a random sample is given by $\sqrt{\frac{p(1-p)}{N}}$, where N is the number of observations.

participants or triggering an investigation by the regulators.[5]

Table A-3 presents the sample statistics for the SUT sample. From the entire dataset, we identify 2,042 option-day observations, for the target firms, that meet our SUT selection criteria.[6] The share of calls is slightly more than half, with a total of 1,106 observations for target firms. The average trading volume is 124 option contracts, and the average trading volumes for calls and puts are, respectively, 137 and 108.[7] The median trading volume is somewhat more stable, with a value of 20 contracts for options written on the target.

We compare the statistics from the SUT sample with those from a randomly selected sample. The sampling procedure used to create the random sample is as follows: For each of the 1,859 events with options traded on the target firms, we randomly select a *pseudo-event* date. We treat the pseudo-event date as a hypothetical announcement date, chosen at random, and then apply the SUT selection criteria to it, i.e., we keep option-day observations with a zero bid price, with non-zero trading volume, that are within 30 days of the pseudo-event date, and that have an expiry date after the pseudo-event date.

The SUT sample statistics are compared to the random sample trading (RST) statistics in Panel B of Table A-3.[8] The number of observations, deals and options are somewhat higher in the RST sample than in the SUT sample, by a factor of between 1.4 and 1.8. However, the average and median trading volumes in the SUT sample are more than double those in the RST sample. The maximum observed trading volumes are significantly higher in the SUT sample than in the RST sample. However, the distributional statistics illustrate that this effect does not arise because of outliers. In the RST sample, from around the 50th percentile of the distribution upwards, volumes are consistently less than half the trading volumes observed in the SUT sample at comparable cut-offs of the volume distribution. Another interesting feature is that the distance between the median and the mean is roughly constant at around 100 traded contracts in the SUT sample. Statistics for the put options are statistically similar across both samples. For the entire sample, the difference between the average volume (124) before the deal announcement in the SUT sample, and the average volume (57) on a random date in the RST sample, is significantly different from zero. The one-sided t-statistic is -6.90, implying a probability of three in a trillion that the trading volume observed before the announcement happened by chance. Moreover, the volumes of the SUT sample are overwhelmingly higher for the percentiles over 30%, and about the same for those less than 30%.

We point out that the difference between the two samples is likely to be *understated* in our procedure compared to the procedure of choosing the random sample from the *entire* sample period. Specifically, in our case, for each event, we have a maximum of one year of data before and after

[5] An additional aspect that we do not explicitly consider is the number of traders involved, and their connections with each other, which could reveal whether the information was shared by many players and potentially leaked to them. Presently, we do not have data on individual trades conducted in this period.

[6] Note that the full sample has approximately 12 million observations. For each event, the event time spans the period from one year before to one year after the announcement date.

[7] The average is taken across all observations satisfying the SUT selection criteria.

[8] Since our study is confined to a limited period, due to the fact that the variance may be large, and to address the possibility that the dates chosen at random may coincide with those of other announcements, we double-checked our results using 100 random samples of 1,859 pseudo-events for the target firms, in order to minimize the standard error of our estimates. As expected, the results from this robustness check were very similar to the original results.

the event, rather than the whole time-span of traded options from as far back as January 1996 until today. Using the whole time-span the difference would likely be even stronger. Hence, our statistical procedure is biased against failing to reject the null hypotheses.

To summarize, the entire distribution of trading volumes differs significantly between the SUT and RST samples for the target firms. In particular, we observe that an average trading volume above 100 contracts, with a mean-to-median distance of 100 contracts, can be considered strongly unusual and non-random when the transactions occur at a "zero-bid," within 30 days of the announcement date, on options expiring after the announcement. This test provides additional evidence in favor of Hypothesis H1, showing that there is a *non-random* increase in the trading volume for target firms prior to public M&A announcements, particularly if we restrict ourselves to the most illiquid and leveraged options in the SUT sample.

A-II.D Excess Implied Volatility - Event Study

Informed traders with accurate information about the timing of an announcement and the offer price will tend to buy OTM calls *just prior* to the announcement (for example, as in the JPM-Bank One case). To obtain leverage, they will buy OTM calls that are likely to become ITM when the stock price reaches or exceeds the takeover offer price. If they are confident about their information, they will be willing to pay the offer price of the option market-maker, typically the seller of such options. Informed traders who anticipate a deal, but are uncertain of the offer price and the timing, will typically buy options that are closer to the money, and will also be willing to pay the offer price. Assuming that the equilibrium price of the option is, on average, between the bid and ask prices, buying at the ask price will result in higher excess implied volatility. The wider the bid-ask spread, the greater will be the measured excess volatility, due to the convexity of option prices. Thus, we anticipate excess implied volatility, albeit not especially large, for all options on the target.[9] More formally, we formulate the following hypothesis:

- H3: *There is positive excess implied volatility for equity options written on the target firms, prior to M&A announcements, provided informed traders primarily buy rather than sell options.*

To test this hypothesis, we conduct a forensic analysis of implied volatility, the summary statistic of the price behavior of options, over the 30 days preceding the M&A announcement date. As a complement to the volume results, we first conduct an event study to test for the presence of positive excess implied volatility relative to a market benchmark. We use the interpolated volatility surface in the OptionMetrics database, a three-dimensional function of the implied volatility in relation to the strike price and the time to expiration, for this exercise. To analyze the behavior of ATM implied volatility, we use the 50 delta (or a 0.50 hedge ratio) options in absolute value (for both calls and puts), and the 80 and 20 delta (or 0.80 and 0.20 hedge ratios) options in absolute value for the ITM and OTM options respectively. We test two different model specifications for our results: a simple

[9]This argument can be related to prior work on the inelasticity of the option supply curve, along the lines analyzed theoretically by Garleanu, Pedersen, and Poteshman (2009) and empirically by Bollen and Whaley (2004) and Deuskar, Gupta, and Subrahmanyam (2011).

constant mean volatility model and a market model, in which we use the S&P 500 VIX index as the market's benchmark for implied volatility. The estimation window runs from 90 to 31 days before the announcement date, while our event window relates to the 30 days before the event, excluding the announcement day itself. All standard errors are clustered by time to account for the bunching of events on a given day.

Panel A in Table A-4 documents that excess implied volatility is pervasive in our sample. At the 5% significance level, using the market model, there are about 812 cases (44% of the 1,859 deals) with positive excess implied volatility for ATM calls, and about 798 cases (43% of the 1,859 deals) with positive excess implied volatility for ATM puts. The frequencies are similar for OTM implied volatilities, and slightly lower for ITM implied volatilities, where positive excess implied volatility is documented for 39% (calls) and 41% (puts) of all cases. This study confirms the existence of positive excess implied volatility for the target companies, confirming Hyopthesis H3. These results are graphically presented in Figure A-3a for ATM implied volatilities. For targets, the daily average excess ATM implied volatility starts increasing about 18 days before the announcement date and rises to an excess of 5% the day before the announcement.

A-II.E Information Dispersion and the Determinants of Bid-ask Spreads

Similar to the rationale behind Hypothesis H3, there should be no clear pattern in the bid-ask spread for the options on the target firm as the announcement date approaches, in the absence of insider activity. An increase in the percentage bid-ask spread, conditional on abnormal trading volumes, would be a natural response of the market-makers to such asymmetric information. This would be indirect evidence that there were informed traders in this market prior to the announcement date, but not necessarily that the information about a potential merger had leaked to the whole market. Thus, we formulate the following additional hypothesis:

- H4 : *The percentage bid-ask spread for options written on target firms widens prior to M&A announcements.*

To address Hypothesis H4, we study the evolution of the bid-ask spread in anticipation of the M&A announcement. The prediction of Hypothesis H4 is that the percentage bid-ask spread in option premia should widen prior to the announcement. Strong evidence in favor of this hypothesis would indicate that the market (i.e., the market-maker) is reacting to a substantial increase in the demand for options, in particular OTM calls. Figure A-3c plots the evolution of the average percentage bid-ask spread from 90 days before the announcement date to 90 days after the event. The figure shows that the average percentage bid-ask spread on target options rises from about 35% to 55%, and then jumps up to approximately 80% following the announcement. Interestingly, this rise in bid-ask spreads is restricted to DOTM and OTM options, as is illustrated in Figure A-3e.

As we did in our earlier exercise, we verify whether we are able to observe such a pattern on a random day. Thus, for each M&A transaction, we draw a random pseudo-event date and construct the average bid-ask spread in pseudo-event time. The outcome is illustrated by the flat line in Figure A-3d. Clearly, the average percentage bid-ask spread calculated in event time, for randomly chosen

announcement dates, exhibits no pattern of rising bid-ask spreads in response to the arrival of any asymmetric information from potential insiders.

Our analysis shows that the average percentage bid-ask spread on target options rises from about 35% to 55%, and then jumps up to approximately 80% following the announcement. Interestingly, this rise in bid-ask spreads is restricted to DOTM and OTM options, and such a pattern of rising bid-ask spreads in response to the arrival of any asymmetric information from potential insiders is not observed ahead of randomly chosen announcement dates. In order to get further insights into the economic drivers of the rise in bid-ask spreads, we build a model of the determinants of bid-ask spreads.

We regress the percentage bid-ask spread BA in the 30 pre-announcement days on a series of option- and issuer-specific measures of trading volume, return performance, volatility and trade imbalance, controlling for the overall level of market activity in both the stock and options markets. More specifically, we examine the impact of trading volume by incorporating the natural logarithm of options volume (OV) at the options level i, and the natural logarithm of stock volume (SV) at the issuer level j, defined as $OV = \ln(1 + Volume_O)$ and $SV = \ln(1 + Volume_S)$, respectively. We also control for return performance through the log returns of stock prices (ret^S) at the issuer level, and through the log returns of option prices (ret^O) at the option level. We capture trade imbalance as the natural logarithm of the ratio of aggregate call-to-put trading volume, measured at the issuer level (CP). In addition, we examine the effect of the option-specific implied volatility (IV) and the realized volatility over the past 30 days ($RV30$), measured at the firm level. To capture overall market activity and trends, we control for the natural logarithm of the median options market volume (Mkt^{OV}), measured across all traded options, and for the natural logarithm of the median stock market volume (Mkt^S), measured across all traded stocks. We further control for the CBOE Volatility Index (VIX), the excess return on the market ($Mktrf$), calculated as the value-weighted return on all NYSE, AMEX, and NASDAQ stocks (from CRSP) minus the one-month Treasury bill rate (from Ibbotson Associates). We further include five dummy variables (D) that take on the value one if an option is DOTM, OTM, ATM, ITM, or DITM, respectively, and zero otherwise. In addition, we include three dummy variables ($TT1$, $TT2$, and $TT3$) that take on the value one if an option is short term (less than 30 days), medium-term (between 30 and 60 days), or long-term (more than 60 days), respectively, and zero otherwise. We examine the relationship between the bid-ask spreads and the lagged values of the economic determinants in order to capture the response of market-makers to activity in the equity and options markets.[10] We run a time-series regression, where the benchmark model is specified as

$$\begin{aligned} BA_{i,j,t+1} = {} & \alpha_0 + \beta_1 OV_{i,j,t} + \beta_2 SV_{j,t} + \beta_3 ret^O_{i,j,t} + \beta_4 ret^S_{j,t} + \beta_5 CP_{j,t} + \beta_6 IV_{i,j,t} \\ & + \beta_7 RV30_{j,t} + \beta_8 Mkt^{OV}_t + \beta_9 Mkt^S_t + \beta_{10} VIX_t + \beta_{11} Mktrf_t \\ & + \sum_{i=2}^{5} D_i + \sum_{i=2}^{3} TTE_i + \sum_{i=1}^{5} D_i \times OV_{i,j,t} + \gamma_i + \varepsilon, \end{aligned} \tag{A-6}$$

[10] With daily data and end-of-day values, the bid-ask spread response is better captured through lagged variables of the economic determinants.

where the interaction terms $\sum_{i=1}^{5} D_i \times OV_{i,j,t}$ measure the response of the bid-ask spread to options volume within each moneyness category. All results are reported in Table A-5. The negative and statistically significant coefficent on OV suggests that, on average, greater options trading volume is associated with lower percentage bid-ask spreads. However, the breakdown by moneyness, characterized through the interaction coefficients between options volume and the moneyness dummy variables, is consistent with the view that market-makers increase bid-ask spreads in response to higher options trading volume in order to protect themselves against the arrival of informed traders. This asymmetric information problem is visible in particular for DOTM and OTM options, which are the options that drive the increase in bid-ask spreads ahead of the announcements. The economic magnitudes suggest that increasing the natural logarithm of options volume from one to two increases the bid-ask spread of the average DOTM (OTM) option by three (one) percentage points, which is an economically meaningful number. In contrast, the effect is negative for ITM and DITM options, which are arguably less vulnerable to the asymmetric information problem. Part of the rise in the percentage bid-ask spread can also be ascribed to trade imbalance, given the positive and statistically significant sign on the log ratio of aggregate call-to-put trading volumes at the firm level. The average percentage bid-ask spread decreases as we move further into the money, as suggested by the negative coefficients on ATM, ITM, and DITM, which measure the percentage bid-ask spreads relative to DOTM options. Moreover, medium- and long-dated options have lower bid-ask spreads than short-dated options in the 30 pre-announcement days.

The time-series regression suggests that the bid-ask spread increases in response to both higher option implied volatility and higher realized stock volatility, the former having a much more meaningful economic impact, as the coefficient is more than six times larger in magnitude. More specifically, the coefficient suggests that the bid-ask spread, as a fraction of the mid option price, will increase by six percentage points in response to an increase in the implied volatility of one percentage point. The relationship between aggregate options volume and the percentage bid-ask spread is negative, suggesting that higher liquidity decreases transactions costs, and similarly for the VIX index, which suggests that higher market volatility decreases percentage bid-ask spreads. Higher aggregate trading volume in the stock market appears to be positively associated with the percentage bid-ask spread, but the effect is insignificant if we control for the lagged bid-ask spread. In that specification, the return on the aggregate stock market exhibits no statistical relationship with the dependent variable.

To summarize, the findings confirm the intuition that dealers increase the bid-ask spreads in response to incoming order flow in the options markets, in order to protect themselves against the arrival of informed traders. This is particularly visible for DOTM, OTM, but slightly less so for ATM options. In addition, an increase in call trading volume relative to put trading volume is associated with higher bid-ask spreads, as well as an increase in implied and realized volatility.

A-II.F The Term Structure of Implied Volatility

Informed traders can obtain the highest leverage by buying short-dated OTM call options that expire soon after the announcement date. Given this preference, demand pressure on short-dated options

should lead to a relative price increase (or a tendency to buy at the offer price) in options with a shorter time to expiration, compared to long-dated options. Thus, the slope of the term structure of implied volatility should decrease for call options written on target firms. Thus, expect to confirm the following hypothesis:

- H5: *The slope of the term structure of implied volatility decreases for options on the target firms before takeover announcements.*

Hypothesis H5 states that the term structure of implied volatility for options on the target firms should decrease before takeover announcements. The justification for this hypothesis is that informed traders obtain the highest leverage by investing in short-dated OTM call options that expire soon after the announcement, so as to maximize the "bang for their buck." Hence, demand pressure for short-dated options should lead to a relative price increase in options with a short time to expiration compared to long-dated options. Thus, a confirmation of our hypothesis would be supportive of the fact that, on average, activity in the options market before major takeover announcements is partially influenced by informed traders. Figure A-3b documents that the slope of the average term structure of implied volatility, calculated as the difference between the implied volatilities of the 3-month and 1-month options, decreases from -1.8% by about 2.5 percentage points to approximately -4.3% over the 30 days before the announcement date. This result is obtained for both call and put options. However, the term structure of implied volatility remains at approximately the same level, essentially unchanged, if we randomize the announcement dates as a control sample. In a nutshell, we find evidence in support of the fact that the term structure of implied volatility becomes more negative for targets as we approach the announcement date.

A-III Additional Tests For Acquirer Firms

According to Hypothesis H2-A, we anticipate an increase in the trading volume of option pairs that have high gammas (convexity), such as ATM straddle strategies, for example. In order to test this hypothesis, we match, on each day, all call-put pairs (CP pairs) that are written on the acquirer's stock, and that have identical strike prices and times to expiration. OptionMetrics only provides information on the total trading volume associated with a specific option, and there is no disclosure on the total number of trades. Thus, the lower of the call and put trading volumes in a CP pair represents an upper bound on the total volume of straddle trading strategies implemented on a given day. Even though this number does not accurately capture the exact straddle volume, a change in its upper bound across event times could be informative about the potential trading strategies undertaken by insiders, as a proxy. Figure A-5 illustrates how the upper bound on the volume of straddle trading strategies changes from 30 days before to 20 days after the first takeover attempt has been publicly announced. In addition, we report the average and total number of CP pairs identified on each event day. According to our hypothesis, the straddle trading volume should increase for acquirer firms prior to the announcement. The upward trend is visually confirmed in the graphical illustrations. We also conduct a more formal statistical test to investigate whether there is

a difference in means, medians and distribution of straddle trading volume across event days. The results for the two-sided t-tests are reported in Table A-6. The null hypothesis is that the straddle trading volume has the same mean in two different event windows, against the alternative that the means are different. Unreported results for differences in medians and distributions using a Wilcoxon rank sum test and a Kolmogorov-Smirnov test, respectively, yield similar conclusions. Overall, the statistical tests confirm what can be visualized in Figure A-5: there is an increase in "long-gamma" trading strategies for the acquirer firms, but not for the target firms.

We conduct three additional tests to emphasize the increase in straddle pairs and trading volume of the acquirer firms. Figures A-5e and A-5f report similar metrics for a sample of randomly drawn announcement dates. It is apparent that both the straddle pairs and trading volume fluctuate randomly, and around levels that are below those obtained in the period immediately preceding, and in particular the ten days prior to, the actual announcement, as can be seen in Figures A-5b and A-5d. In addition, while there is a steady and persistent *increase* in the straddle pairs and trading volume of the acquirer firms, there is a persistent *decrease* in straddle pairs of the target firms, while the trend is *flat* for straddle volume. These findings are visualized in Figures A-5a and A-5c, respectively, and are backed by formal statistical t-tests, which show that there is no statistically significant difference in means, medians or distribution of straddle trading volume across event windows. Third, we show that this increase in straddle trading volume is exclusively driven by ATM options. Figure A-6 reports the numbers and volumes of CP pairs separately for ATM, ITM and OTM options. The graphs for ITM and OTM options are flat at zero, indicating that we only capture straddle trading in ATM options.

We have documented that there is, on average, a greater trading volume in ATM options for acquiring companies, and that, prior to announcements, the trading volumes of strike-matched CP pairs increase. We therefore evaluate, next, whether any increase in the ATM trading volume in the pre-event window is random. For this purpose, we present a modified strongly unusual trading sample for the acquirer (SUT-A). We select all options that (1) are ATM, (2) expire on or after the announcement day (the so-called front month option), (3) have strictly positive trading volume, and (4) are traded within 30 days of the event date. Table A-7 presents the sample statistics for the SUT-A sample. From the entire dataset, we identify 5,343 option-day observations for the acquirer firms that meet our SUT-A selection criteria. The share of calls is slightly more than half, with a total of 2,860 observations. The average trading volume is 1,046 option contracts, and the average trading volumes for calls and puts are 1,257 and 803, respectively. The median trading volume for all options is 202, and the median for calls (puts) is 244 (163). We compare the statistics from the SUT-A sample with those from a randomly selected sample. For each deal, we randomly select a *pseudo-event* date and apply the SUT-A selection criteria. Panel B illustrates that, in the random sample, there are fewer ATM trades (about half as many as in the SUT-A sample). For the entire sample, the difference between the average volume (1,046) before the deal announcement, in the SUT-A sample, and the average volume (658) on a random date in the RST sample, is significantly different from zero. The one-sided t-statistic is -5.72, implying a probability of six in a billion that the trading volume observed before the announcement happened by chance.

We further verify the above results using several robustness checks. First, we plot in Figure A-7 distributional statistics of the options trading volume, defined as the number of traded contracts, and stock trading volume, defined as the number of traded shares, over event-day windows from 30 days before up to the day of the announcement. More precisely, subfigures A-7b, A-7d, and A-7f plot the average, the median, the 90th percentile and either the distribution (below the 95th percentile) or the interquartile range, of the ratios of call-to-stock volume, put-to-stock volume, and call-to-put volume, respectively, for the acquirer firms. These figures show that the call-to-stock and put-to-call volume ratios rise for targets, but that they stay flat for acquirers.

Second, we repeat the approximation to the bivariate Kolmogorov-Smirnov test for the options trading volume on acquirer firms to test whether the entire option surface distribution shifts in anticipation of takeover news releases. Table A-8 confirms that the FF-statistic, which reflects the distance between the two bivariate empirical distribution functions (EDFs), monotonically increases for acquirer firms as we get closer to the announcement date. The difference in EDFs are larger between event windows $[-29, -25]$ and $[-24, -20]$, than between $[-29, -25]$ $[-19, -15]$, and so forth. In addition, the FF-statistics increase relatively more for short-dated options, which mature closer to, but after, the announcement date. The FF test reveals statistically significant differences in the bivariate volume-moneyness distributions, as we move closer to the announcement date. We compare the distributions in event-window blocks of five days. The test is statistically significant, at the 1% level, for almost all pair-wise comparisons. In addition, the magnitude of the statistic is monotonically increasing as we move from the left to the right, and as we move from the bottom to the top of the table.

An important subtlety to emphasize is that the magnitude of the FF-statistics are similar across call and put options, while they were greater for call than for put options in the case of target firms. This suggests that the shift of the option surface is more symmetric across calls and puts for acquirer firms. In addition, the two-dimensional visualization of the shift over different event windows in Figure A-8 further confirms that the shift is symmetric around ATM options, whereas we had noted a migration towards OTM call options for target companies.

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Table A-1: Bivariate Kolmogorov-Smirnov Tests - Target

Each entry in Table A-1 represents the test statistic from a generalization of the bivariate two-sample Kolmogorov-Smirnov test based on Fasano and Franceschini (1987). The null hypothesis of the test is that two bivariate samples come from the same empirical distribution function. The bivariate distribution of trading volume is compared across different event-time windows of five consecutive days (except for the announcement window, which contains a single day, and the event window immediately preceding it, which contains only four days): The first event window stretches from $t = -29$ to $t = -25$ ($[-29, -25]$) and the last from $t = -4$ to $t = -1$ ($[-4, -1]$). We also compare every event-time window against the announcement day ($[0, 0]$). Panel A contains the results for call options and Panel B contains the results for put options. For each group, we report the results from sub-samples based on the time to expiration (TTE): less than or equal to 30 days, greater than 30 but less than or equal to 60 days, and more than 60 days. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

Panel A: Calls							**Panel B: Puts**					
Full Sample							**Full Sample**					
Event Window	$[-24,-20]$	$[-19,-15]$	$[-14,-10]$	$[-9,-5]$	$[-4,-1]$	$[0,0]$	$[-24,-20]$	$[-19,-15]$	$[-14,-10]$	$[-9,-5]$	$[-4,-1]$	$[0,0]$
$[-29,-25]$	0.0279^{***}	0.0482^{***}	0.0616^{***}	0.1007^{***}	0.1592^{***}	0.4070^{***}	0.0331^{***}	0.0414^{***}	0.0382^{***}	0.0607^{***}	0.0820^{***}	0.2760^{***}
$[-24,-20]$	.	0.0228^{***}	0.0368^{***}	0.0744^{***}	0.1334^{***}	0.3911^{***}	.	0.0209^{**}	0.0242^{***}	0.0403^{***}	0.0677^{***}	0.2657^{***}
$[-19,-15]$	.	.	0.0173^{**}	0.0556^{***}	0.1134^{***}	0.3694^{***}	.	.	0.0176^{*}	0.0301^{***}	0.0524^{***}	0.2549^{***}
$[-14,-10]$	.	.	.	0.0410^{***}	0.0988^{***}	0.3581^{***}	.	.	.	0.0295^{***}	0.0561^{***}	0.2564^{***}
$[-9,-5]$	.	.	.	.	0.0606^{***}	0.3256^{***}	.	.	.	.	0.0389^{***}	0.2351^{***}
$[-4,-1]$	.	.	.	.	.	0.2798^{***}	.	.	.	.	.	0.2132^{***}
TTE = [0,30]							**TTE = [0,30]**					
Event Window	$[-24,-20]$	$[-19,-15]$	$[-14,-10]$	$[-9,-5]$	$[-4,-1]$	$[0,0]$	$[-24,-20]$	$[-19,-15]$	$[-14,-10]$	$[-9,-5]$	$[-4,-1]$	$[0,0]$
$[-29,-25]$	0.0348	0.1255^{***}	0.2157^{***}	0.2750^{***}	0.3388^{***}	0.6102^{***}	0.0318	0.1246^{***}	0.1978^{***}	0.2886^{***}	0.3400^{***}	0.5275^{***}
$[-24,-20]$	.	0.1212^{***}	0.2121^{***}	0.2645^{***}	0.3340^{***}	0.6093^{***}	.	0.1280^{***}	0.1978^{***}	0.2893^{***}	0.3407^{***}	0.5266^{***}
$[-19,-15]$	.	.	0.0979^{***}	0.1667^{***}	0.2377^{***}	0.5105^{***}	.	.	0.1003^{***}	0.1752^{***}	0.2280^{***}	0.4149^{***}
$[-14,-10]$	.	.	.	0.0979^{***}	0.1700^{***}	0.4408^{***}	.	.	.	0.0961^{***}	0.1484^{***}	0.3397^{***}
$[-9,-5]$	.	.	.	.	0.0867^{***}	0.3607^{***}	.	.	.	.	0.0653^{***}	0.2509^{***}
$[-4,-1]$	.	.	.	.	.	0.2854^{***}	.	.	.	.	.	0.2104^{***}
TTE =]30,60]							**TTE =]30,60]**					
Event Window	$[-24,-20]$	$[-19,-15]$	$[-14,-10]$	$[-9,-5]$	$[-4,-1]$	$[0,0]$	$[-24,-20]$	$[-19,-15]$	$[-14,-10]$	$[-9,-5]$	$[-4,-1]$	$[0,0]$
$[-29,-25]$	0.0605^{***}	0.0859^{***}	0.0905^{***}	0.1341^{***}	0.1843^{***}	0.4324^{***}	0.0670^{***}	0.0975^{***}	0.0907^{***}	0.1228^{***}	0.1355^{***}	0.3370^{***}
$[-24,-20]$	.	0.0390^{**}	0.0453^{***}	0.0874^{***}	0.1421^{***}	0.3925^{***}	.	0.0465^{**}	0.0430^{*}	0.0672^{***}	0.0896^{***}	0.3047^{***}
$[-19,-15]$	.	.	0.0246	0.0628^{***}	0.1111^{***}	0.3746^{***}	.	.	0.0353	0.0484^{***}	0.0747^{***}	0.2895^{***}
$[-14,-10]$	.	.	.	0.0554^{***}	0.1050^{***}	0.3605^{***}	.	.	.	0.0619^{***}	0.0983^{***}	0.3094^{***}
$[-9,-5]$	.	.	.	.	0.0611^{***}	0.3232^{***}	.	.	.	.	0.0514^{**}	0.2729^{***}
$[-4,-1]$	.	.	.	.	.	0.2885^{***}	.	.	.	.	.	0.2361^{***}
TTE = [60,...]							**TTE = [60,...]**					
Event Window	$[-24,-20]$	$[-19,-15]$	$[-14,-10]$	$[-9,-5]$	$[-4,-1]$	$[0,0]$	$[-24,-20]$	$[-19,-15]$	$[-14,-10]$	$[-9,-5]$	$[-4,-1]$	$[0,0]$
$[-29,-25]$	0.0227^{***}	0.0323^{***}	0.0364^{***}	0.0675^{***}	0.1195^{***}	0.3897^{***}	0.0293^{***}	0.0309^{***}	0.0264^{**}	0.0371^{***}	0.0657^{***}	0.2706^{***}
$[-24,-20]$	.	0.0165^{*}	0.0210^{***}	0.0503^{***}	0.1009^{***}	0.3763^{***}	.	0.0288^{***}	0.0288^{***}	0.0337^{***}	0.0553^{***}	0.2703^{***}
$[-19,-15]$	.	.	0.0158^{*}	0.0390^{***}	0.0885^{***}	0.3623^{***}	.	.	0.0187	0.0184^{*}	0.0487^{***}	0.2525^{***}
$[-14,-10]$	.	.	.	0.0350^{***}	0.0853^{***}	0.3599^{***}	.	.	.	0.0175	0.0454^{***}	0.2534^{***}
$[-9,-5]$	.	.	.	.	0.0549^{***}	0.3324^{***}	.	.	.	.	0.0361^{***}	0.2429^{***}
$[-4,-1]$	.	.	.	.	.	0.2883^{***}	.	.	.	.	.	0.2235^{***}

Table A-2: Zero-Volume Runs

Table A-2 reports sample proportions of observations that have more than, respectively, 0, 100, 500 and 1,000 option contracts (for instance, $P(V_t > 0)$). The proportions are reported for the overall sample, and for categories stratified by depth-in-moneyness. We assign five groups for depth-in-moneyness, which is defined as S/K, the ratio of the stock price S to the strike price K. Deep out-of-the money (DOTM) corresponds to $S/K \in [0, 0.80]$ for calls ($[1.20, \infty)$ for puts), out-of-the-money (OTM) corresponds to $S/K \in (0.80, 0.95]$ for calls ($[1.05, 1.20)$ for puts), at-the-money (ATM) corresponds to $S/K \in (0.95, 1.05)$ for calls ($(0.95, 1.05)$ for puts), in-the-money (ITM) corresponds to $S/K \in [1.05, 1.20)$ for calls ($(0.80, 0.95]$ for puts), and deep in-the-money (DITM) corresponds to $S/K \in [1.20, \infty)$ for calls ($[0, 0.80]$ for puts). Panel A reports sample statistics for March 5, 2003. Panel B reports statistics for our entire sample. Panel C reports statistics for the five days preceding the actual announcement days ($t \in [-5, -1]$), as well as for the five days preceding random pseudo-event dates. Each comparison indicates the number of standard deviations difference between the random proportion and the actual proportion. Panel C also reports proportions of observations that have more than, respectively, 0, 100, 500 and 1,000 option contracts, conditional on there having been zero trading volume on the preceding day, and respectively during the five preceding days.

		DOTM	OTM	ATM	ITM	DITM	Full Sample
Panel A: March 5, 2003							
	N	28,402	17,319	12,052	17,319	28,404	103,496
$P(V_t > 0)$		0.1064	0.2718	0.3022	0.1524	0.0539	0.1502
$P(V_t \geq 100)$		0.0193	0.0641	0.0720	0.0243	0.0046	0.0297
$P(V_t \geq 500)$		0.0038	0.0172	0.0241	0.0059	0.0011	0.0080
$P(V_t \geq 1000)$		0.0021	0.0083	0.0128	0.0035	0.0004	0.0042
Panel B: Full Sample							
	N	3,411,873	1,428,467	2,380,397	1,428,286	3,412,545	12,061,568
$P(V_t > 0)$		0.1033	0.2581	0.3487	0.1584	0.0688	0.1668
$P(V_t \geq 100)$		0.0155	0.0474	0.0879	0.0220	0.0071	0.0320
$P(V_t \geq 500)$		0.0040	0.0138	0.0270	0.0062	0.0018	0.0093
$P(V_t \geq 1000)$		0.0022	0.0076	0.0144	0.0034	0.0010	0.0050
Panel C: $t \in [-5, -1]$ **- Actual vs. Random**							
	N	78,424	32,500	27,074	32,540	78,436	248,974
	N_{RS}	34,508	15,185	21,066	15,192	34,553	120,504
$P(V_t > 0)$	Actual	0.1155	0.3681	0.4265	0.2408	0.0922	0.1913
	Random	0.0982	0.2519	0.3239	0.1502	0.0695	0.1554
	# SD away	11	33	32	31	17	34
$P(V_t \geq 1000)$	Actual	0.0038	0.0165	0.0260	0.0067	0.0023	0.0078
	Random	0.0016	0.0052	0.0110	0.0024	0.0008	0.0036
	# SD away	10	19	21	11	10	24
$P(V_t > 0 \mid V_{t-1} = 0)$	Actual	0.1037	0.2734	0.2766	0.2034	0.0859	0.1521
	Random	0.0882	0.1852	0.2120	0.1260	0.0647	0.1201
	# SD away	10	28	23	29	16	34
$P(V_t \geq 1000 \mid V_{t-1} = 0)$	Actual	0.0034	0.0121	0.0163	0.0054	0.0022	0.0058
	Random	0.0016	0.0037	0.0073	0.0021	0.0008	0.0027
	# SD away	8	17	15	9	9	21
$P(V_t > 0 \mid \sum_{i=1}^{3} V_{t-i} = 0)$	Actual	0.0835	0.1499	0.1155	0.1429	0.0746	0.1006
	Random	0.0711	0.1029	0.0910	0.0892	0.0559	0.0765
	# SD away	9	19	12	23	15	31
$P(V_t \geq 1000 \mid \sum_{i=1}^{3} V_{t-i} = 0)$	Actual	0.0027	0.0067	0.0063	0.0038	0.0020	0.0035
	Random	0.0012	0.0020	0.0035	0.0018	0.0007	0.0016
	# SD away	8	13	7	6	9	16
$P(V_t > 0 \mid \sum_{i=1}^{5} V_{t-i} = 0)$	Actual	0.0676	0.0799	0.0481	0.1004	0.0650	0.0705
	Random	0.0568	0.0583	0.0371	0.0623	0.0485	0.0518
	# SD away	9	11	8	19	14	29
$P(V_t \geq 1000 \mid \sum_{i=1}^{5} V_{t-i} = 0)$	Actual	0.0021	0.0036	0.0025	0.0023	0.0017	0.0022
	Random	0.0009	0.0014	0.0015	0.0011	0.0007	0.0010
	# SD away	7	7	4	5	7	13

Table A-3: Strongly Unusual Trading (SUT) Sample and Matched Random Sample

Panel A presents sample statistics for the strongly unusual trading (SUT) sample, reflecting four selection criteria: (1) the best bid price of the day is zero, (2) non-zero volume, (3) option expiration after the announcement date, and (4) transaction within the 30 days prior to the announcement date. Panel B presents comparative statistics for a sample randomly selected from the entire dataset, where for each event we choose a pseudo-event date and then apply the same selection criteria as for the SUT sample. Both panels contain statistics for the aggregated sample, as well as separately for call and put options. We report the number of observations (Obs), the corresponding number of unique announcements (# Deals) and unique option classes (# Options), the average (Mean vol) and median (Med vol) trading volume, the percentiles of the distribution, and the minimum and maximum observations. Panel C shows results for the one- and two-sided Kolmogorov-Smirnov (KS) tests for the difference in distributions, and the one- and two-sided tests for differences in means (t-test). The statistical tests are carried out for the samples including both call and put options. *H0* denotes the null hypothesis of each test, *Statistic* denotes the test statistic type (D-distance for the KS test and t-statistic for the t-test), *Value* indicates the test$t$-statistic value, and *p-val* the p-value of the test.

Panel A: SUT selection with the historical 1,859 event dates for the target - zero bid

Target

	Obs	# Deals	# Options	Mean vol	Med vol	Min vol	1st pctile	5th pctile	25th pctile	75th pctile	95th pctile	99th pctile	Max vol
All	2,042	437	1,243	123.78	20	1	1	1	6	62	479	2,076	13,478
Calls	1,106	299	570	137.23	20	1	1	1	5	65	543	2,517	6,161
Puts	936	316	673	107.9	20	1	1	1	7.5	60	390	1,494	13,478

Panel B: One random sample of 1,859 pseudo-event dates for the target

Target

	Obs	# Deals	# Options	Mean vol	Med vol	Min vol	1st pctile	5th pctile	25th pctile	75th pctile	95th pctile	99th pctile	Max vol
All	3,412	574	1,901	57	10	1	1	1	5	32	200	813	5,000
Calls	1,813	351	941	64	11	1	1	1	5	40	232	893	5,000
Puts	1,599	387	960	49	10	1	1	1	5	30	182	759	3,000

Panel C: Tests for statistical significance between SUT and random sample with all options

Target

	KS (two-sided)	KS (one-sided)	KS (one-sided)	t-test (mean)	t-test (mean)	t-test (mean)
H0:	SUT=RS	SUT≤ RS	SUT≥ RS	SUT=RS	SUT≤ RS	SUT≥ RS
Statistic	D	D	D	t	t	t
Value	0.12	0.12	1.00	-6.90	-6.90	-6.90
p-val	2.80e-12	4.14e-17	1.00	5.99e-12	2.99e-12	1.00

Table A-4: Positive Excess Implied Volatility

Panel A in this table reports the results from a classical event study in which we test whether there was statistically significant positive excess implied volatility in anticipation of the M&A announcements. Two different models are used: excess implied volatility relative to a constant-mean-volatility model, and a market model, in which we use as the market-implied volatility the CBOE S&P 500 Volatility Index (VIX). The estimation window starts 90 days before the announcement date and runs until 30 days before it. The event window stretches from 30 days before until one day before the announcement date. Panel A reports the number (#) and frequency (freq.) of events with statistically significant positive excess implied volatility at the 5% significance level. The results are illustrated separately for the 30-day at-the-money (ATM), in-the-money (ITM) and out-of-the-money (OTM) implied volatility, defined as, respectively, 50, 80 and 20 delta (δ) options in absolute value.

Panel A

	Market Model (VIX)		Constant-Mean Model	
Option Type	Calls	Puts	Calls	Puts
30-day ATM Implied Volatility ($\|\delta\| = 50$) - Target				
Sign.t-stat 5% (#)	812	798	794	766
Sign.t-stat 5% (freq.)	0.44	0.43	0.43	0.41
30-day ITM Implied Volatility ($\|\delta\| = 80$) - Target				
Sign.t-stat 5% (#)	733	756	712	762
Sign.t-stat 5% (freq.)	0.39	0.41	0.38	0.41
30-day OTM Implied Volatility ($\|\delta\| = 20$) - Target				
Sign.t-stat 5% (#)	791	671	772	668
Sign.t-stat 5% (freq.)	0.43	0.36	0.42	0.36

Table A-5: Bid-Ask Spread Determinants

This table presents the results from a regression of the percentage bid-ask spread, BA, in the 30 pre-announcement days, on a series of option- and issuer-specific measures of trading volume, return performance, volatility and trade imbalance, controlling for the overall level of market activity in both the stock and options market. OV (OS) denotes the natural logarithm of options (stock) volume, defined as $OV = \ln(1 + Volume_O)$ ($SV = \ln(1 + Volume_S)$). The log returns of stock (option) prices is represented by ret^S (ret^O). CP denotes the natural logarithm of the ratio of aggregate call-to-put trading volume, measured at the issuer level. IV denotes the option-specific implied volatility and $RV30$ denotes the trailing 30-day realized stock volatility. The natural logarithm of the median options (stock) market volume, measured across all traded options (stocks), is given by Mkt^{OV} (Mkt^S). VIX is the CBOE Volatility Index, $Mktrf$ is the excess return on the market, calculated as the value-weighted return on all NYSE, AMEX, and NASDAQ stocks (from CRSP) minus the one-month Treasury bill rate (from Ibbotson Associates). $D1$ to $D5$ are dummy variables that take the value one if an option is DOTM, OTM, ATM, ITM, or DITM, respectively, and zero otherwise. $TT1$, $TT2$, and $TT3$ are dummy variables that take the value one if an option is short-term (less than 30 days), medium-term (between 30 and 60 days), and long-term (more than 60 days), respectively, and zero otherwise. N denotes the number of firm-quarter observations, $adj.R2$, the R-squared of the model in percentage terms. The time-series regressions contain option fixed effects. We report the within-adjusted $R2$, and we cluster at the option level to correct for serial correlation in the error terms. Source: OptionMetrics, CRSP, CBOE, Kenneth French's website.

	(1)	(2)
VARIABLES	BA_{t+1}	BA_{t+1}
BA_t		0.6786***
OV	-0.0097***	-0.0009***
OS	0.0169***	0.0028***
$DOTM \times OV$	0.0223***	0.0316***
$OTM \times OV$	-0.0038	0.0055***
$ATM \times OV$	-0.0124***	-0.0024***
$ITM \times OV$	-0.0279***	-0.0109***
$DITM \times OV$	-0.0278***	-0.0120***
CP	0.0004*	0.0006***
OTM	-0.2239***	-0.0994***
ATM	-0.2981***	-0.1327***
ITM	-0.3185***	-0.1411***
$DITM$	-0.3326***	-0.1474***
$TTE2$	-0.1457***	-0.0478***
$TTE3$	-0.2270***	-0.0757***
ret^O	-0.0911***	-0.0109***
ret^S	-0.0410***	-0.0486***
$RV30$	0.0197***	0.0031**
IV	0.1095***	0.0631***
Mkt^{OV}	-0.0110***	-0.0036***
Mkt^S	0.0070***	-0.0004
VIX	-0.0013***	-0.0009***
$Mktrf$	-0.1248***	-0.0225
Constant	0.4939***	0.2544***
	-0.0235	(0.0136)
N	868,021	868,021
Option FE	YES	YES
CLUSTER TIME	NO	NO
CLUSTER OPTION	YES	YES
adj.R2(%)	7.82	46.63

*** p<0.01, ** p<0.05, * p<0.1

Table A-6: Straddle Trading Volume - Tests

This table reports the p-values from a two-sided t-test where the null hypothesis is that the straddle trading volume has the same mean in two different event windows. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels respectively.

Panel A: Target (p-values)					
Event Window	[−30]	[−15]	[−10]	[−5]	[−1]
Mean	48.22	52.53	54.69	61.84	86.19
SD	252.52	346.72	325.76	679.57	933.11
Event Window	[−30]	[−15]	[−10]	[−5]	[−1]
[−30]	.	0.72	0.57	0.50	0.16
[−15]	.	.	0.87	0.66	0.22
[−10]	.	.	.	0.73	0.24
[−5]	.	.	.	.	0.43
Panel A: Acquirer (p-values)					
Event Window	[−30]	[−15]	[−10]	[−5]	[−1]
Mean	183.61	246.42	284.27	302.23	392.54
SD	633.13	948.24	1154.99	1035.89	1551.49
Event Window	[−30]	[−15]	[−10]	[−5]	[−1]
[−30]	.	0.15	0.04**	0.01***	0.001***
[−15]	.	.	0.5	0.29	0.03**
[−10]	.	.	.	0.76	0.14
[−5]	.	.	.	.	0.20

Table A-7: Strongly Unusual Trading (SUT) Sample and Matched Random Sample - Acquirer

Panel A presents sample statistics for the strongly unusual trading (SUT) sample, reflecting four selection criteria: (1) the option trades ATM ($S/K \in [0.95, 1.05]$), (2) there is non-zero volume, (3) the option expires after the announcement date, and (4) the transaction occurs within the 30 days prior to the announcement date. Panel B presents comparative statistics for a randomly selected sample from the entire dataset, where for each event we choose a pseudo-event date and then apply the same selection criteria as for the SUT sample. Both panels contain statistics for the aggregate sample, as well as separately for call and put options. We report the number of observations (Obs), the corresponding number of unique announcements (# Deals) and unique option classes (# Options), the average (Mean vol) and median (Med vol) trading volume, the percentiles of the distribution, and the minimum and maximum observations. Panel C shows results for the one- and two-sided Kolmogorov-Smirnov (KS) tests for the difference in distributions, and the one- and two-sided tests for differences in means (t-test). The statistical tests are carried out for the samples including both call and put options. *HO* denotes the null hypothesis of each test, *Statistic* the test statistic type (D-distance for the KS test and t-statistic for the t-test), *Value* the value of the test statistic , and *p-val* the p-value of the test. Source: OptionMetrics

Panel A: SUT selection with the historical 792 event dates for the acquirer

Acquirer

	Obs	# Deals	# Options	Mean vol	Med vol	Min vol	1st pctile	5th pctile	25th pctile	75th pctile	95th pctile	99th pctile	Max vol
All	5,343	235	1,035	1045.85	202	1	1	5	35	1,020	4,783	10,927	164,439
Calls	2,860	228	534	1257.00	244	1	1	4	38	1,276	5,465	12,110	164,439
Puts	2,483	223	501	802.65	163	1	1	5	32	774	3,858	7,939	16,486

Panel B: One random sample of 792 pseudo-event dates for the acquirer

Acquirer

	Obs	# Deals	# Options	Mean vol	Med vol	Min vol	1st pctile	5th pctile	25th pctile	75th pctile	95th pctile	99th pctile	Max vol
All	2,258	127	479	657.79	145	1	1	5	30	584	2,925	7,749	25,855
Calls	1,206	120	244	758.42	198	1	1	4	35	700	3,263	9,215	23,425
Puts	1,052	119	235	542.42	110	1	1	5	25	469	2,434	5,903	25,855

Panel C: Tests for statistical significance between SUT and random sample

Target

	KS (two-sided)	KS (one-sided)	KS (one-sided)	(t-test mean)	t-test (mean)	t-test (mean)
H0:	SUT=RS	SUT≤ RS	SUT≥ RS	SUT=RS	SUT≤ RS	SUT≥ RS
Statistic	D	D	D	t	t	t
Value	0.09	0.09	0.00	-5.72	-5.72	-5.72
p-val	2.69e-11	1.34e-11	1.00	1.12e-08	5.61e-09	1.00

Table A-8: Bivariate Kolmogorov-Smirnov Tests - Acquirer

This table reports the test statistics from a generalization of the bivariate two-sample Kolmogorov-Smirnov test based on Fasano and Franceschini (1987) . The null hypothesis of the test is that two bi-variate samples come from the same empirical distribution function. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

Panel A: Calls							
Full Sample							
Event Window	$[-29,-25]$	$[-24,-20]$	$[-19,-15]$	$[-14,-10]$	$[-9,-5]$	$[-4,-1]$	$[0,0]$
$[-29,-25]$	.	0.0098	0.0220^{***}	0.0248^{***}	0.0287^{***}	0.0499^{***}	0.1074^{***}
$[-24,-20]$	.	.	0.0207^{***}	0.0267^{***}	0.0267^{***}	0.0475^{***}	0.1051^{***}
$[-19,-15]$	.	.	.	0.0091	0.0183^{***}	0.0320^{***}	0.0880^{***}
$[-14,-10]$	.	.	.	.	0.0154^{***}	0.0291^{***}	0.0867^{***}
$[-9,-5]$	.	.	.	.	.	0.0239^{***}	0.0847^{***}
$[-4,-1]$	.	.	.	.	.	.	0.0695^{***}
$[0,0]$	.	.	.	.	.	.	.
TTE = [0,30]							
Event Window	$[-29,-25]$	$[-24,-20]$	$[-19,-15]$	$[-14,-10]$	$[-9,-5]$	$[-4,-1]$	$[0,0]$
$[-29,-25]$	.	0.0608	0.0866^{**}	0.1154^{***}	0.1259^{***}	0.1374^{***}	0.1732^{***}
$[-24,-20]$	.	.	0.0666	0.0877^{**}	0.1040^{***}	0.1100^{***}	0.1625^{***}
$[-19,-15]$	.	.	.	0.0443	0.0674^{***}	0.0742^{***}	0.1198^{***}
$[-14,-10]$	.	.	.	.	0.0370	0.0359	0.1077^{***}
$[-9,-5]$	.	.	.	.	.	0.0222	0.1077^{***}
$[-4,-1]$	.	.	.	.	.	.	0.0982^{***}
$[0,0]$	.	.	.	.	.	.	.
TTE =]30,60]							
Event Window	$[-29,-25]$	$[-24,-20]$	$[-19,-15]$	$[-14,-10]$	$[-9,-5]$	$[-4,-1]$	$[0,0]$
$[-29,-25]$	.	0.0357^{*}	0.0537^{***}	0.0535^{***}	0.0686^{***}	0.0666^{***}	0.1159^{***}
$[-24,-20]$	.	.	0.0394^{**}	0.0429^{***}	0.0462^{***}	0.0461^{***}	0.1133^{***}
$[-19,-15]$	.	.	.	0.0159	0.0289^{*}	0.0244	0.0840^{***}
$[-14,-10]$	.	.	.	.	0.0253	0.0265	0.0918^{***}
$[-9,-5]$	.	.	.	.	.	0.0345^{**}	0.0917^{***}
$[-4,-1]$	.	.	.	.	.	.	0.0779^{***}
$[0,0]$	.	.	.	.	.	.	.
TTE = [60,...]							
Event Window	$[-29,-25]$	$[-24,-20]$	$[-19,-15]$	$[-14,-10]$	$[-9,-5]$	$[-4,-1]$	$[0,0]$
$[-29,-25]$	.	0.0100	0.0140^{**}	0.0136^{**}	0.0141^{***}	0.0339^{***}	0.0897^{***}
$[-24,-20]$	.	.	0.0142^{**}	0.0133^{**}	0.0138^{***}	0.0340^{***}	0.0890^{***}
$[-19,-15]$	.	.	.	0.0103	0.0087^{***}	0.0242^{***}	0.0815^{***}
$[-14,-10]$	.	.	.	.	0.0121^{***}	0.0283^{***}	0.0839^{***}
$[-9,-5]$	.	.	.	.	.	0.0247^{***}	0.0841^{***}
$[-4,-1]$	.	.	.	.	.	.	0.0678^{***}
$[0,0]$	.	.	.	.	.	.	.
Panel B: Puts							
Full Sample							
Event Window	$[-29,-25]$	$[-24,-20]$	$[-19,-15]$	$[-14,-10]$	$[-9,-5]$	$[-4,-1]$	$[0,0]$
$[-29,-25]$	.	0.0165^{**}	0.0205^{***}	0.0232^{***}	0.0356^{***}	0.0483^{***}	0.1174^{***}
$[-24,-20]$	.	.	0.0163^{**}	0.0192^{***}	0.0293^{***}	0.0405^{***}	0.1072^{***}
$[-19,-15]$	.	.	.	0.0149^{**}	0.0238^{***}	0.0357^{***}	0.1030^{***}
$[-14,-10]$	.	.	.	.	0.0172^{***}	0.0305^{***}	0.0975^{***}
$[-9,-5]$	.	.	.	.	.	0.0218^{***}	0.0860^{***}
$[-4,-1]$	.	.	.	.	.	.	0.0726^{***}
$[0,0]$	.	.	.	.	.	.	.
TTE = [0,30]							
Event Window	$[-29,-25]$	$[-24,-20]$	$[-19,-15]$	$[-14,-10]$	$[-9,-5]$	$[-4,-1]$	$[0,0]$
$[-29,-25]$	.	0.0668	0.0739	0.0712	0.0843^{***}	0.1283^{***}	0.2036^{***}
$[-24,-20]$	.	.	0.0774	0.0640	0.0713^{***}	0.1159^{***}	0.1861^{***}
$[-19,-15]$	.	.	.	0.0393	0.0769^{***}	0.1034^{***}	0.1798^{***}
$[-14,-10]$	.	.	.	.	0.0616^{***}	0.0917^{***}	0.1547^{***}
$[-9,-5]$	.	.	.	.	.	0.0624^{***}	0.1390^{***}
$[-4,-1]$	.	.	.	.	.	.	0.0928^{***}
$[0,0]$	.	.	.	.	.	.	.
TTE =]30,60]							
Event Window	$[-29,-25]$	$[-24,-20]$	$[-19,-15]$	$[-14,-10]$	$[-9,-5]$	$[-4,-1]$	$[0,0]$
$[-29,-25]$	.	0.0331	0.0382^{*}	0.0450^{**}	0.0577^{***}	0.0663^{***}	0.1235^{***}
$[-24,-20]$	.	.	0.0460^{***}	0.0410^{**}	0.0556^{***}	0.0642^{***}	0.1294^{***}
$[-19,-15]$	.	.	.	0.0198	0.0381^{**}	0.0379^{**}	0.0972^{***}
$[-14,-10]$	.	.	.	.	0.0295	0.0350^{*}	0.1038^{***}
$[-9,-5]$	.	.	.	.	.	0.0318	0.0923^{***}
$[-4,-1]$	.	.	.	.	.	.	0.0828^{***}
$[0,0]$	.	.	.	.	.	.	.
TTE =]60,...]							
Event Window	$[-29,-25]$	$[-24,-20]$	$[-19,-15]$	$[-14,-10]$	$[-9,-5]$	$[-4,-1]$	$[0,0]$
$[-29,-25]$	.	0.0153^{*}	0.0160^{**}	0.0126	0.0182^{**}	0.0268^{***}	0.0919^{***}
$[-24,-20]$	.	.	0.0157^{**}	0.0205^{***}	0.0172^{**}	0.0224^{***}	0.0843^{***}
$[-19,-15]$	.	.	.	0.0139	0.0128	0.0166^{*}	0.0885^{***}
$[-14,-10]$	.	.	.	.	0.0155^{**}	0.0243^{***}	0.0914^{***}
$[-9,-5]$	.	.	.	.	.	0.0137	0.0839^{***}
$[-4,-1]$	.	.	.	.	.	.	0.0774^{***}
$[0,0]$	.	.	.	.	.	.	.

Table A-9: Takeover Prediction Model

This table reports the maximum likelihood estimation results from a logit regression for the prediction of takeover probability, where the dependent variable takes the value one if a takeover of a company was completed in a calendar year. *Ln_Assets* is the natural log of total assets. The industry dummy ($WAVE$) equals one if a takeover attempt occurred in the same four-digit SIC code industry in the previous calendar year. $BLOCK$ equals one if there exists at least one institutional shareholder with a minimum 5% equity stake. *Leverage* is defined as the ratio of total liabilities to total assets. Log_Volume is the natural log of the average stock trading volume in the previous calendar year. $Option1$ takes the value one if the company has option information in OptionMetrics. $DivYield2$ is a company's dividend yield. $PPENT\_ratio$ is the net total power, property and equipment scaled by total assets. *ROA* refers to return on assets, *ROE* is the return on equity and *CumRet* defines the 12-month cumulative log-return in the previous calendar year. *RE_ratio* is the ratio of retained earnings to total assets. The market-to-book ratio is denoted by Q. $MarketEquity$ is the previous year's market capitalization. *Ln_Employees* is the natural log of of the number of employees a company has, measured in thousands. EPS is the earnings per share ratio. $CAPEX\_ratio$ is the ratio of capital expenditure to total assets. All balance sheet variables are winsorized at the 99th percentile level and correspond to the calendar year preceding the takeover announcement. Each regression contains year fixed effects ($YEAR\ FE$), industry fixed effects ($INDUSTRY\ FE$), and ratings fixed effects ($RATING\ FE$), and standard errors are clustered at the firm level ($CLUSTER$). We report the number of observations (*Observations*), the log-likelihood function value (LL), the pseudo R-squared in per cent ($ps.R2$), the number of target firm-year observations ($M\&A(\#)$), the percentage of target firm-year observations ($M\&A(\%)$), and the fraction of target firm-year observations belonging to the option sample ($M\&A\ in\ sample(\%)$). ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Source: Thomson Reuters SDC Platinum, CRSP, OptionMetrics, Compustat, Thomson Reuters 13f filings.

	(1)	(2)	(3)
VARIABLES	MA2	MA2	MA2
Ln_Assets	0.15***	0.14***	0.22***
	(0.01)	(0.01)	(0.02)
WAVE	0.22***	0.22***	0.21***
	(0.03)	(0.03)	(0.04)
BLOCK	0.44***	0.43***	0.39***
	(0.03)	(0.03)	(0.04)
Leverage	-0.10***	-0.03	-0.11***
	(0.02)	(0.03)	(0.04)
Log_Volume	0.07***	0.07***	0.08***
	(0.01)	(0.01)	(0.01)
Option1	-0.78***	-0.77***	-0.70***
	(0.04)	(0.04)	(0.04)
DivYield2			-0.05***
			(0.01)
PPENT_ratio			-0.11
			(0.10)
ROA		0.19***	0.14***
		(0.04)	(0.04)
ROE		-0.02	-0.03
		(0.02)	(0.02)
CumRet			-0.00
			(0.00)
RE_ratio			0.10***
			(0.02)
Q			0.00*
			(0.00)
MarketEquity			-0.00***
			(0.00)
Ln_Employees			-0.03**
			(0.02)
EPS		-0.03***	-0.02***
		(0.01)	(0.01)
CAPEX_ratio			0.19
			(0.29)
Constant	-6.44***	-6.20***	-5.21***
	(0.70)	(0.70)	(0.97)
Observations	121,696	119,664	101,306
LL	-19,884	-19,643	-16,241
ps.R2(%)	4.35	4.46	4.70
M&A(#)	4,978	4,933	4,061
M&A(%)	4.09	4.12	4.01
M&A in sample(%)	72.83	72.46	67.78

Table A-10: News Database Categorization

Table A-10 reports the categorization of news and rumor items as reported by RavenPack News Analytics. RavenPack News Analytics extracts textual information from major publishers, such as Dow Jones Newswires, the Wall Street Journal, Barron's, regulatory and public relation feeds and over 19,000 other traditional and social media sites, and transforms it into a structured data feed that can be used in quantitative analysis. Each news source is classified as "full articles", "hot news flashes", "news flashes", "press releases", or "tabular material". We rely on the information category referred to as "acquisitions-mergers," from January 2000 to August 2012. The table shows the news type, the frequency of the source (*Freq.*), its percentage in the sample (*Percent*), and the cumulative percentages (*Cum.*). Source: RavenPack News Analytics.

News Type	Freq.	Percent	Cum.
FULL-ARTICLE	15,300	17.37	17.37
HOT-NEWS-FLASH	1,621	1.84	19.21
NEWS-FLASH	53,207	60.39	79.60
PRESS-RELEASE	17,488	19.85	99.45
TABULAR-MATERIAL	487	0.55	100.00
Total	88,103	100.00	–

Table A-11: Score Distribution of Sentiment Indicators

Table A-11 reports the mean and multiple percentiles of the distribution of two sentiment indicators published by RavenPack News Analytics. The sentiment indicators are meant to capture financial experts' views on whether there will be a short-term positive or negative, financial or economic impact. The indicators take scores between 0 and 100, a score above 50 reflecting a bullish sentiment, and one below 50 a bearish short-term view about the stock. The two indicators are constructed using slightly different methodologies, but they are meant to pick up the same type of information. RavenPack News Analytics extracts textual information from major publishers, such as Dow Jones Newswires, the Wall Street Journal, Barron's, regulatory and public relation feeds and over 19,000 other traditional and social media sites, and transforms it into a structured data feed that can be used in quantitative analysis. The time period is January 2000 to August 2012. Source: RavenPack News Analytics.

	Mean	1^{st}pctile	5^{th}pctile	25^{th}pctile	50^{th}pctile	75^{th}pctile	95^{th}pctile	99^{th}pctile
SI1	56.33	44	48	49	49	62	76	81
SI2	51.29	47	49.67	50	52	52	53	55

Table A-12: Insider Filings Table 2 Transaction Codes

This table provides a detailed description of the transactions codes used from Table 2 of the Thomson Reuters Insider Filing Data Files. Source: Thomson Reuters Insider Data Feed Manual.

1. Sale and Purchase

P: Open market or private purchase of non-derivative or derivative security.

S: Open market or private sale of non-derivative or derivative security.

2. Exercise

M: Exercise of in-the-money or at-the-money derivative security acquired pursuant to Rule 16b-3.

C: Conversion of derivative security.

O: Exercise of out-of-the-money derivative security.

X: Exercise of in-the-money or at-the-money derivative security.

3. Award

A: Grant or award transaction pursuant to Rule 16b-3(c) plan.

N: Participant-directed transactions pursuant to Rule 16b-3(d)(1) (**no longer in use as of 8-96).

T: Acquisition or disposition transaction under an employee benefit plan other than pursuant to Rule 16b-3 (**no longer in use as of 8-96).

I: Discretionary transaction in accordance with Rule 16b-3(F) resulting in an acquisition or disposition of issuer securities.

G: Bona fide gift.

W: Acquisition or disposition by will or laws of descent or distribution.

J: Other acquisition or disposition (describe transaction)

Table A-13: Insider Filings Table 2 Securities Codes

This table provides a detailed description of the securities used from Table 2 of the Thomson Reuters Insider Filing Data Files. Source: Thomson Reuters Insider Data Feed Manual

- OPTNS: Options.
- CALL: Call Option.
- PUT: Put Option.
- WT: Warrants.
- DIREO: Non-Employee Director Stock Option.
- DIRO: Director's Stock Options.
- EMPO: Employee Stock Option.
- ISO: Incentive Stock Option.
- NONQ: Non-Qualified Stock Option.
- CVP: Convertible Preferred.
- CVS: Convertible Securities.
- CVD: Convertible Debentures.
- NTS: Notes (Convertible or Otherwise).
- RGHTS: Rights.
- DEFR: Deferred Security, Award, or Compensation.

Table A-14: Legal Insider Trading

This table reports the number of shares (in units of 100) underlying derivative security trasnactions as recorded in Table 2 from the Thomson Reuters insider filings, which "contains all Table II derivative transaction and holdings information filed on Forms 3, 4, and 5. The data in this file includes open market derivative transactions as well as information on the award, exercise, and expiration of stock options." The information below excludes all records that are flagged with the cleansing codes S or A, indicating inaccuracies in the data that are impossible to validate or are missing, and we only retain information from the Form 4 filings, which document a change in an insider's ownership position. We further retain information only for the 1,859 target stocks in our sample, dropping records if they occur more than 365 days before or after the announcement date. We separately examine straight purchases and sales (transaction codes P and S), exercises (transaction codes M, C, O, and X), and awards (transaction codes A, N, T, I, G, W, and J) of different types of derivatives. A detailed description of each transaction code is provided in Table A-12. Regarding different derivative security types, we retain options, calls and puts (security titles OPTNS, CALL, and PUT), warrants (security title WT), and employee stock options (security titles DIREO, DIRO, EMPO, ISO, and NONQ), and we group derivative security types with option-embedded features, such as convertibles (security titles CVP, CVS, CVD, NTS, RGHTS, and DEFR). Source: Thomson Reuters.

Time frame	-365 to 0	-30 to -1	-5 to -1	0		-365 to 0	-30 to -1	-5 to -1	0		-365 to 0	-30 to -1	-5 to -1	0
Buy Call	114,746	-	-	-	M Call	38,772	2,890	252	1,006	O Call	-	-	-	-
Buy Put	63,084	-	-	-	M Put	-	-	-	-	O Put	-	-	-	-
Buy Options	-	-	-	-	M Options	1,462,149	205,193	162,302	6,370	O Options	-	-	-	-
Buy Warrants	64,625	-	-	-	M Warrants	14,611	-	-	-	O Warrants	-	-	-	-
Buy DIREO	-	-	-	-	M DIREO	1,294	250	-	-	O DIREO	-	-	-	-
Buy DIRO	-	-	-	-	M DIRO	6,713	1,074	250	50	O DIRO	-	-	-	-
Buy EMPO	-	-	-	-	M EMPO	-	-	-	-	O EOPO	-	-	-	-
Buy ISO	-	-	-	-	M ISO	43,470	2,968	1,880	800	O ISO	-	-	-	-
Buy NONQ	13,000	-	-	-	M NONQ	204,832	10,817	260	1,076	O NONQ	-	-	-	-
Buy CONV	29,900	-	-	-	M CONV	3,135	594	90	-	O CONV	-	-	-	-
SELL Call	20,750	-	-	-	C Call	-	-	-	-	X Call	108,466	87,543	-	-
SELL Put	35,753	-	-	-	C Put	-	-	-	-	X Put	106,066	-	-	-
SELL Options	-	-	-	-	C Options	24,253	-	-	-	X Options	61,059	-	-	-
SELL Warrants	142	27	-	-	C Warrants	10,000	-	-	-	X Warrants	232,269	38,883	-	-
SELL DIREO	-	-	-	-	C DIREO	-	-	-	-	X DIREO	-	-	-	-
SELL DIRO	-	-	-	-	C DIRO	-	-	-	-	X DIRO	-	-	-	-
SELL EMPO	-	-	-	-	C ECPO	-	-	-	-	X EMPO	-	-	-	-
SELL ISO	800	-	-	-	C ISO	212	-	-	-	X ISO	917	-	-	-
SELL NONQ	147	-	-	-	C NONQ	453	90	90	-	X NONQ	5,409	-	-	-
SELL CONV	19,154	1,261	1,261	-	C CONV	3,183,126	29	29	-	X CONV	154	-	-	-
A Call	-	-	-	-	W Call	-	-	-	-	N Call	-	-	-	-
A Put	-	-	-	-	W Put	-	-	-	-	N Put	-	-	-	-
A Options	-	-	-	-	W Options	-	-	-	-	N Options	127	-	-	-
A Warrants	-	-	-	-	W Warrants	-	-	-	-	N Warrants	-	-	-	-
A DIREO	-	-	-	-	W DIREO	-	-	-	-	N DIREO	-	-	-	-
A DIRO	-	-	-	-	W DIRO	-	-	-	-	N DIRO	-	-	-	-
A EAPO	-	-	-	-	W EAPO	-	-	-	-	N EBPO	-	-	-	-
A ISO	-	-	-	-	W ISO	-	-	-	-	N ISO	-	-	-	-
A NONQ	-	-	-	-	W NONQ	-	-	-	-	N NONQ	-	-	-	-
A CONV	-	-	-	-	W CONV	-	-	-	-	N CONV	-	-	-	-
T Call	-	-	-	-	I Call	-	-	-	-	G Call	-	-	-	-
T Put	-	-	-	-	I Put	-	-	-	-	G Put	-	-	-	-
T Options	-	-	-	-	I Options	97	-	-	-	G Options	804	336	-	-
T Warrants	-	-	-	-	I Warrants	-	-	-	-	G Warrants	-	-	-	-
T DIREO	-	-	-	-	I DIREO	-	-	-	-	G DIREO	200	-	-	-
T DIRO	-	-	-	-	I DIRO	-	-	-	-	G DIRO	-	-	-	-
T EAPO	-	-	-	-	I EAPO	-	-	-	-	G EAPO	-	-	-	-
T ISO	-	-	-	-	I ISO	-	-	-	-	G ISO	-	-	-	-
T NONQ	-	-	-	-	I NONQ	-	-	-	-	G NONQ	-	-	-	-
T CONV	-	-	-	-	I CONV	38	-	-	-	G CONV	-	-	-	-

Table A-15: Positive Abnormal Trading in Stocks

Panel A reports the number (#) and frequency (freq.) of deals with statistically significant positive cumulative abnormal volumes and returns, respectively, at the 5% significance level, as well as the average cumulative abnormal volume and returns ($E[CAV]$) and corresponding t-statistic ($t_{C\bar{A}V}$), computed using heteroscedasticity-robust standard errors. We report our results using five different models for abnormal volumes and abnormal returns. The constant-mean-model incorporates a simple constant, the market model for options controls for the mean or the median of the total daily trading volume across all stocks, while the market model for stocks controls for the excess return on the market, calculated as the value-weighted return on all NYSE, AMEX, and NASDAQ stocks (from CRSP) minus the one-month Treasury bill rate (from Ibbotson Associates). In addition, we use two more conservative models for stock returns and volumes. For volumes, the MMV model accounts for the median market volume in stocks, the market return of stocks, and the small minus big (SMB) and high minus low (HML) risk factors. The MMV-L model augments the MMV model with lagged values of the dependent and all independent variables. For stock returns, we use the Fama-French 3-Factor (FF3F) model that controls for the market return, SMB and HML. In addition, we use an augmented model (CAR), which additionally controls for the Carhart momentum factor (MOM). Finally, we use a model for normal returns (CAR-L), which augments the CAR model with lagged values of the dependent and all independent variables. The estimation window starts 90 days before the announcement date and runs until 30 days before the announcement date. The event window stretches from 30 days before until one day before the announcement date. Source: Thomson Reuters SDC Platinum, CRSP, OptionMetrics, Compustat, Kenneth French's website.

Panel A	Constant Mean	Market (Mean)	Market (Median)	MMV	MMV-L	Constant Mean	MKT	FF3F	CAR	CAR-L
	Log Volume - Target					**Returns - Target**				
Sign.t-stat 5% (#)	609	559	559	592	448	147	131	123	126	135
Sign.t-stat 5% (freq.)	0.33	0.30	0.30	0.32	0.24	0.08	0.07	0.07	0.07	0.07
$E[CAV]$	2.21	1.40	1.64	1.91	1.64	0.07	0.07	0.06	0.06	0.06
$t_{C\bar{A}V}$	7.56	4.96	5.83	6.25	7.20	9.47	10.70	10.35	10.49	9.80

Table A-16: List of SEC-litigated Cases

Table A-16 summarizes the information about unusual options trades ahead of M&A announcements that have had litigations conducted in relation to them by the Securities and Exchange Commission (SEC). All information is hand-collected from the SEC litigation reports, which are publicly available on the SEC's web site, and complemented with information from the Public Access to Court Electronic Records (PACER), available through the U.S. Department of Justice (DoJ). We only summarize cases that involve options trades and M&A announcements. A $*$ in front of the entry in the first column indicates that the M&A is a cash-financed deal. If the transaction is stock-financed, the first column is preceded by a # sign. In addition, the numbers preceding the entries in the first column indicate whether the insider trading involved only options (1), or both options and stocks (2). *Acquirer* and *Target* indicate the acquirer's and target's company name, respectively. The column *Ann.Date* indicates the date of the M&A announcement as reported by the Thomson Reuters SDC Platinum database. The remaining pieces of information in the table are the final takeover/merger price (*Offer Pr.*), the deal value in the transaction (*Deal Val.*), the stock price on the day of the options trade (*Stock Pr.*), the option purchase date (*Op. Date*), the number of option contracts (*Options*), the expiration month of the option (*Exp.*), the strike price of the option (*Strike*), the option depth, defined as the ratio of the stock price to the strike price (*S/K*), the option type, which can be either a call or a put (*Type*), the total value of illicit profits reaped through the insider trade (*Tot. Illicit Prof.*), and the monetary fine imposed in the litigation (*Fine*). Source: https://www.sec.gov/litigation/litreleases.shtml, SEC, DoJ, PACER, CRSP, Thomson Reuters SDC Platinum.

Acquirer	Target	Ann.Date	Offer Pr.	Deal Val.	Stock Pr.	Op. Date	Options	Exp.	Strike	S/K	Type	Illicit Prof.	Fine
* 1 Seagate	Xyratex	12/23/13	$13.25	$367,206,000	$10.38	12/17/13	943				C	$104,382	Unresolved
Dealertrack	dealer.com	12/19/13		$993,665,000	$41.75	12/05/13	1,062				C	$106,031	Unresolved
* 1 Otsuka	Astex	09/05/13	$8.50	$886,863,000	$5.80	08/26/13	890				C	$61,448	Unresolved
* 1 Amgen	Onyx	06/30/13	$120.00	$9,700,000,000	$84.17	06/26/13	80	Jul	$80.00	1.05	C	$4,600,000	Unresolved
	Pharmaceuticals				$84.17	06/26/13	175	Jul	$85.00	0.99	C		
					$85.20	06/27/13	544	Jul	$85.00	1.00	C		
					$86.82	06/28/13	50	Jul	$90.00	0.96	C		
					$86.82	06/28/13	270	Jul	$92.50	0.94	C		
* 2 Shuanghui	Smithfield Foods	05/29/13	$34.00	$4,700,000,000	$25.79	05/21/13	1,300	Jul	$29.00	0.89	C	$3,200,000	$5,200,000
					$25.97	05/21/13	1,700	Jul	$29.00	0.90	C		
# 2 Office Depot	OfficeMax	02/18/13	$13.50	$181,660,000	$10.78	01/31/13	400	Feb	$11.00	0.98	C	$573,332	Unresolved
					$10.78	01/31/13	1,610				C		
* 1 Berkshire Hath. 3G Capital Partners	H.J.Heinz Company	02/14/13	$72.50	$28,000,000,000	$60.48	02/13/13	2,533	Jun	$65.00	0.93	C	$1,809,857	$4,809,857
* 1 Gilead Sciences	YM Biosciences	12/12/12	$2.95	$510,000,000	$1.55	11/21/12	327				C	$9,621	Unresolved
Chicago Bridge & Iron Co.	The Shaw Group	07/30/12	$46.00	$3,000,000,000		07/06/12	180	Jul			C	$9,384,614	$1,064,869
					$25.75	07/20/12	1,146	Aug			C		
					$48.82	07/06/12	1,600	Jul			C		
					$48.82	07/06/12	600	Aug			C		
					$26.00	07/13/12	10	Sep			C		
					$48.82	07/06/12		Aug			C		
					$28.39	07/09/12	851	Aug			C		
					$28.39	07/09/12	200				C		
					$28.39	07/09/12	30	Jul	$30.00	0.95	C		
					$28.39	07/09/12	50	Jul	$31.00	0.92	C		
					$28.39	07/09/12	10	Jul	$33.00	0.86	C		
					$28.39	07/09/12	72	Aug	$30.00	0.95	C		
					$28.39	07/09/12	139	Aug	$29.00	0.98	C		
					$28.39	07/09/12	10	Aug	$28.00	1.01	C		
					$28.39	07/09/12	100	Aug	$31.00	0.92	C		
					$26.00	07/18/12	11	Aug	$28.00	0.93	C		

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Table A-16 – *Continued from previous page*

Acquirer	Target	Ann.Date	Offer Pr.	Deal Val.	Stock Pr.	Op. Date	Options	Exp.	Strike	S/K	Type	Illicit Prof.	Fine
					$26.05	07/19/12	40	Aug	$29.00	0.90	C		
					$25.75	07/20/12	30	Aug	$29.00	0.89	C		
					$25.77	07/23/12	137	Aug	$30.00	0.86	C		
					$25.77	07/23/12	50	Aug	$31.00	0.83	C		
					$28.39	07/09/12	50	Aug	$30.00	0.95	C		
					$25.78	07/10/12	70	Aug	$30.00	0.86	C		
					$26.05	07/19/12	90	Aug	$29.00	0.90	C		
					$25.77	07/23/12	50	Aug	$29.00	0.89	C		
					$25.77	07/23/12	100	Aug	$30.00	0.86	C		
					$25.30	07/11/12	200	Aug	$30.00	0.84	C		
					$26.10	07/16/12	300	Aug	$30.00	0.87	C		
					$25.12	07/24/12	150	Aug	$27.00	0.93	C		
					$26.33	07/17/12	15	Aug	$27.00	0.98	C		
					$26.00	07/13/12	20	Oct	$26.00	1.00	C		
					$26.00	07/13/12	15	Aug	$27.00	0.96	C		
					$26.05	07/19/12	20	Aug	$27.00	0.96	C		
* [1] Bristol-Myers-Squibb	Amylin Pharmaceuticals	06/29/12	$31.00	$5,300,000,000	$25.80	05/24/12	-100	Jul	$21.00	1.23	P	$55,784	$324,422.00
					$25.80	05/24/12	-100	Jul	$20.00	1.29	P		
					$28.21	05/29/12	-100	Jul	$22.00	1.28	P		
					$27.33	06/11/12	-200	Jul	$22.00	1.24	P		
					$27.81	06/18/12	-210	Jul	$25.00	1.11	P		
					$27.90	06/26/12	30	Jul	$30.00	0.93	C		
					$28.04	06/27/12	50	Jul	$28.00	1.00	C		
					$28.20	06/29/12	50	Jul	$29.00	0.97	C		
* [2] Wolverine World Wide	Collective Brands	05/01/12	$21.75	$2,000,000,000	$19.32	04/16/12	500	May	$20.00	0.97	C	$360,775	Unresolved
					$19.32	04/16/12	60	May	$20.00	0.97	C		
					$19.32	04/16/12	700	May	$20.00	0.97	C		
					$19.42	04/17/12	1,584				C		
					$19.42	04/17/12	-50				P		
* [2] Zhongpin's management	Zhongpin	03/27/12	$13.50	$503,000,000	$8.36	03/14/12	307	Apr	$10.00	0.84	C	$8,710,761	$272,993
					$8.36	03/14/12	1,493	Apr	$10.00	0.84	C		
					$8.36	03/14/12	178	Jun	$10.00	0.84	C		
					$8.36	03/15/12	400	Apr	$7.50	1.11	C		
					$8.36	03/15/12	500	Jun	$7.50	1.11	C		
					$8.36	03/14/12	4,035				C		
					$8.36	03/14/12	306				C		
					$8.36	03/14/12	257				C		
					$8.36	03/14/12	169				C		
* [2] UnionBanCal Corporation	Pacific Capital	03/09/12	$46.00	$1,500,000,000	$28.99	02/08/12	120				C	$365,000	$1,905,893
* [1] Oracle	Taleo	02/09/12	$46.00	$1,908,820,000	$38.25	02/03/12					C	$450,000	Unresolved
					$38.41	02/06/12					C		
					$38.94	02/08/12					C		
* [1] Gilead Sciences	Pharmasset	11/21/11	$137.00	$11,000,000,000	$69.07	11/08/11	10	Dec	$85.00	0.81	C	$225,026	$324,422
					$69.07	11/08/11	19	Feb	$100.00	0.69	C		
					$72.83	11/17/11	10	Dec	$90.00	0.81	C		
					$72.83	11/17/11	20	Dec	$100.00	0.73	C		
Superior Energy Services	Complete Product Services	10/10/11	$32.90	$2,700,000,000	$20.51	09/29/11	33,000	Oct	$27.50	0.75	C	$40,575	Unresolved
					$20.51	09/29/11	3,500	Nov	$22.50	0.91	C		
* [2] Omnicare	PharMerica	08/22/11	$15.00	$440,796,000	$13.36	06/21/11		Dec	$15.00	0.89	P	$1,517,092	Unresolved
					$12.65	06/22/11		Dec	$15.00	0.84	P		
					$13.11	06/23/11		Dec	$15.00	0.87	P		

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Table A-16 – *Continued from previous page*

Acquirer	Target	Ann.Date	Offer Pr.	Deal Val.	Stock Pr.	Op. Date	Options	Exp.	Strike	S/K	Type	Illicit Prof.	Fine
					$13.11	06/23/11		Mar	$17.50	0.75	P		
					$13.36	06/21/11	1,511				C		
* [2] Silver Lake	SMART Modular	04/26/11	$9.25	$645,000,000	$7.05	02/02/11	-100	Apr	$7.50	0.94	P	$1,575,382	Unresolved
					$6.89	02/03/11	-100	Apr	$7.50	0.92	P		
					$6.89	02/03/11	-300	Apr	$7.50	0.92	P		
					$6.89			Oct	$7.50	0.92	P		
					$6.89			Apr	$7.50	0.92	C		
Samsung	Seagate	04/19/11		$1,494,570,000	$13.19	03/18/11	10				C	$1,201	Unresolved
					$14.28	03/29/11	50				C		
					$14.59	04/04/11	5				C		
* [2] Ebay	GSI Commerce	03/28/11	$29.25	$2,404,740,000	$19.38	03/25/11	3,500	Apr	$19.00	1.02	C	$751,416	$460,266
					$19.38	03/25/11		Jul			C		
Kirby Corporation	K-Sea	03/13/11	$8.15	$604,000,000		10/25/10	205	Sep			C	$1,716,000	$451,067
	Transportation					10/25/10	2	Jun			C		
	Partners				$4.03	11/01/10	100	Mar			C		
					$5.33	02/11/11	200	Sep			C		
					$5.64	02/14/11	94	Jun			C		
						12/29/10	50	Feb			C		
Rock-Tenn Company	Smurfit-Stone	01/23/11	$35.00	$3,500,000,000	$27.90	01/19/11	810				C	$1,488,000	$451,067
	Container Corp.				$27.90	01/19/11	50	May			C		
					$27.90	01/19/11	371	Feb			C		
* [1] DSM N.V.	Martek	12/21/10	$31.50	$1,100,000,000	$22.49	12/10/10	648	Jan	$25.00	0.90	C	$1,200,000	$1,445,700
					$22.49	12/10/10	1,193	Mar	$25.00	0.90	C		
					$22.49	12/10/10	774	Jun	$30.00	0.75	C		
* [2] Pfizer	King Pharma.	10/12/10	$14.25	$3,566,079,000	$10.20	08/18/10	300				C	$452,915	Unresolved
						08/19/10	300				C		
						08/23/10	75				C		
* [1] Bain Capital	Gymboree	10/11/10	$65.40	$1,800,000,000	$42.88	09/28/10	10				C	$4,417	Unresolved
Southwest Airlines	AirTran	09/27/10	$7.69	$1,400,000,000	$4.39	09/22/10	200	Jan			C	$159,160	$327,707
* [1] Bristol-Myers-	ZymoGenetics	09/07/10	$9.75	$885,000,000	$5.04	08/25/10	45	Oct	$5.00	1.01	C	$30,551	$324,422
Squibb					$5.51	09/03/10	35	Feb	$5.00	1.10	C		
* [2] 3G Capital	Burger King	09/02/10	$24.00	$4,000,000,000	$20.07	05/17/10	300	Jul	$20.00	1.00	C	$1,680,000	$5,634,232
					$19.85	05/18/10	2,850	Jul	$22.50	0.88	C		
					$19.36	06/02/10	2,000	Jul	$20.00	0.97	C		
					$16.72	08/19/10	1,400	Oct	$17.50	0.96	C		
					$17.51	08/25/10	100	Jan	$20.00	0.88	C		
					$17.05	08/26/10	1,794	Oct	$19.00	0.90	C		
* [1] BHP Billiton	Potash Corp.	08/17/10	$130.00	$38,600,000,000	$112.04	08/12/10	31	Aug	$110.00	1.02	C	$1,073,000	Unresolved
					$112.04	08/12/10	50	Aug	$115.00	0.97	C		
					$112.04	08/12/10	95	Aug	$120.00	0.93	C		
					$112.04	08/12/10	22	Aug	$125.00	0.90	C		
					$112.04	08/12/10	32	Aug	$130.00	0.86	C		
					$111.34	08/13/10	5	Aug	$115.00	0.97	C		
					$111.34	08/13/10	12	Aug	$120.00	0.93	C		
					$110.57	08/16/10	50	Aug	$110.00	1.01	C		
					$110.57	08/16/10	5	Sep	$110.00	1.01	C		
					$110.57	08/16/10	5	Sep	$115.00	0.96	C		
					$110.57	08/16/10	5	Sep	$120.00	0.92	C		
					$112.04	08/12/10	331	Sep	$125.00	0.90	C		
* [2] GENCO	ATC Technology	07/19/10	$25.00	$512,600,000	$13.82	03/26/10	58	Aug			C	$579,400	$451,067
Distribution						04/08/10	185	May			C		

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Acquirer	Target	Ann.Date	Offer Pr.	Deal Val.	Stock Pr.	Op. Date	Options	Exp.	Strike	S/K	Type	Illicit Prof.	Fine
Systems						04/08/10	185	Jun			C		
* [2] Covidien	Somanetics	06/16/10	$25.00	$250,000,000	$17.75	06/10/10	72	Jun	$17.50	1.01	C	$553,000	Unresolved
					$17.75	06/10/10	200	Jun	$20.00	0.89	C		
					$18.67	06/11/10	110	Jun	$17.50	1.07	C		
					$18.67	06/11/10	473	Jun	$20.00	0.93	C		
					$18.72	06/14/10	288	Jun	$20.00	0.94	C		
					$18.90	06/15/10	19	Jun	$20.00	0.95	C		
Grifols S.A.	Talecris Biotherapeutics	06/07/10	$27.22	$3,559,930,000	$16.13	05/26/10	20	Jun	$17.50	0.92	C	$7,700	$153,411
* [1] Gentiva Health Services	Odyssey Healthcare	05/24/10	$27.00	$895,526,000	$21.11	05/19/10	50	Jun	$22.50	0.94	C	$50,400	$342,286
					$21.11	05/19/10	50	Jun	$22.50	0.94	C		
					$19.29	05/21/10	50	Jun	$22.50	0.86	C		
* [1] CGI Group	Stanley Inc.	05/07/10	$37.50	$940,050,000	$23.47	05/03/10	10	May	$30.00	0.78	C	$4,300	$153,411
* [2] The Thomas H. Lee Partners	inVentiv Health	05/06/10	$26.00	$1,128,140,000	$24.25	05/05/10	10	May	$22.50	1.08	C	$2,960	$342,286
					$24.25	05/06/10	200	May	$25.00	0.97	C		
					$23.47	05/03/10	50	May	$25.00	0.94	C		
					$24.25	05/06/10	150	May	$25.00	0.97	C		
The GEO Group	Cornell Companies	04/19/10	$24.96	$685,000,000	$18.61	04/14/10	10	May	$20.00	0.93	C	$15,400	$342,286
					$18.58	04/15/10	40	May	$20.00	0.93	C		
Apache	Mariner	04/15/10	$26.22	$3,916,290,000	$17.55	04/12/10	1,488				C	$5,137,721	$9,524,110
					$17.65	04/13/10	2,512				C		
					$17.65	04/13/10	200				C		
					$18.09	04/14/10	1,000				C		
					$18.09	04/14/10	200				C		
* [2] Cerberus Capital Management	DynCorp	04/12/10	$17.55	$1,500,000,000	$11.87	03/17/10	10	Apr	$12.50	0.95	C	$34,776	$342,286
					$11.69	03/25/10	30	Apr	$12.50	0.94	C		
					$11.45	03/29/10	30	May	$12.50	0.92	C		
* [2] **CONSOL Energy Inc**	Dominion Resources	03/15/10		$3,740,000,000	$53.68	03/10/10	140	Apr	$55.00	0.98	P	$64,425	$64,425
* [2] Abbot Labs.	Facet Bitoech	03/09/10	$27.00	$718,760,000	$16.51	03/08/10	10	Mar	$17.50	0.94	C	$23,083	$342,286
					$16.51	03/08/10	10	Apr	$17.50	0.94	C		$-
Tyco International	Brink's Home Security	01/18/10	$42.50	$2,000,000,000	$31.42	01/14/10	100	Feb	$35.00	0.90	C	$862,376	Unresolved
					$31.42	01/14/10	30	Jun	$30.00	1.05	C		
					$32.64	12/31/09	-160	Mar	$30.00	1.09	P		
					$32.64	12/31/09		Mar	$35.00	0.93	C		
					$32.64	12/31/09		Feb	$35.00	0.93	C		
* [2] Shiseido	Bare Escentuals	01/14/10	$18.20	$1,700,000,000	$12.74	01/14/10	280				C	$157,066	Unresolved
* [2] Sanofi-Aventis	Chattem	12/21/09	$93.50	$1,900,000,000	$67.80	12/07/09	1,900	Jan	$75.00	0.90	C	$4,296,500	Unresolved
					$68.69	12/17/09	940	Jan	$80.00	0.86	C		
# [2] Exxon Mobil	XTO Energy	12/14/09	$51.86	$30,000,000,000	$41.49	12/11/09	200	Dec	$40.00	1.04	C	$573,515	Unresolved
					$41.49	12/11/09	1,000	Dec	$45.00	0.92	C		
* [2] Dell	Perot Systems	09/21/09	$30.00	$3,900,000,000	$16.66	09/04/09	9,332	Oct			C	$8,600,000	Unresolved
Dainippon Sumitomo Pharma	Sepracor	09/03/09	$23.00	$2,600,000,000	$13.26	05/01/09					C	$1,758,000	$1,014,849
					$13.26	05/01/09					P		
					$15.05	05/27/09	50	Oct	$15.00	1.00	C		
					$15.29	05/28/09	100	Jul	$17.50	0.87	C		
					$15.29	05/28/09	100	Oct	$17.50	0.87	C		
					$15.29	05/28/09	100	Jan	$15.00	1.02	C		
					$15.65	05/29/09	200	Oct	$17.50	0.89	C		
					$16.05	06/03/09	200	Oct	$17.50	0.92	C		
					$16.39	06/05/09	500	Jul	$17.50	0.94	C		

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Table A-16 – *Continued from previous page*

Acquirer	Target	Ann.Date	Offer Pr.	Deal Val.	Stock Pr.	Op. Date	Options	Exp.	Strike	S/K	Type	Illicit Prof.	Fine
					$16.39	06/05/09	150	Oct	$15.00	1.09	C		
					$15.59	07/22/09	100	Oct	$15.00	1.04	C		
					$15.59	07/22/09	200	Oct	$17.50	0.89	C		
					$15.05	05/27/09	-250	Oct	$15.00	1.00	P		
					$15.05	05/27/09	-100	Jan	$15.00	1.00	P		
					$15.05	05/27/09	50	Oct	$15.00	1.00	C		
					$15.29	05/28/09	100	Oct	$17.50	0.87	C		
					$15.29	05/28/09	100	Jan	$15.00	1.02	C		
					$15.65	05/29/09	240	Oct	$17.50	0.89	C		
					$15.90	06/01/09	60	Oct	$17.50	0.91	C		
					$16.24	06/04/09	50	Oct	$17.50	0.93	C		
					$15.59	07/22/09	200	Oct	$17.50	0.89	C		
					$15.07	05/27/09	-50	Oct	$15.00	1.00	P		
					$15.29	05/28/09	-100	Jan	$15.00	1.02	P		
Walt Disney Company	Marvel Entertainment	08/31/09	$50.00	$4,000,000,000	$39.01	08/13/09	125	Sep	$50.00	0.78	C	$193,840	$800,985
					$38.73	08/14/09	2	Sep	$45.00	0.86	C		
					$37.76	08/17/09	60	Sep	$45.00	0.84	C		
					$38.61	08/26/09	75	Sep	$45.00	0.86	C		
					$38.24	08/27/09	200	Sep	$45.00	0.85	C		
					$38.65	08/28/09	185	Sep	$45.00	0.86	C		
					$38.65	08/28/09	9	Sep	$40.00	0.97	C		
					$38.65	08/28/09	3	Dec	$40.00	0.97	C		
* [2] IBM	SPSS	07/28/09	$50.00	$1,200,000,000	$32.71	06/25/09	50	Sep	$40.00	0.82	C	$685,572	$924,758
					$32.71	06/25/09	20	Jul	$35.00	0.93	C		
					$32.71	06/25/09	20	Jul	$35.00	0.93	C		
					$33.20	06/26/09	20	Jul	$35.00	0.95	C		
					$32.73	07/02/09	25	Sep	$40.00	0.82	C		
					$32.73	07/02/09	25	Aug	$40.00	0.82	C		
					$32.54	07/06/09	50	Sep	$40.00	0.81	C		
					$32.54	07/06/09	75	Sep	$40.00	0.81	C		
					$30.70	07/08/09	100	Sep	$35.00	0.88	C		
					$30.92	07/09/09	25	Sep	$35.00	0.88	C		
					$30.92	07/09/09	75	Sep	$40.00	0.77	C		
					$31.03	07/10/09	25	Sep	$35.00	0.89	C		
					$31.63	07/13/09	50	Sep	$40.00	0.79	C		
					$31.73	07/14/09	25	Sep	$35.00	0.91	C		
					$31.73	07/14/09	50	Sep	$40.00	0.79	C		
					$34.09	07/21/09	20	Sep	$40.00	0.85	C		
					$34.09	07/21/09	10	Sep	$40.00	0.85	C		
					$34.38	07/22/09	29	Sep	$35.00	0.98	C		
					$34.38	07/22/09	50	Sep	$40.00	0.86	C		
					$34.38	07/22/09	100	Aug	$40.00	0.86	C		
					$34.38	07/22/09	30	Aug	$40.00	0.86	C		
					$34.38	07/22/09	100	Sep	$40.00	0.86	C		
					$35.10	07/24/09	20	Sep	$40.00	0.88	C		
					$35.09	07/27/09	100	Aug	$40.00	0.88	C		
					$34.02	06/04/09	300	Jul	$35.00	0.97	C		
					$34.02	06/04/09	300	Jul	$40.00	0.85	C		
					$32.14	06/24/09	500	Sep	$40.00	0.80	C		
					$32.14	07/09/09	-100	Sep	$30.00	1.07	P		
The Middleby Corporation	TurboChef Technologies	08/12/08	$6.47	$200,000,000	$4.62	07/01/08	200	Jan	$5.00	0.92	C	$68,000	$10,000
					$4.29	07/10/08	100	Oct	$5.00	0.86	C		

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Acquirer	Target	Ann.Date	Offer Pr.	Deal Val.	Stock Pr.	Op. Date	Options	Exp.	Strike	S/K	Type	Illicit Prof.	Fine
					$4.29	07/10/08	100	Jan	$5.00	0.86	C		
					$4.60	07/22/08	200	Aug	$5.00	0.92	C		
					$5.25	07/30/08	500	Aug	$5.00	1.05	C		
					$5.25	07/30/08	300	Oct	$5.00	1.05	C		
					$5.26	08/01/08	200	Aug	$5.00	1.05	C		
* [2] Dow	Rohm & Hass	07/10/08	$78.00	$16,300,000,000	$78.94	07/09/08	200	Aug	$50.00	1.58	C	$641,572	$1,359,179
					$78.94	07/09/08	210	Jan	$50.00	1.58	C		
					$78.94	07/09/08	20	Aug	$50.00	1.58	C		
					$78.94	07/09/08	10	Jan	$50.00	1.58	C		
* [2] Finmeccanica	DRS	05/08/08	$81.00	$5,200,000,000	$61.70	04/29/08	550	Jun	$65.00	0.95	C	$3,799,268	$8,805,683
					$64.72	05/05/08	170	Jun	$70.00	0.92	C		
					$63.07	05/06/08	170	Jun	$70.00	0.90	C		
					$63.74	05/07/08	800	Jun	$65.00	0.98	C		
						05/07/08	130	Jun	$65.00	0.00	C		
					$58.29	04/15/08	100	Jun	$65.00	0.90	C		
					$61.70	04/29/08	250	Jun	$65.00	0.95	C		
					$64.72	05/02/08	76	May	$70.00	0.92	C		
					$64.72	05/02/08	200	Jun	$70.00	0.92	C		
					$63.07	05/06/08	1,421	May	$65.00	0.97	C		
					$63.07	05/06/08	310	Jun	$65.00	0.97	C		
					$63.74	05/07/08	100	May	$70.00	0.91	C		
					$63.74	05/07/08	659	May	$65.00	0.98	C		
* [2] Liberty Mutual Insurance	Safeco Corp.	04/23/08	$68.50	$6,200,000,000	$45.00	04/15/08	22	Apr	$50.00	0.90	C	$886,310	$2,953,997
					$46.17	04/17/08	105	May	$55.00	0.84	C		
					$46.17	04/17/08	50	May	$50.00	0.92	C		
					$46.17	04/17/08	3	May	$55.00	0.84	C		
					$46.49	04/18/08	250	May	$50.00	0.93	C		
					$45.61	04/21/08	20	May	$50.00	0.91	C		
					$45.23	04/22/08	50	May	$50.00	0.90	C		
					$45.23	04/22/08	5	May	$45.00	1.01	C		
					$45.23	04/22/08	100	May	$50.00	0.90	C		
* [2] Takeda Pharmaceutical	Millennium Pharmaceuticals	04/10/08	$25.00	$8,800,000,000	$13.75	03/04/08	100	Apr	$15.00	0.92	C	$1,871,166	$2,260,926
					$13.75	03/04/08	100	May	$17.50	0.79	C		
					$13.40	03/05/08	100	Apr	$17.50	0.77	C		
					$13.08	03/07/08	250	May	$17.50	0.75	C		
					$13.32	03/11/08	100	May	$15.00	0.89	C		
					$14.11	03/03/08	10	Apr	$15.00	0.94	C		
					$13.40	03/05/08	10	May	$15.00	0.89	C		
					$12.82	03/10/08	5	Apr	$15.00	0.85	C		
					$12.82	03/10/08	5	May	$15.00	0.85	C		
					$15.06	03/26/08	5	May	$17.50	0.86	C		
					$13.99	02/29/08	65	Apr	$17.50	0.80	C		
					$14.11	03/03/08	500	Apr	$17.50	0.81	C		
					$13.40	03/05/08	200	May	$20.00	0.67	C		
					$13.48	03/06/08	25	May	$20.00	0.67	C		
					$14.46	03/24/08	200	May	$20.00	0.72	C		
					$15.86	04/02/08	100	May	$20.00	0.79	C		
					$13.99	02/29/08	125	May	$17.50	0.80	C		
					$13.99	02/29/08	75	May	$15.00	0.93	C		
					$14.11	03/03/08	1,100	May	$20.00	0.71	C		
					$13.40	03/05/08	751	May	$20.00	0.67	C		
					$13.48	03/06/08	300	May	$20.00	0.67	C		

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Acquirer	Target	Ann.Date	Offer Pr.	Deal Val.	Stock Pr.	Op. Date	Options	Exp.	Strike	S/K	Type	Illicit Prof.	Fine
					$13.99	02/29/08	-270	Jan	$10.00	1.40	P		
* [2] Freescale	SigmaTel	02/04/08	$3.00	$110,000,000	$1.96	01/07/08	410				C	$92,298	$298,262
					$1.78	01/16/08	90				C		
					$1.79	02/01/08	250				C		
					$1.85	01/09/08	-47	Jan 10	$2.50	0.74	P		
					$1.78	01/16/08	-90	Jan 09	$2.50	0.71	P		
					$1.78	01/16/08	-10	Jan 10	$2.50	0.71	P		
					$1.70	01/17/08	-80	Jan 09	$2.50	0.68	P		
					$1.70	01/17/08	-100	Jan 09	$2.50	0.68	P		
* [2] STMicroelectro.	Genesis Microchip	12/11/07	$8.65	$336,000,000	$5.73	11/14/07	30				C	$85,181	$152,475
					$5.40	12/10/07	70				C		
* [1] Vivendi S.A.	Activision, Inc.	12/02/07	$27.50	$1,700,000,000	$21.54	11/27/07	26				C	$29,695	$21,239
					$9.56	08/24/07	174	Dec	$22.50	0.42	C		
					$9.56	08/24/07	110	Dec	$25.00	0.38	C		
Celgene	Pharmion	11/19/2007	$79.30	$3,214,720,000	$44.21	9/25/2007	37	Jan	$50.00	0.88	C	$443,000	$1,554,968
					$44.21	9/25/2007	10	Jan	$55.00	0.8	C		
					$44.21	09/25/07	20	Nov	$55.00	0.80	C		
					$44.21	09/25/07	30	Dec	$55.00	0.80	C		
					$43.70	09/21/07	5	Nov	$50.00	0.87	C		
					$43.70	09/21/07	25	Jan	$50.00	0.87	C		
					$43.70	09/21/07	10	Jan	$55.00	0.79	C		
					$43.70	09/21/07	25	Nov	$55.00	0.79	C		
					$43.70	09/21/07	47	Dec	$55.00	0.79	C		
					$44.21	09/25/07	17	Dec	$55.00	0.80	C		
					$46.66	09/27/07	5	Dec	$55.00	0.85	C		
VestarCapital Partners	Radiation Therapy Services	10/19/07	$32.50	$764,000,000	$22.10	10/09/07	4	Feb	$25.00	0.88	C	$16,200	$1,246,077
					$22.70	10/15/07	3	Feb	$25.00	0.91	C		
* [2] Sumitomo Chemical Company	Cambridge Display Technology	07/31/07	$12.00	$285,000,000	$6.61	07/02/07	20				C	$71,654	$157,248
* [1] Siemens	Dade Behring	07/25/07	$77.00	$7,000,000,000	$57.00	07/12/07	100	Aug	$60.00	0.95	C	$138,100	Unresolved
Blackstone Group	Hilton Hotels Corp.	07/03/07	$47.50	$26,000,000,000	$33.87	07/02/07	550	Aug	$35.00	0.97	C	$6,393,000	Unresolved
					$36.05	07/03/07	100	Jul	$35.00	1.03	C		
					$36.05	07/03/07	1,283				C		
* [2] Roche Holdings	Ventana	06/25/07	$75.00	$3,665,414,000	$53.08	06/15/07	20				C	$220,725	Unresolved
* [2] Silver Lake P.	Avaya	06/04/07	$17.50	$8,200,000,000	$16.72	06/04/07	305				C	$170,000	Unresolved
and TPG LLP					$16.72	06/04/07	125				C		
* [2] Elevation	Palm	06/04/07		$325,000,000								$507,492	$32,531,066
Partners					$16.69	05/22/07	3,229	Jun	$15.00	1.11	C		
* [2] The Blackstone	Alliance Data	05/17/07	$81.75	$6,760,000,000	$66.23	04/09/07	55	Jun	$65.00	1.02	C	$114,000	$564,608
Group	Systems Corp.				$62.88	05/11/07	30	May	$65.00	0.97	C		
					$64.33	05/04/07	60	Jun	$65.00	0.99	C		
* [1] Warburg Pincus	Bausch & Lomb	05/16/07	$65.00	$4,500,000,000	$48.56	09/05/06	80	Sep	$30.00	1.62	C	$16,667	Unresolved
* [2] Fortress	Florida	05/08/07	$62.50	$3,500,000,000	$63.62	04/03/07	15	Jun			C	$1,011,777	$345,913
Investment Group	East Coast				$68.80	04/19/07	17	Jun			C		
	Industries				$70.32	05/01/07	15	Jun			C		
					$66.36	04/17/07	66	Jun			C		
					$66.58	04/18/07	34	Jun			C		
					$72.20	04/23/07	25	Jun			C		
					$70.51	04/30/07	100	Jun			C		
					$74.13	05/07/07	10				C		
					$62.73	04/02/07	50	Jun			C		

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Acquirer	Target	Ann.Date	Offer Pr.	Deal Val.	Stock Pr.	Op. Date	Options	Exp.	Strike	S/K	Type	Illicit Prof.	Fine
					$68.80	04/19/07	17	Jun			C		
					$70.32	05/01/07	45	Jun			C		
					$62.73	04/02/07	50	Jun			C		
					$68.80	04/19/07	17	Jun			C		
					$70.32	05/01/07	45	Jun			C		
Alcoa	Alcan	05/07/07	$73.25	$33,000,000,000	$57.93	05/01/07	240				C	$597,770	Unresolved
* [2] Eurex Frankfurt	International Securities Exchange Holdings	04/30/07	$67.50	$2,800,000,000	$46.24	12/26/06	100	Feb	$50.00	0.92	C	$1,135,000	$1,054,979
					$46.92	12/28/06	200	Feb	$50.00	0.94	C		
					$45.72	04/27/07	300	May	$55.00	0.83	C		
					$45.72	04/27/07	100	Jun	$55.00	0.83	C		
					$45.72	04/27/07	300	Jun	$60.00	0.76	C		
					$45.72	04/27/07	29	Jul	$60.00	0.76	C		
Jarden	K2	04/25/07	$15.50	$1,200,000,000	$12.58	04/24/07	150	May	$12.50	1.01	C	$27,280	Unresolved
* [2] AstraZeneca	MedImmune, Inc. (MEDI)	04/23/07	$58.00	$15,600,000,000	$32.44	03/15/07	500	Apr	$32.50	1.00	C	$13,978,752	$600,000
					$33.04	03/19/07	300	May	$35.00	0.94	C		
					$32.66	03/20/07	800	May	$35.00	0.93	C		
					$34.04	03/21/07	250	May	$35.00	0.97	C		
					$34.04	03/21/07	24	Jun	$40.00	0.85	C		
					$34.98	03/28/07	1,515	Jun	$40.00	0.87	C		
					$34.98	03/28/07	200	May	$40.00	0.87	C		
					$35.72	03/29/07	1,500	Jun	$40.00	0.89	C		
					$35.72	03/29/07	500	May	$40.00	0.89	C		
					$36.39	03/30/07	500	May	$40.00	0.91	C		
					$36.13	04/03/07	250	May	$40.00	0.90	C		
					$36.13	04/03/07	247	Apr	$40.00	0.90	C		
					$35.44	04/04/07	7	Jun	$40.00	0.89	C		
					$35.44	04/04/07	250	May	$40.00	0.89	C		
					$35.44	04/04/07	250	Apr	$35.00	1.01	C		
					$36.76	04/09/07	450	May	$40.00	0.92	C		
					$36.76	04/09/07	250	Apr	$37.50	0.98	C		
					$36.76	04/09/07	500	Apr	$40.00	0.92	C		
					$37.07	04/10/07	99	Apr	$40.00	0.93	C		
					$37.84	04/11/07	250	Apr	$40.00	0.95	C		
					$44.19	04/13/07	1,565	May	$50.00	0.88	C		
					$44.19	04/13/07	1,100	May	$47.50	0.93	C		
					$45.44	04/16/07	2,000	May	$50.00	0.91	C		
					$45.44	04/16/07	10	May	$47.50	0.96	C		
					$45.09	04/17/07	815	May	$50.00	0.90	C		
					$45.09	04/17/07	500	May	$47.50	0.95	C		
					$48.01	04/20/07	2,300	Apr	$47.50	1.01	C		
* [2] Software AG	webMethods	04/05/07	$9.15	$548,030,000	$7.25	04/03/07	40	May	$7.50	0.97	C	$13,000	$564,608
					$7.25	04/03/07	40	Jul	$7.50	0.97	C		
Hellman & Friedman	Kronos	03/22/07	$55.00	$1,793,086,000	$31.04	03/16/07	35	Apr	$40.00	0.78	C	$315,000	Unresolved
* [2] KKR, TPG, Goldman	TXU Corp	02/26/07	$69.25	$45,000,000,000	$56.47	02/06/07	130	Feb			C	$6,390,771	$564,608
					$57.01	01/29/07	400	Apr			C		
					$56.76	02/13/07	300	Mar			C		
					$56.07	02/21/07	560	Mar	$60.00	0.93	C		
					$56.07	02/21/07	40	Mar	$60.00	0.93	C		
					$56.07	02/21/07	220	Apr	$62.50	0.90	C		
					$60.02	02/23/07	3,500	Mar	$57.50	1.04	C		
					$60.02	02/23/07	3,200	Mar	$60.00	1.00	C		
					$56.47	02/06/07	80	Apr	$57.50	0.98	C		

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Acquirer	Target	Ann.Date	Offer Pr.	Deal Val.	Stock Pr.	Op. Date	Options	Exp.	Strike	S/K	Type	Illicit Prof.	Fine
					$56.47	02/06/07	75	Apr	$60.00	0.94	C		
					$56.47	02/06/07	20	Jul	$57.50	0.98	C		
					$55.73	02/08/07	49	Apr	$57.50	0.97	C		
					$55.73	02/08/07	130	Apr	$60.00	0.93	C		
* [2] Tenaris	Hydril	02/12/07	$97.00	$2,160,000,000	$84.54	02/06/07	150	Feb			C	$108,000	Unresolved
* [2] Polycom	Spectralink	02/07/07	$11.75	$231,519,000	$8.94	02/02/07	130	Feb	$10.00	0.89	C	$128,024	$298,262
					$8.82	01/29/07	340	Mar	$10.00	0.88	C		
					$8.82	01/29/07	200	Feb	$10.00	0.88	C		
					$8.56	02/06/07	150				C		$74,282
* [2] MDS	Molecular Devices	01/29/07	$34.50	$615,000,000	$23.11	01/22/07	5	Feb	$22.50	1.03	C	$1,035,200	$5,251,077
					$23.11	01/22/07	10	Mar	$25.00	0.92	C		
					$23.11	01/22/07	-3	Apr	$25.00	0.92	C		
					$23.81	01/24/07	30	Feb, Mar, and Apr	$25.00	0.95	C		
					$23.81	01/24/07	870	Feb, Mar, and Apr	$25.00	0.95	C		
Formation Capital , LLC and JER Partners	Genesis	01/16/07	$69.35	$1,853,517	$47.23	12/29/06	30	Feb	$55.00	0.86	C	$572,575	$884,829
					$47.23	12/29/06	74	Jan	$45.00	1.05	C		
					$47.23	12/29/06	356	Jan	$50.00	0.94	C		
					$47.23	12/29/06	110	Jan	$55.00	0.86	C		
# [1] CVS	Caremark	12/18/06	$48.18	$21,000,000,000	$50.61	12/14/06	100	Jan			C	$35,800	Unresolved
* [2] TPG and Silver Lake P.	Sabre Holdings	12/11/06	$32.75	$4,987,300,000	$28.01	12/05/06	120	Jan	$30.00	0.93	C	$18,300	$564,608
					$28.17	12/06/06	184	Feb	$30.00	0.94	C		
* [1] NVIDIA	Portal Player	11/06/06	$13.50	$357,000,000	$11.21	10/30/06	500	Nov	$12.50	0.90	C	$16,375	Unresolved
					$12.03	10/31/06	28	Nov	$12.50	0.96	C		
* [1] Schneider Electric	American Power Conversion Corp.	10/30/06	$31.00	$6,100,000,000	$21.30	09/21/06	1,600	Dec	$22.50	0.95	C	$1,440,850	$3,001,946
					$21.40	09/22/06	800	Dec	$22.50	0.95	C		
* [1] GlaxoSmithKline	CNS Inc	10/09/06	$37.50	$566,000,000	$32.01	09/28/06	270	Nov	$30.00	1.07	C	$499,696	$374,655
					$35.62	10/02/06	230	Oct	$30.00	1.19	C		
					$32.36	09/29/06	135	Nov	$30.00	1.08	C		
					$32.36	09/29/06	45	Nov	$30.00	1.08	C		
					$32.62	10/02/06	200	Oct	$30.00	1.09	C		
					$32.62	10/02/06	25	Nov	$30.00	1.09	C		
PNC Financial Services Corporation	Mercantile	10/09/06	$47.24	$5,981,802,000	$40.13	10/06/06	20				C	$98,390	Unresolved
* [2] Gilead Sciences	Myogen, Inc.	10/02/06	$52.50	$247,360,000	$34.29	09/21/06	50	Oct	$40.00	0.86	C	$102,000	$366,001
					$34.29	09/21/06	20	Oct	$35.00	0.98	C		
					$34.29	09/21/06	10	Dec	$35.00	0.98	C		
* [1] The Carlyle Group Permira Funds Texas Pacific Group	Freescale Semiconductor	09/14/06	$40.00	$17,600,000,000	$31.39	09/05/06	243	Sep	$35.00	0.90	C	$376,640	Unresolved
					$27.89	07/18/06	50	Aug	$30.00	0.93	C		
					$27.89	07/19/06	20	Aug	$30.00	0.93	C		
					$30.94	08/30/06	610	Sep	$35.00	0.88	C		
					$30.94	08/30/06	50	Oct	$30.00	1.03	C		
					$30.94	09/08/06	80	Sep	$30.00	1.03	C		
					$30.14	08/28/06	370	Sep	$35.00	0.86	C		
					$30.03	08/17/06	80				C		
AMD	ATI	07/24/06	$20.47	$5,400,000,000	$15.09	06/26/06	15	Jul	$17.50	0.86	C	$22,070	Unresolved
					$15.45	07/05/06	39	Jul	$17.50	0.88	C		
					$15.75	07/19/06	93	Aug	$17.50	0.90	C		
* [2] Green Equity Investors IV, TPG	Petco Animal Supplies	07/14/06	$29.00	$1,800,000,000	$19.80	06/28/06	665	Jul	$22.50	0.88	C	$465,325	Unresolved
					$19.45	07/13/06	185	Aug	$20.00	0.97	C		
* [2] **Tenaris SA**	Maverick Tube	06/12/06	$65.00	$2,600,000,000	$49.19	06/01/06	100	Jun	$50.00	0.98	C	$1,138,832	$1,079,342
					$49.19	06/01/06	100	Jun	$55.00	0.89	C		

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Table A-16 – *Continued from previous page*

Acquirer	Target	Ann.Date	Offer Pr.	Deal Val.	Stock Pr.	Op. Date	Options	Exp.	Strike	S/K	Type	Illicit Prof.	Fine
					$49.98	06/02/06	100	Jun	$55.00	0.91	C		
					$49.98	06/02/06	20	Jul	$50.00	1.00	C		
					$47.64	06/05/06	100	Jun	$55.00	0.87	C		
					$47.64	06/05/06	40	Jul	$55.00	0.87	C		
					$47.98	06/06/06	100	Jun	$55.00	0.87	C		
					$47.98	06/06/06	20	Jul	$55.00	0.87	C		
					$46.49	06/07/06	200	Jun	$55.00	0.85	C		
					$46.49	06/07/06	40	Jul	$55.00	0.85	C		
					$47.58	06/09/06	50	Jul	$55.00	0.87	C		
					$47.58	06/09/06	250	Jun	$55.00	0.87	C		
						06/09/06	25	Jun	$33.00	0.00	C		
* [2] Boeing	Aviall	05/01/06	$48.00	$1,700,000,000	$37.70	04/07/06					C	$792,383	Unresolved
					$38.08	04/01/06					C		
					$37.63	04/21/06		May			C		
					$36.31	04/17/06					C		
					$38.70	03/29/06					C		
* [2] Watson Pharma.	Andrx Corp	03/13/06	$25.00	$1,900,000,000	$17.87	02/24/06		Mar			C	$1,174,421	$619,699
						02/24/06		Mar			C		
						02/24/06					C		
Cerberus, Supervalu, CVS	Albertson's, LLC	01/20/06	$26.29	$17,543,845,000	$22.72	01/12/06	425				C	$7,836,807	$53,134
					$23.02	01/17/06	25				C		
					$23.61	01/18/06	15				C		
* [2] Amgen	Abgenix	12/14/05	$22.50	$2,200,000,000	$14.10	12/01/05	155				C	$275,390	$2,650,423
* [2] Koch Industries	Georgia-Pacific	11/14/05	$48.00	$13,200,000,000	$33.89	11/10/05	241				C	$689,401	Unresolved
Barrick Gold Corp.	Placer Dome	10/31/05	$20.50	$9,200,000,000	$16.45	10/25/05	5,000	Nov			C	$1,900,000	Unresolved
* [2] GlaxoSmithKline	ID Biomedical Corp	09/07/05	$28.82	$1,400,000,000	$20.90	08/03/05	12	Sep	$20.00	1.05	C	$(17,779)	$4,403,916
					$20.41	08/04/05	49	Sep	$20.00	1.02	C		
					$19.31	08/08/05	33	Sep	$20.00	0.97	C		
					$20.46	07/29/05	310	Aug	$20.00	1.02	C		
					$20.90	08/03/05	58	Sep	$20.00	1.05	C		
					$20.46	07/29/05	319	Aug	$20.00	1.02	C		
* [2] Adidas-Salomon	Reebok International	08/03/05	$59.00	$11,800,000,000	$42.76	08/01/05	1,997				C	$6,170,131	$6,478,049
					$42.76	08/01/05	1,180				C		
					$42.76	08/01/05	465				C		
					$42.76	08/01/05	455				C		
					$43.95	08/02/05	60				C		
MGI Pharma	Guilford Pharmaceuticals	07/21/05	$3.75	$177,500,000	$2.25	07/13/05	150	Sep	$2.50	0.90	C	$39,837	$4,403,916
					$2.37	07/15/05	48	Sep	$2.50	0.95	C		
# [2] Duke Energy	Cinergy	05/09/05	$45.80	$8,832,940,000	$40.15	05/04/05	645				C	$142,729	Unresolved
GameStop	Electronics Boutique Holdings Corp.	04/18/05	$55.18	$1,440,000,000	$43.10	04/12/05	400	May	$45.00	0.96	C	$308,336	$481,416
					$43.10	04/12/05	400	May	$47.50	0.91	C		
					$43.10	04/12/05	400	May	$50.00	0.86	C		
* [2] Novartis	Eon Labs	02/21/05	$31.00	$2,632,877,000	$28.25	02/17/05	50				C	$29,292	Unresolved
# [2] P&G	Gillette	01/27/05	$53.94	$54,906,810,000	$45.00	01/26/05	346				C	$94,581	Unresolved
# [2] Cimarex Energy	Magnum Hunter Resources	01/26/05	$16.84	$1,500,000,000	$12.90	12/31/04					C	$46,200	$103,800
* [1] Citizens Bank	Charter One	05/04/04	$44.50	$10,529,984,000	$34.00	04/29/04	90	May	$35.00	0.97	C	$785,330	$1,142,450

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Table A-16 – *Continued from previous page*

Acquirer	Target	Ann.Date	Offer Pr.	Deal Val.	Stock Pr.	Op. Date	Options	Exp.	Strike	S/K	Type	Illicit Prof.	Fine
	Financial				$34.00	04/29/04	150	Jun	$35.00	0.97	C		
					$35.07	04/30/04	20	Aug	$35.00	1.00	C		
					$35.07	04/30/04	230	May	$35.00	1.00	C		
					$35.07	04/30/04	130	Jun	$35.00	1.00	C		
					$34.93	05/03/04	130	Jun	$35.00	1.00	C		
					$34.93	05/03/04	310	Aug	$35.00	1.00	C		
					$34.93	05/03/04	172	May	$35.00	1.00	C		
					$34.45	05/04/04	160	May	$35.00	0.98	C		
					$34.45	05/04/04	20	Aug	$35.00	0.98	C		
					$34.93	05/03/04	50	May	$35.00	1.00	C		
* [1] GE	InVision	03/15/04	$50.00	$900,000,000	$40.54	03/06/04	2,500	Mar	$45.00	0.90	C	$1,700,000	Unresolved
					$40.54	03/06/04	1,965	Apr	$45.00	0.90	C		
# [1] Bank of America	FleetBoston Financial Corporation	10/27/03	$45.00	$47,000,000,000	$31.80	10/24/03	1,100	Nov	$35.00	0.91	C	$473,000	Unresolved
# [2] USA Interactive	LendingTree	05/05/03	$21.70	$734,000,000	$14.18	04/30/03	25	Jun	$15.00	0.95	C	$211,471	$422,942
					$14.69	05/02/03	200	May	$15.00	0.98	C		
DHL Worldwide Express	Airborne Express	03/24/03	$21.50	$1,050,000,000		02/27/03	10	Apr			C	$432,742	$1,071,110
					$14.04	02/28/03	50	May			C		
						03/13/03	400	Apr			C		
						03/13/03	400	May			C		
					$13.60	03/05/03	80	Apr			C		
					$13.54	03/06/03	50	May			C		
					$18.05	03/24/03	30	Apr			C		
					$13.11	03/10/03	80	May			C		
					$13.11	03/10/03	50	Aug			C		
					$13.02	03/11/03	100	May			C		
Citibank	Golden State Bancorp	05/21/02	$40.40	$5,882,760,000	$30.02	03/10/02	480				C	$250,000	Unresolved
Suiza Foods	Dean Foods	04/05/01	$40.29	$1,500,000,000	$77.41	04/04/01	250				C	$124,600	$306,063
# [2] American International Group	American General Corporation	04/03/01	$46.00	$23,000,000,000	$36.80	04/03/01	250	Apr	$37.50	0.98	C	$273,000	$305,000
					$36.80	04/03/01	250	May	$37.50	0.98	C		
					$36.80	04/03/01	80	Apr	$40.00	0.92	C		
* [2] Nestl S.A.	Ralston Purina	01/16/01	$33.50	$10,000,000,000							C	$300,000	Unresolved
# [1] Manugistics	Talus Solutions	12/22/00		$366,000,000	$50.75	12/13/00	-30	Jan			P	$7,218	$185,000
* [1] Siemens Medical Engineering Group	Acuson Corporation	09/27/00	$23.00	$700,000,000	$14.63	09/21/00	200	Oct	$15.00	0.98	C	$137,486	Unresolved
# [2] Sun Microsystems	Cobalt Networks	09/18/00	$57.63	$2,000,000,000	$41.13	09/18/00						$411,697	$823,393
# [1] Citigroup	Associates First Capital	09/06/00	$42.22	$31,100,000,000	$27.81	09/05/00	20	Sep	$30.00	0.93	C	$40,875	$57,239
					$38.63	09/06/00	30	Sep	$30.00	1.29	C		
Telus Corporation	Clearnet Communications	08/21/00	$47.50	$3,100,000,000	$30.44	08/17/00	20	Sep	$30.00	1.01	C	$159,194	Unresolved
* [2] NCR Corporation	4Front Technologies, Inc.	08/03/00	$18.50	$250,000,000	$17.81	07/17/00	460	Aug	$12.50	1.43	C	$127,288	$265,644
* [2] ING	ReliaStar	05/01/00	$54.00	$6,100,000,000	$30.81	04/27/00	60	May	$35.00	0.88	C	$879,085	$350,000
					$30.81	04/27/00	100	May	$35.00	0.88	C		
					$43.00	04/28/00	39	May	$30.00	1.43	C		
					$30.81	04/27/00	250	May	$35.00	0.88	C		
					$30.81	04/27/00	50	May	$30.00	1.03	C		
					$30.81	04/27/00	36	Jul	$35.00	0.88	C		
					$43.00	04/28/00	40	May	$30.00	1.43	C		

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Table A-16 – *Continued from previous page*

Acquirer	Target	Ann.Date	Offer Pr.	Deal Val.	Stock Pr.	Op. Date	Options	Exp.	Strike	S/K	Type	Illicit Prof.	Fine
* [1] Citigroup	Travelers Property Casualty Corp	03/21/00	$25.00	$2,400,000,000	$40.94	03/21/00	15				C	$7,875	Unresolved
* [2] Kellogg	Worthington	10/01/99	$24.00	$307,000,000	$13.56	09/29/99	90	Oct	$15.00	0.90	C	$545,489	$506,530
					$12.19	09/27/99	115	Oct	$12.50	0.98	C		
* [2] Merck	VWR Scientific Products Corp	06/08/99	$37.00	$625,000,000	$28.38	06/02/99					C	$45,863	$91,726
# [1] Exxon Corporation	Mobil	12/01/98	$99.01	$82,000,000,000	$73.50	11/19/98	100	Dec			C	$70,000	$144,597
* [2] Medtronic	Arterial Vascular Engineering	11/30/98	$54.00	$3,700,000,000	$30.69	11/19/98	250				C	$1,440,131	$3,026,393
					$31.19	11/25/98	800				C		
					$30.69	11/19/98	235				C		
ABB Asea Brown Boveri	Elsag Bailey Process Automation	10/14/98		$1,100,000,000	$21.00	09/10/98	150	Nov	$30.00	0.70	C	$7,495,455	$11,717,249
					$21.00	10/02/98	50	Nov	$20.00	1.05	C		
					$21.00	10/02/98	50	Nov	$25.00	0.84			
					$22.88	09/15/98	20				C		
					$20.75	10/05/98	25	Nov	$20.00	1.04	C		
					$20.75	10/06/98	5	Nov	$25.00	0.83	C		
					$20.88	10/07/98	50	Nov	$20.00	1.04	C		
					$20.88	10/07/98	45	Nov	$25.00	0.84	C		
					$20.88	10/07/98	75	Nov	$22.50	0.93	C		
					$19.25	10/13/98	3	Nov	$22.50	0.86	C		
					$19.25	10/13/98	20	Nov	$22.50	0.86	C		
					$19.25	10/13/98	90	Nov	$22.50	0.86	C		
					$19.25	10/13/98	6	Nov	$22.50	0.86	C		
					$19.25	10/13/98	3	Nov	$22.50	0.86	C		
					$19.25	10/13/98	3	Nov	$22.50	0.86	C		
* [2] ADC Telecommunications	Teledata Communications Ltd.	09/16/98	$15.75	$200,000,000	$9.50	09/01/98	225				C	$300,000	Unresolved
# [2] DST Systems	USCS International	09/02/98	$35.19	$874,000,000	$26.00	09/02/98	200				C	$70,000	Unresolved
* [2] Hercules	BetzDearborn	07/30/98	$72.00	$3,100,000,000	$67.69	07/30/98	100				C	$1,596,856	$2,835,643
					$34.75	07/28/98	20	Aug	$40.00	0.87	C		
					$39.94	07/09/98	40	Aug	$40.00	1.00	C		
					$39.94	07/09/98	20	Oct	$50.00	0.80	C		
					$39.06	07/15/98	50	Oct	$45.00	0.87	C		
# [2] Elan Corporation	Neurex Corp.	04/29/98	$32.70	$700,000,000	$20.13	04/27/98					C	$83,663	Unresolved
# [2] Exel Ltd	Mid Ocean Ltd	03/16/98	$75.00	$2,100,000,000	$63.31	03/13/98		Mar	$65.00	0.97	C	$493,678	$502,390
					$63.31	03/13/98					C		
# [1] Williams Companies	Mapco Inc.	11/24/97	$46.00	$2,650,000,000	$34.38	11/20/97						$134,209	Unresolved
# [2] Nations Bank Corporation	Barnett Banks	08/29/97	$75.18	$15,500,000,000	$52.31	08/26/97	280				C	$320,635	$1,760,509
					$52.31	08/26/97	80				C		
# [1] Hewlett-Packard	VeriFone	04/23/97	$50.50	$1,180,000,000	$15.75	04/21/97						$209,281	Unresolved
* [1] Neptune Orient Lines	APL Ltd	04/13/97	$33.50	$825,000,000	$21.50	04/11/97	400	May			C		$2,253,594
					$21.50	04/11/97	340	May	$20.00	1.08	C		
					$21.50	04/11/97	550	May	$22.50	0.96	C		
* [1] Henkel KGaA	Loctite Corp	10/28/96	$56.00	$1,289,056,000	$46.13	10/24/96	65	Dec	$50.00	0.92	C	$55,000	$53,640
* [2] CSX	Conrail	10/15/96	$115.00	$12,300,890,000	$69.50	10/09/96	10	short			C	$37,138	$83,516
# [1] The Gillette	Duracell International	09/12/96	$58.87	$7,000,000,000	$48.13	09/10/96	1,100	Sep	$50.00	0.96	C	$1,040,699	$2,823,944
					$49.13	09/11/96	600	Sep	$55.00	0.89	C		

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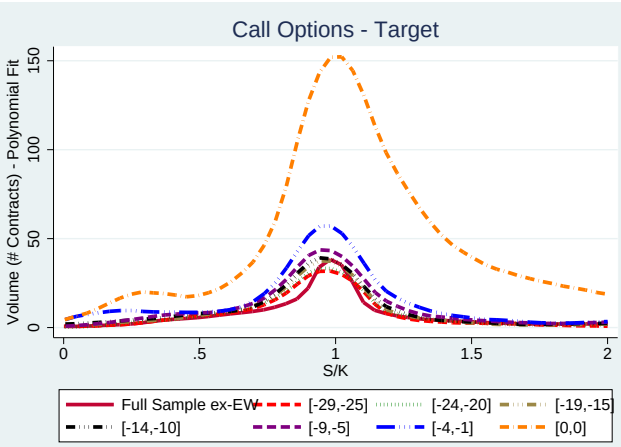
Table A-16 – *Continued from previous page*

Acquirer	Target	Ann.Date	Offer Pr.	Deal Val.	Stock Pr.	Op. Date	Options	Exp.	Strike	S/K	Type	Illicit Prof.	Fine
Texas Utilities	Enserch Corp.	04/15/96	$7.81	$1,686,500,000								$154,276	$377,335
United Healthcare	MetraHealth	06/21/95		$1,650,000,000	$36.50	05/24/95		Jan	$35.00	1.04	C	$274,199	Unresolved
					$36.13	05/26/95		Jan	$35.00	1.03	C		
					$39.38	06/06/95		Sep	$35.00	1.13	C		
					$40.00	06/14/95		Dec	$35.00	1.14	C		
* [2] IBM	Lotus Development Corporation	06/05/95	$64.00	$3,200,000,000	$32.50	06/02/95	10	Jun	$35.00	0.93	C	$381,584	$690,905
					$32.50	06/02/95	20	Jun	$35.00	0.93	C		
					$32.50	06/05/95	20	Jun	$35.00	0.93	C		
					$32.50	06/02/95	20	Jun	$35.00	0.93	C		
					$32.50	06/02/95	15	Jun	$35.00	0.93	C		
* [2] Luxottica S.p.A.	U.S. Shoe Corp	03/03/95	$24.00	$1,400,000,000	$16.25	12/15/94	15				C	$906,932	$1,665,175
					$17.25	02/17/95	100				C		
					$19.00	12/19/94	10				C		
					$19.13	12/20/94	1,000				C		
					$18.75	01/06/95	36				C		
					$17.25	02/17/95	200						
					$17.25	02/17/95	270				C		
					$17.25	02/17/95	300				C		
					$19.25	02/21/95	410				C		
# [2] Silicon Graphics	Alias Research, Inc.	02/07/95	$28.13	$124,400,000							C	$38,561	$103,716
* [1] ITT Corp.	Caesars World	12/19/94	$67.50	$1,700,000,000	$45.25	12/16/94	26	Jan	$50.00	0.91	C	$50,306	$30,619
					$41.75	12/13/94	8	Jan	$50.00	0.84	C		
* [2] The Thomson Corporation	The MEDSTAT Group, Inc.	11/16/94	$27.00	$339,000,000	$17.25	11/16/94	40				C	$244,103	$323,181
# [2] Microsoft	Intuit, Inc.	10/13/94	$76.49	$1,500,000,000	$47.00	10/13/94					C	$202,803	Unresolved
# [1] Martin Marietta	Lockheed	08/29/94	$78.65	$10,000,000,000	$63.25	08/22/94	189	Sep	$70.00	0.90	C	$177,236	Unresolved
# [2] Foundation Health	Intergroup Healthcare Corp.	07/28/94	$65.00	$720,000,000	$20.50	07/18/94					C, P	$109,003	Unresolved
Merck	Medco Containment Services Inc.	07/28/93	$39.00	$6,000,000,000	$29.00	07/23/93	75				C	$121,437	$15,082
					$29.75	07/27/93	210				C		
Sovereign Bancorp	The Rochester Community Savings Bank	05/05/93			$12.50	04/01/93	60				C	$52,562	$72,171
# [1] AT&T	NCR Corporation	12/02/90	$110.00	$7,400,000,000							C	$650,000	Unresolved

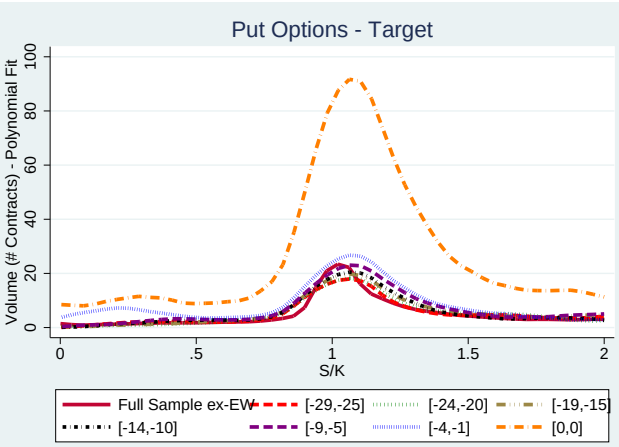
Figure A-1: Volume vs. Depth-in-Moneyness across Event Windows

Figure A-1 shows local polynomial functions fitted to the volume-depth distribution across seven different event windows and for the full sample (excluding the event windows). Figures (A-1a) and (A-1b) show the polynomial fits for, respectively, call and put options on the target companies. Volume is defined as the number of option contracts. Depth-in-moneyness is defined as S/K, the ratio of the stock price S to the strike price K. Deep out-of-the-money (DOTM - solid line) corresponds to $S/K \in [0, 0.80]$ for calls ($[1.20, \infty)$ for puts), out-of-the-money (OTM - dashed-dotted line) corresponds to $S/K \in (0.80, 0.95]$ for calls ($[1.05, 1.20)$ for puts), at-the-money (ATM - dashed-double-dotted line) corresponds to $S/K \in (0.95, 1.05)$ for calls ($(0.95, 1.05)$ for puts), in-the-money (ITM - dotted) corresponds to $S/K \in [1.05, 1.20)$ for calls ($(0.80, 0.95]$ for puts), and deep in-the-money (DITM - dash-triple-dot) corresponds to $S/K \in [1.20, \infty)$ for calls ($[0, 0.80]$ for puts). Volume is winsorized at the upper 99th percentile. Figures (A-1c) and (A-1d) replicate Figures (A-1a) and (A-1a), but omit the announcement effect. Source: OptionMetrics.

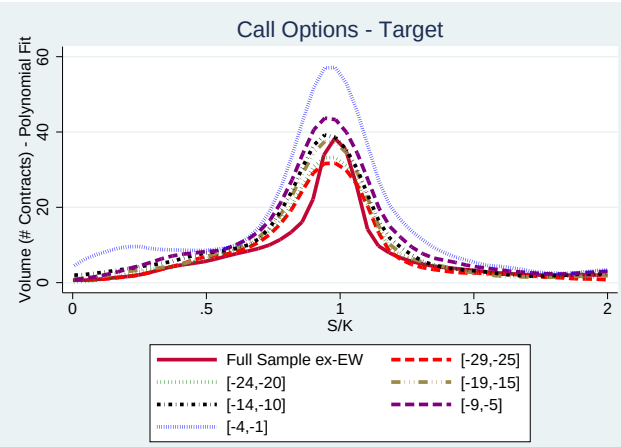
(a)



(b)



(c)



(d)

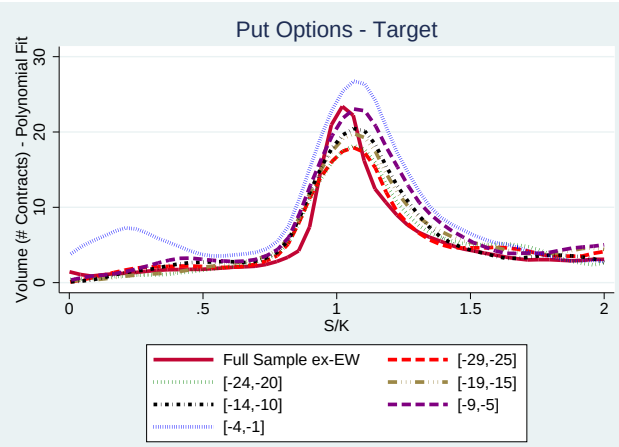


Figure A-2: Trading Volume Distribution around Announcement Dates

Figure A-2 plots distributional statistics of the options trading volume, defined as the number of traded contracts, from 30 days before until 20 days after the announcement date. The left axis on each subfigure plots the 90th (dashed line) and 95th (solid line) percentiles of the volume distribution, while the right axis on each subfigure refers to the interquartile range (dotted line). Figures (A-2a) and (A-2b) refer to, respectively, the call and put volumes for the target companies. Source: OptionMetrics.

(a) (b)

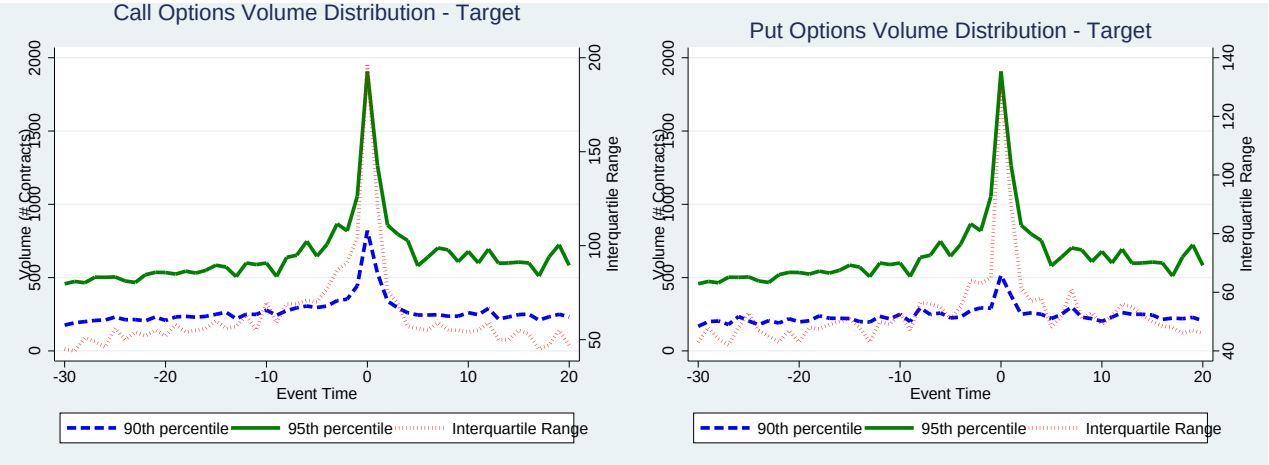
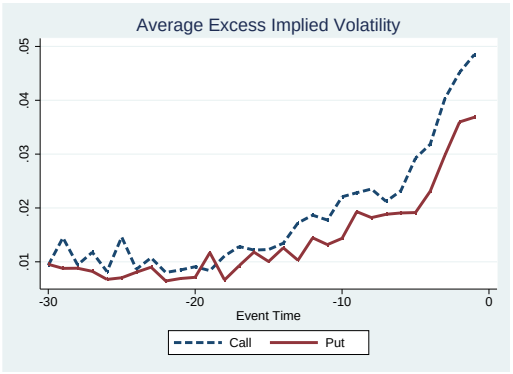


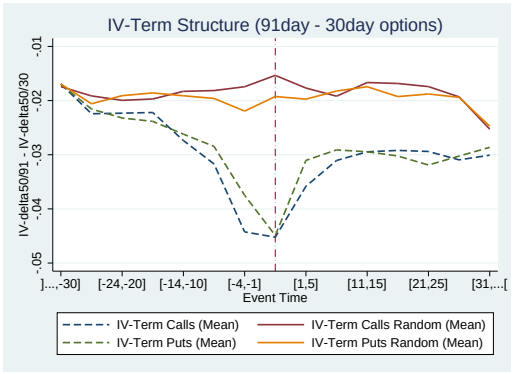
Figure A-3: Excess Implied Volatility and the Term Structure of Implied Volatility

Figure (A-3a) plots, for the target companies, the average excess implied volatility (IV) relative to the VIX index for the 30-day at-the-money (ATM) implied volatility for call (dashed line) and put (solid line) options, respectively, over the 30 pre-announcement days. Figure (A-3b) depicts the IV term structure for call options, defined as the difference between the ATM IVs of call options (delta = 50) with 91 and respectively 30 days to maturity (left axis), respectively, as well as the IV term structure for put options, defined as the difference between the ATM IVs of put options (delta = 50) with 91 and respectively 30 days to maturity (left axis). Each node in Figure A-3b represents the cross-sectional average within a time window defined on the x-axis. We compare the actual averages to that computed for a sample of randomly selected announcement dates. Figure (A-3c) illustrates the evolution of the average percentage bid-ask spread from 90 days before the announcement date to 90 days after the announcement date. Figure (A-3d) compares the evolution of the average percentage bid-ask spread against the average percentage bid-ask calculated for randomly chosen announcement dates. Figure (A-3e) illustrates a stratification by depth-in-moneyness, defined by the ratio of the stock price to the strike price (S/K): DOTM (solid line), OTM (dashed-dotted line), ATM (dashed-double-dotted line), ITM (dotted line), and DITM (dashed-triple-dotted line). All moneyness categories are defined in Section 4.1. Source: OptionMetrics.

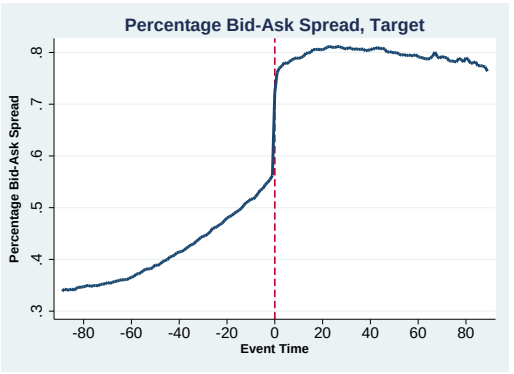
(a)



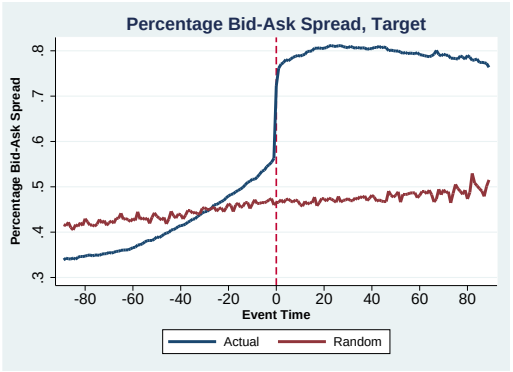
(b)



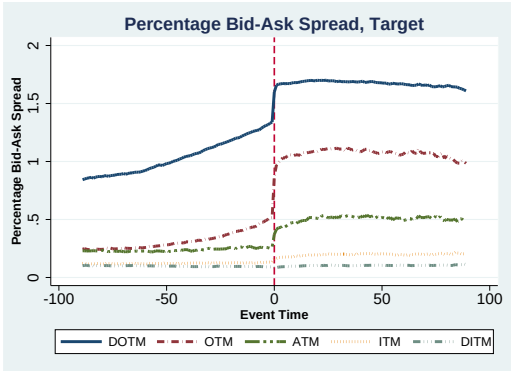
(c)



(d)



(e)



(f)

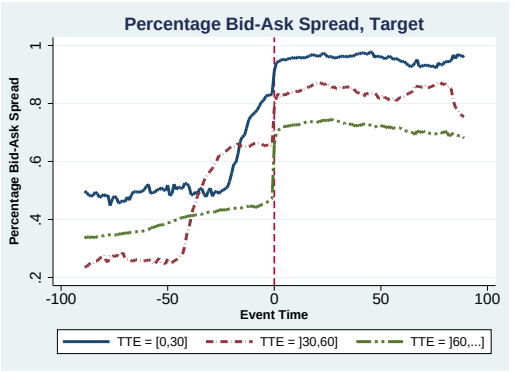


Figure A-4: Abnormal Trading Volumes Acquirer - CASH vs. STOCK - LOG SCALE

Figures (A-4a) and (A-4b) plot the average and average cumulative abnormal natural logarithm of trading volume for the acquirer firms for cash (solid line) and stock (dotted line) financed deals over the 30 days preceding the announcement dates. Volume is defined as the number of option contracts. Source: OptionMetrics.

(a) (b)

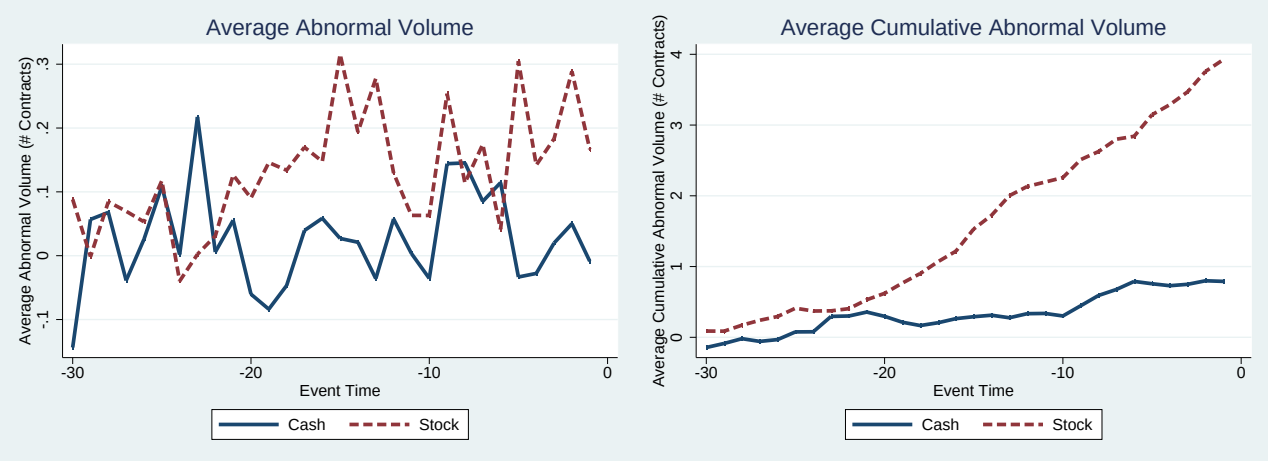
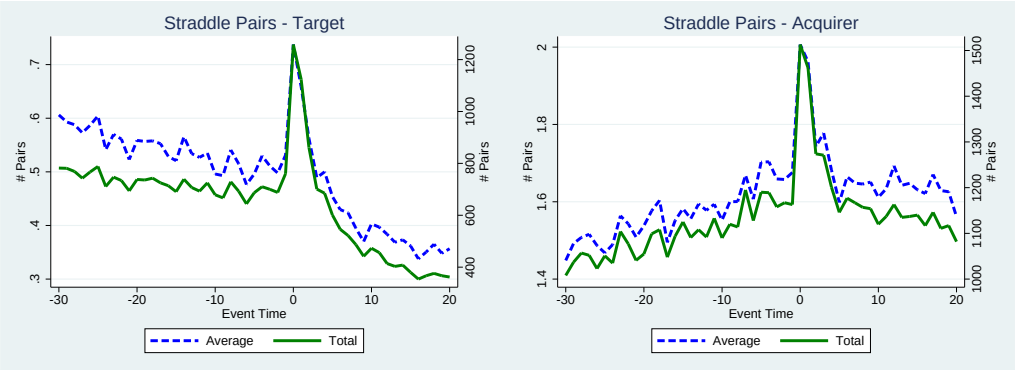


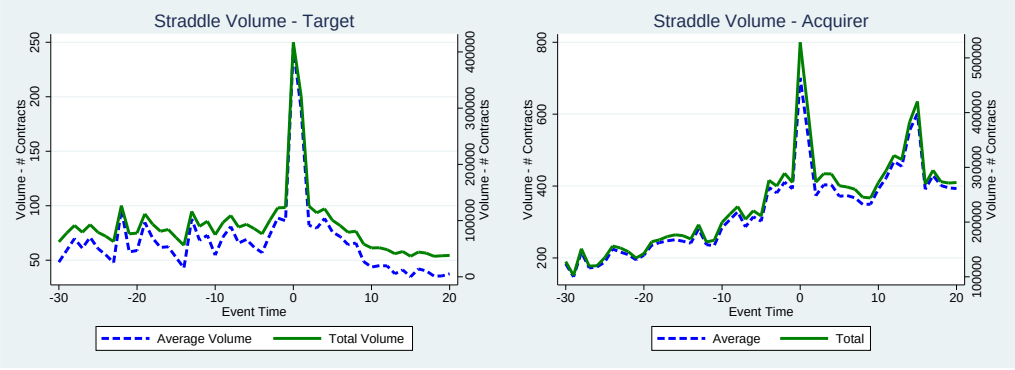
Figure A-5: Straddle Trading Volume

Figure A-5 characterizes the evolution of straddle pairs and trading volume around M&A announcement dates. Figures (A-5a) and (A-5b) plot the evolution of the average (left scale) and total (right scale) number of straddle trading strategies for the target and acquirer firms, respectively. Figures (A-5c) and (A-5d) report the evolution of the average (left scale) and total (right scale) straddle trading volume for the target and the acquirer firms, respectively. For each deal on each day, we identify call-put pairs (CP pairs) that are written on the same underlying stock and that have identical strike prices and times to expiration. For each CP pair, the lower of the volumes of the call and put options reflects an upper bound on the number of implementable straddle trading strategies. Figures (A-5e) and (A-5f) compare the straddle pairs and trading volume of the acquirer firms against those of a sample of randomly drawn announcement dates. Source: OptionMetrics.

(a) (b)



(c) (d)



(e) (f)

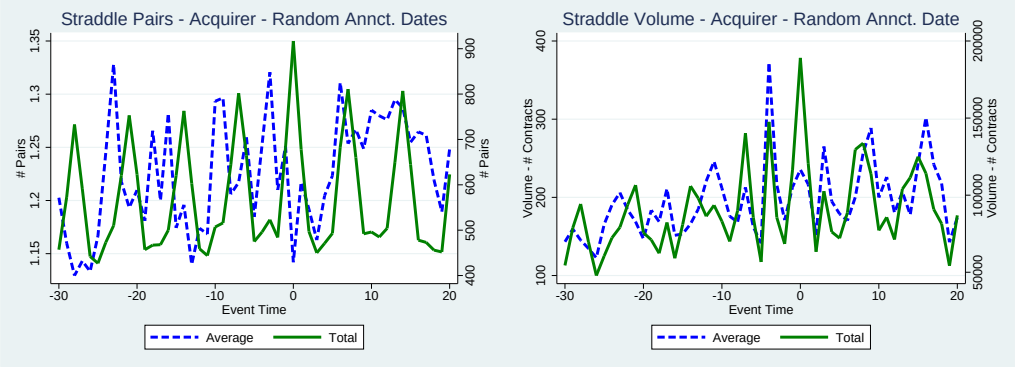
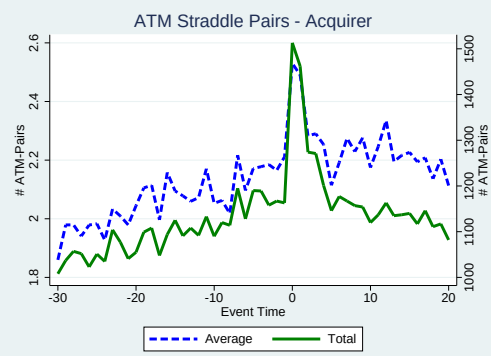


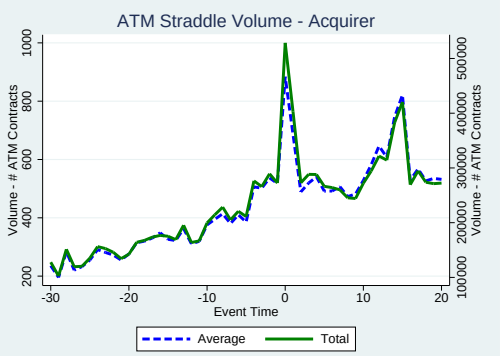
Figure A-6: ATM Straddle Trading Volume

Figure A-6 characterizes the evolution of at-the-money (ATM), out-of-the-money (OTM), and in-the-money (ITM) straddle pairs and trading volume around M&A announcement dates. Figure (A-6a) (A-6c, A-6e) plots the evolution of the average (left scale) and total (right scale) number of ATM (OTM, ITM) straddle trading strategies for the acquirer. Figure (A-6b) (A-6d, A-6f) reports the evolution of the average (left scale) and total (right scale) ATM (OTM, ITM) straddle trading volume for the acquirer. For each deal on each day, we identify call-put pairs (CP pairs) that are written on the same underlying stock and that have identical strike prices and times to expiration. For each CP pair, the lower of the volumes of the call and put option reflects an upper bound on the number of implementable straddle trading strategies. These graphs separately examine options that trade ATM, OTM, or ITM. Depth-in-moneyness is defined as S/K, the ratio of the stock price S to the strike price K. OTM corresponds to $S/K \in (0.00, 0.95]$ for calls ($[1.05, \infty)$ for puts), ATM corresponds to $S/K \in (0.95, 1.05)$ for calls ($(0.95, 1.05)$ for puts), and ITM corresponds to $S/K \in [1.05, \infty)$ for calls ($(0, 0.95]$ for puts). Source: OptionMetrics.

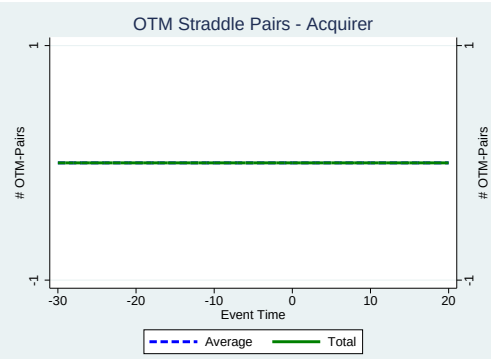
(a)



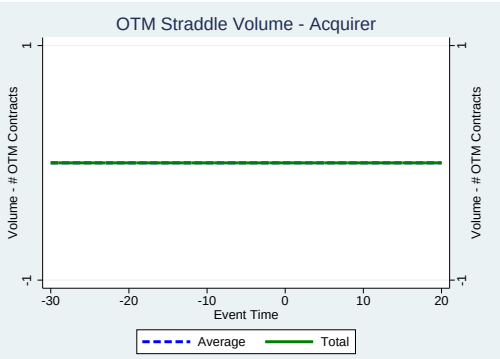
(b)



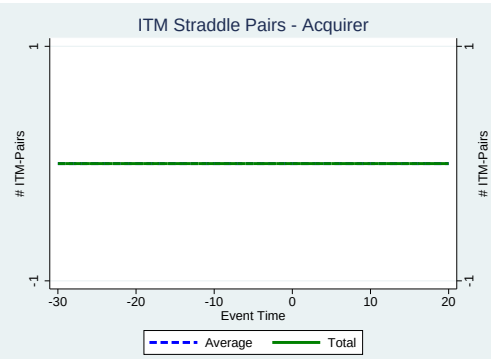
(c)



(d)



(e)



(f)

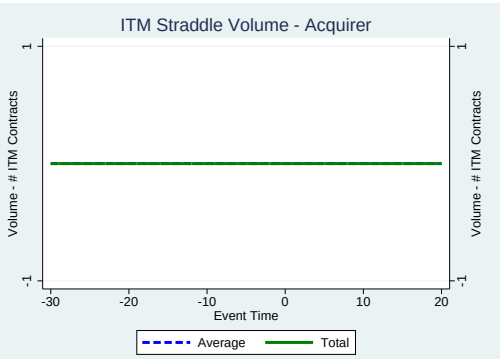
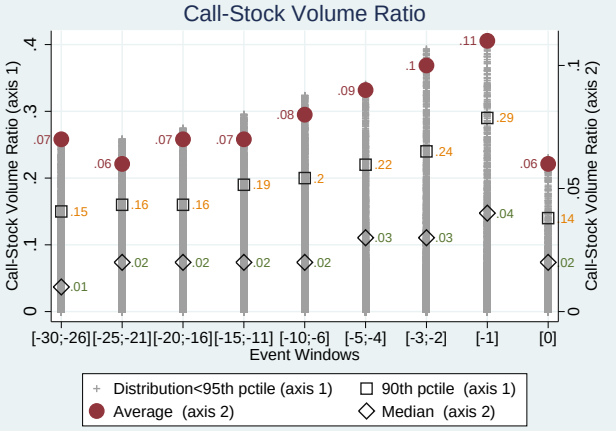


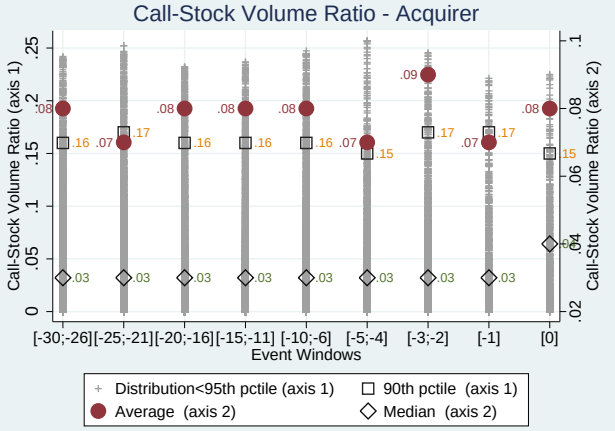
Figure A-7: Option-to-Stock Trading Volumes

Figure A-7 plots distributional statistics of the option trading volume, defined as the number of traded contracts, and stock trading volume, defined as the number of traded shares, over event-day windows from 30 days before until the day of the announcement. On each graph, we report the average, the median, the 90th percentile and either the distribution (below the 95th percentile) or the interquartile range. Figures (A-7a) and (A-7b) plot the call-to-stock volume ratios. Figures (A-7c) and (A-7d) plot the put-to-stock volume ratios. Figures (A-7e) and (A-7f) plot the call-to-put volume ratio. The left column (Figures (A-7a), (A-7c) and (A-7e)) corresponds to the ratios for the target firms. The right column (Figures (A-7b), (A-7d) and (A-7f)) corresponds to the ratios for the acquirer firms. Source: OptionMetrics.

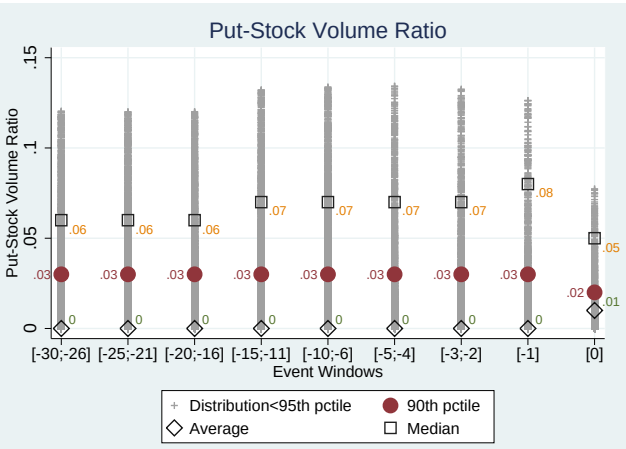
(a)



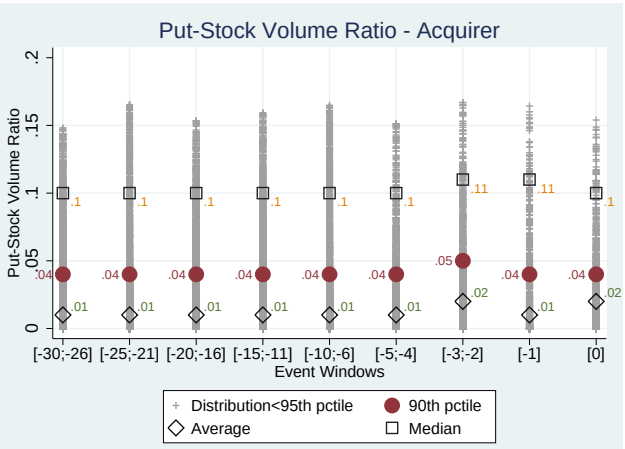
(b)



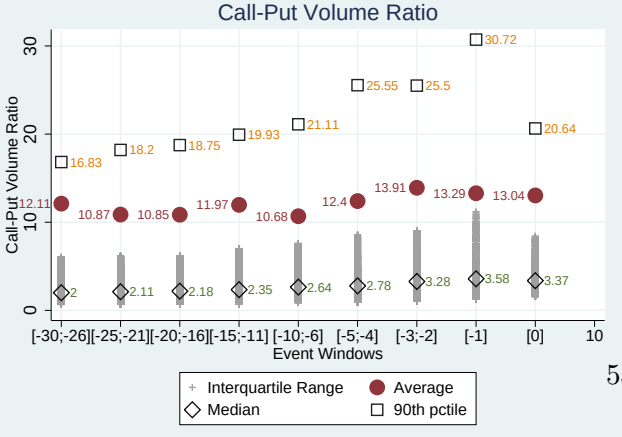
(c)



(d)



(e)



(f)

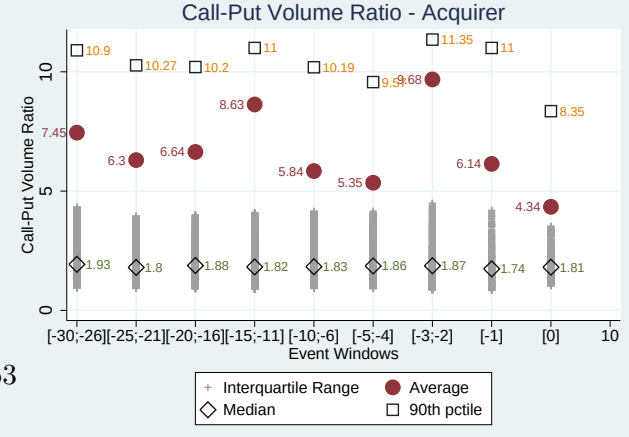


Figure A-8: Volume vs. Depth-in-Moneyness across Event Windows

Figure A-8a shows local polynomial functions fitted to the volume-depth distribution across seven different event windows and for the full sample (excluding the event windows). Figures (A-8a) and (A-8b) show the polynomial fits for call and put options, respectively, on the acquirer companies. Volume is defined as the number of option contracts. Depth-in-moneyness is defined as S/K, the ratio of the stock price S to the strike price K. Deep out-of-the-money (DOTM - solid line) corresponds to $S/K \in [0, 0.80]$ for calls ($[1.20, \infty)$ for puts), out-of-the-money (OTM - dashed-dotted line) corresponds to $S/K \in (0.80, 0.95]$ for calls $([1.05, 1.20)$ for puts), at-the-money (ATM - dashed-double-dotted line) corresponds to $S/K \in (0.95, 1.05)$ for calls $((0.95, 1.05)$ for puts), in-the-money (ITM - dotted) corresponds to $S/K \in [1.05, 1.20)$ for calls $((0.80, 0.95]$ for puts), and deep in-the-money (DITM - dash-triple-dot) corresponds to $S/K \in [1.20, \infty)$ for calls $([0, 0.80]$ for puts). Volume is winsorized at the upper 99th percentile. Source: OptionMetrics.

(a) (b)

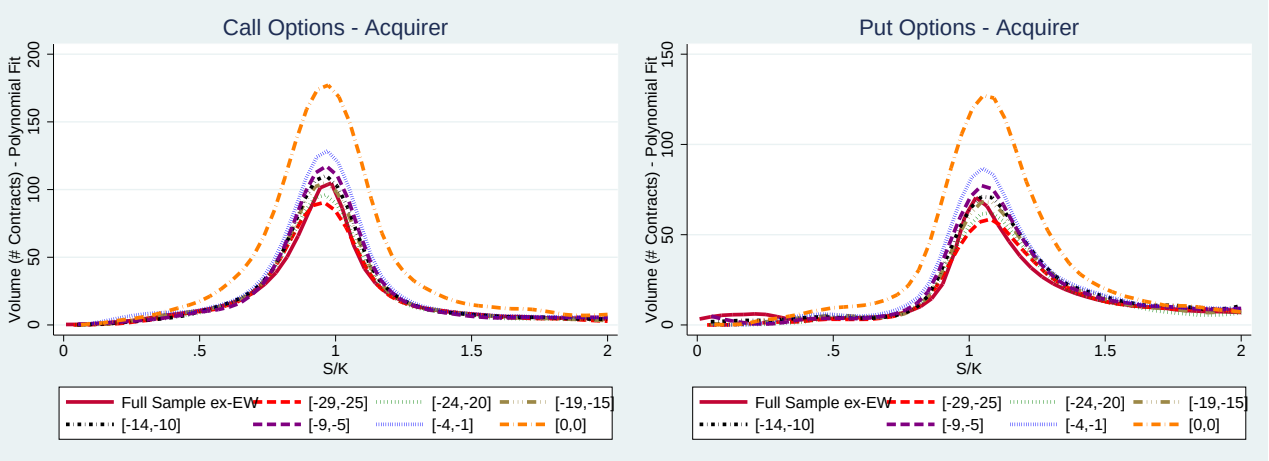


Figure A-9: Percentiles of the Estimated Takeover Probability

Figure A-9 plots the estimated takeover probabilities against the associated percentile rankings of the sample. The takeover probabilities are estimated using a logistic regression framework. Source: Thomson Reuters SDC Platinum, CRSP, OptionMetrics, Compustat, Thomson Reuters 13f filings.

(a)

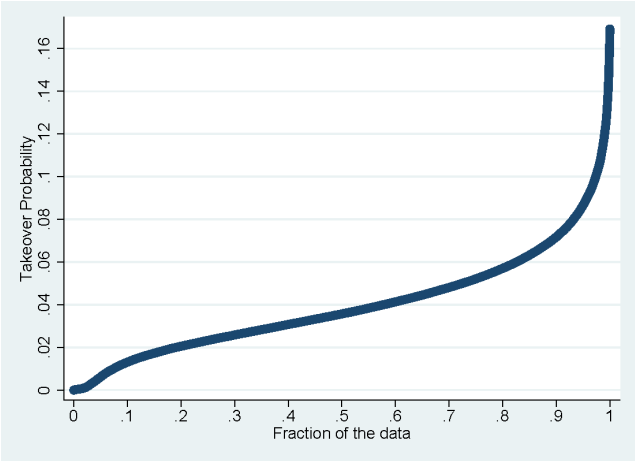
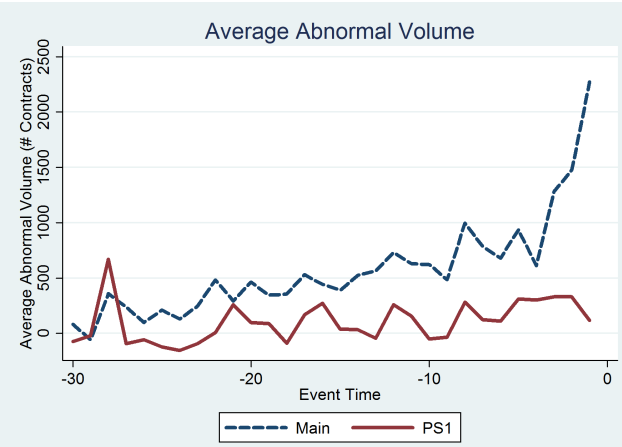


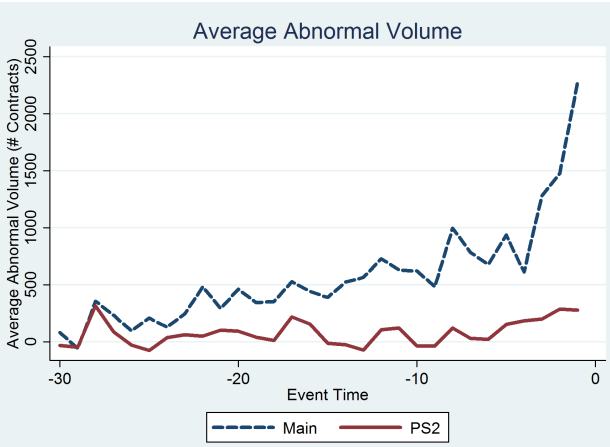
Figure A-10: Abnormal Trading Volumes in Treatment and Control Groups

Figures (A-10a) and (A-10c) plot the average and average cumulative abnormal trading volume, respectively, for aggregate options volume in the treatment group (Main - dashed line) and the propensity-matched control group using the best match (PS1 - solid line), over the 30 days preceding the announcement date. Volume is defined as the number of option contracts. Figures (A-10b) and (A-10d) report analogous figures for a different propensity-matched control group using the two closest matches. All graphs are based on the constant-mean volume model. Source: Thomson Reuters SDC Platinum, CRSP, OptionMetrics, Compustat, Thomson Reuters 13f filings.

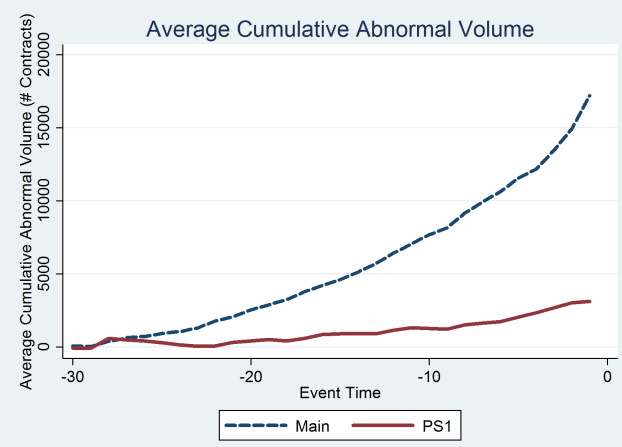
(a)



(b)



(c)



(d)