Does informed option trading before a merger deal announcement differ according to deal side?

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Abstract

There is pre-announcement cross-sectional information assimilation in changes in option implied model-free skewness in respect to announcement period equity returns. We show that changes in the option implied model-free skewness has significantly greater predictive capacity for principally cash financed target firms. A rationale for this pre-announcement option trading is (i) that the primarily cash financed target firms exhibit the largest discontinuous price impact at announcement and (ii) this finance mechanism, unlike in primarily equity financed deals, does not facilitate equity hedging of deal risk with an equity position in the counterpart deal firm. We formalize this intuition by simulating a simple model to show the information assimilation in changes in implied moments with respect to announcement returns. The results are robust to different run-up period windows and a wide set of cross-sectional stock return predictors. Pending merger deal announcements, we therefore show that, as reflected in changes in model-free option implied skewness, the options market plays an important role in price discovery.

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1 Introduction

In this paper, we study the price discovery process in the options market before merger event announcements. Our main findings are novel and important relative to the comparable prior literature, such as Cao, Chen and Griffin (2005) and Chan, Ge and Lin (2013), as we examine the extent to which there is, prior to merger events, forward-looking information content in changes in option implied model-free skewness with respect to announcement period stock returns. As a result of pronounced patterns in announcement stock returns associated with merger events, and the feasibility of hedging that risk, we further test if the predictive capacity of option implied information is associated principally with the side of the deal or the financing mechanism adopted. We therefore contribute to the debate concerning whether information, before extreme informational events, is reflected in option prices before it is reflected in stock prices or whether the options markets trade on publicly available information with no role to play in the price discovery process.

There are pronounced patterns associated with merger event announcement stock price responses according to deal side, whereby target firms exhibit a larger merger premium.[1] In addition, there are pronounced patterns associated with merger event announcement stock price responses according to the main finance mechanism adopted, whereby principally cash financed deals exhibit a larger merger premium.[2] These typical patterns in the announcement stock market returns in respect to merger announcements[3], may constitute a significant (upside or downside) prospective risk to options traders, who can formulate expectations based partially on these typical patterns in historical data. Furthermore, primarily equity financed target firm merger deals imply a straightforward hedge of deal risk in a position in the equity of the acquiring firm (Subramanian, 2004) and that, as a first approximation, the stock price of the acquirer can be ignored with respect to primarily cash financed target firms (Bester, Martinez and Rosu, 2012). A rationale, hence, for a larger expected extent of pre-announcement informed option trading, in respect to mainly cash financed target firms, is that historically these firms exhibit the largest announcement period returns, and that unlike in primarily equity financed deals, the deal risk is not offset in a position in the counterpart deal firm equity. Due to the typically lower liquidity (wider bid ask spreads) of options on target firms (Chan, Ge and Lin, 2013), and the likelihood of less available information on typically smaller target firms, however, informed traders can be impeded by these frictions. Therefore, even if options play a role in the price discovery process, it is an empirical question, despite the relatively low mean merger event announcement period returns on bidding firms, whether there is more information traded into options contracts on bidding firms than target firms.

The likelihood of a preference for options relative to stock, on the part of informed traders, follows due to the characterising features of these derivative instruments: the down-side protection in long options positions, relatively low short selling costs, trading constraints in comparison to equity and the capacity

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[1] In particular, three-day short-window event studies suggest the abnormal return for target firms is 16 per cent and this abnormal return is remarkably stable inter industry from the 1970s to the 1990s (Andrade and Stafford, 2004). The counterpart abnormal return for bidders is -0.7 per cent and it is associated with greater variability (Andrade and Stafford, 2004). These findings are corroborated in earlier studies by Jensen and Ruback (1983) and Jarrell, Brickley and Netter, (1988).

[2] Stock-financed mergers can be viewed as two simultaneous transactions: a merger and an equity issue. Investors who observe an equity issue, can bid down the stock price as managers are more likely to issue equity when they perceive that it is overvalued by the stock market (Myers and Majluf, 1984). Equity issues are associated with mean negative abnormal returns of around -2 to -3 percent during the few days surrounding the announcement. Andrade and Stafford (2004) also provide short-window event studies in respect to merger announcement stock returns according to the financing mechanism adopted. Bidding firms, which avail of any equity finance, have reliably negative three-day average abnormal returns of -1.5 percent, while if they do not avail of equity finance they have average abnormal returns of 0.4 percent which are indistinguishable to zero. The target firm three-day average abnormal return is reported to be 13 percent for stock-financed mergers and just over 20 percent for mergers financed without stock.

[3] These patterns are corroborated in this paper's sample of large United States mergers with options traded on the equity of at least one deal side.

to make leveraged bets using options instruments (Black, 1975 and Cao, 1999). Back (1993) develops a theoretical model which shows that options are non-redundant securities. Furthermore, Easley, O'Hara, and Srinivas (1998) suggest a 'pooling equilibrium' in which informed traders, in markets with frictions, will prefer to use the options market when implicit leverage in options is high and options are relatively liquid compared to stocks. As a result, we expect that should a merger deal be anticipated, informed traders can prefer to trade this information into prices via the options market as opposed to the stock market.

In typical trading environments, on a day-to-day basis, where asset price movements do not necessarily relate to extreme informational events, there is somewhat mixed evidence of price discovery in the options markets. For example, Chan, Chung, and Fong (2002) and Muravyev, Pearson, and Broussard (2013) find no evidence of price discovery in the options market but Pan and Poteshman (2006), Bali and Hovakimian (2009) and Conrad, Dittmar and Ghysels (2013) find to the contrary. In atypical trading environments in which there are large price effects, however, where substantial information is evidently revealed to the market, the empirical literature is relatively clear in its conclusions in relation to a significant role of options trading in price discovery (Diavatopoulos, Doran, Fodor and Peterson (2012) and Driessen, Lin and Lu (2013)). Notwithstanding, despite the fact that certain merger type events (*e.g.* principally cash financed target firm deals) have large announcement stock return effects, there is a limited body of research findings in respect to the role of the options market in price discovery prior to merger events. Cao, Chen and Griffin (2005) focus exclusively on target firms and find that prior to take overs call volume imbalances are strongly related to next day stock returns. Target firms with the greatest call volume imbalance pre-announcement exhibit the largest announcement day stock returns. Chan, Ge and Lin (2013) find a positive (negative) predictive capacity of implied volatility spread (skew) on the cumulative abnormal return of bidder firms and target firms.[4] While Chan, Ge and Lin (2013) have examined both bidder and target firms, they do not test differences in predictive capacity across deal side or across primary financing mechanisms though they do, interestingly, allude to weaker results for target firms. They ascribe the weaker results to lower levels of liquidity and higher information asymmetries.

In this paper, we depart from the study of the information content of call volume imbalances, implied volatility spread and skew to directly estimate the influence of *ex ante* changes in nonparametric model free higher moments of the underlying individual securities' risk-neutral returns distribution (following Bakshi, Kapadia and Madan (2003), Diavatopoulos, Doran, Fodor and Peterson (2012) and Conrad, Dittmar and Ghysels (2013)) on merger announcement returns.[5] Using a nonparametric approach, we therefore extract forward-looking option implied model-free information (changes in the values of our artificial contracts) in the run-up to merger events. This permits, relative to implied volatility spread and skew measurements, the use of a larger information set in the formulation of probability distributions (Jackwerth and Rubinstein, (1996)). Indeed, Conrad, Dittmar and Ghysels (2013), in their internet appendix, conduct simulation exercises, using a Heston model with plausible parameter values, which suggest that the Bakshi, Kapadia, and Madan (2003) approach of model free implied skewness estimation is relatively precise on a mean squared error metric, at least compared to the implied volatility skew adopted by Xing, Zhang, and Zhao (2010).

We hypothesise that option prices, prior to merger announcement events, can contain superior information to stock prices. Thus, the changes in implied skewness can contain information concerning the direction of the subsequent announcement return at extreme informational events. We, hence, provide meaningful new

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[4] The implied volatility spread statistic is detailed in Bali and Hovakimian (2009) and Cremers and Weinbaum (2010). The implied volatility skew statistic is detailed in Bollen and Whaley (2004) and Xing, Zhang and Zhao (2010). These variables are constructed from option implied volatilities with a view to capturing the decisions of potentially informed traders.

[5] Bakshi, Kapadia and Madan, (2003), show that higher risk neutral moments, such as skewness and kurtosis, can be expressed as functions of out-of-the-money calls and puts.

evidence with respect to the price discovery process in the options market before merger events as we test for differences in the predictive capacity of options trading before different deal events, as categorised by both the deal side and the main financing mechanism adopted. These categories of deal events are selected due to the distinct patterns which characterise their event period returns. We hypothesize that target firms with deal finance principally comprised of cash, which are anticipated in the options market, will exhibit significantly higher explanatory co-movement in implied higher moments, with respect to merger announcement period stock returns.

Our dataset comprises 440 (287 bidder and 153 target firm) merger event announcement returns from the Thompson One Banker Worldscope database, from January 1997 to August 2013. In respect to each bidding and target firm, we obtain options data from the OptionMetrics IvyDB database. We construct option implied model-free skewness (Bakshi, Kapadia and Madan, 2003, Diavatopoulos, Doran, Fodor and Peterson, 2012 and Conrad, Dittmar and Ghysels, 2013). We also construct a set of well-known cross-sectional equity return predictors, in relation to firm characteristics and the information content of options trading.

Our main findings are twofold. First, changes in model-free option implied skewness provides significant predictive power on announcement period returns, even after controlling for known cross-sectional return predictors, including implied volatility. Second, in respect to principally cash financed target firms we find a significant greater predictive capacity of changes in implied higher moments with respect to announcement period stock returns. To our knowledge, this is the first paper to test for a different predictive capacity inherent in options trading across deal side and/or principal financing mechanism in a merger deals setting.

We also conduct robustness tests which substantiate our main findings. We extend our set of control variables, to include implied volatility spread (Bali and Hovakimian (2009) and Cremers and Weinbaum (2010)) and skew (Bollen and Whaley (2004) and Xing, Zhang and Zhao (2010)). In addition, we then account for the effects of informed trading in options markets as the logarithm of the option volume to the share volume traded (Roll, Schwartz and Subrahmanyam (2010) and Johnson and So (2012)). Finally, we vary the run-up period before the announcement of the deal. Our main findings do not change. Taking our findings together, forward looking option implied model-free moment adjustments in the pre-announcement period, for principally cash financed deals, have significant explanatory power with respect to announcement period stock returns. The extent of this predictive capacity does vary according to the side of the deal and the finance mechanism adopted. Consistent with our expectations, the capacity of higher implied moment changes to predict announcement period returns is strongest in the setting of principally cash financed target firms.

The paper is organized as follows. Section 2 summarizes related literature. Section 3 describes the data set and the associative descriptive statistics. Section 4 states and motivates, availing of simulation studies, our hypotheses tests. Section 5 presents the main results with respect to the information content in changes in option implied model-free higher moments on merger event announcement returns. Section 6 provides robustness tests. The final section concludes.

2 Related Literature

In typical trading environments, where asset price movements do not relate to relatively extreme informational events, Chan, Chung, and Fong (2002) show that options trading volume, after controlling for stock trading volume, does not contribute to price discovery for the underlying stock. DeLong, Shleifer, Summers and Waldmann (1990) and Chan, Chung and Johnson (1993) provide findings in the same vein. In a recent contribution, Muravyev, Pearson, and Broussard (2013), show that option price quotes do not contain information beyond that which is already contained in the stock price quotes. These findings suggest that informed traders, at least in typical trading environments, initiate their trades in the stock market rather than in the options market. In contrast, Pan and Poteshman (2006), Bali and Hovakimian (2009), Roll, Schwartz and Subramanyam (2010), Xing, Zhang and Zhao (2010), Johnson and So (2012), DeMiguel, Plyakha, Uppal and Vilkov (2012) and Conrad, Dittmar and Ghysels (2013) find that the options markets do play an important role in price discovery, even in typical trading environments. The empirical literature on the role of options in price discovery, in typical trading environments, is, hence, fraught with conflicted conclusions.

In atypical trading environments, however, where substantial information is evidently revealed to the market as there are substantive mean stock price responses to the new information, the empirical literature is relatively clear in its conclusions. Informed traders may seek to capitalize on their private information in option markets prior to announcement. Diavatopoulos, Doran, Fodor and Peterson (2012) conduct a simulation analysis to show that changing expectations of certain unusually large subsequent price movements (those specifically associated with earnings announcements) will lead to contemporaneous changes in implied skewness. Hence, under the assumption of informed traders trading in the options markets, they illustrate the likely interaction between changes in option model free implied higher moments and subsequent stock returns, and they provide supporting empirical evidence. Furthermore, Driessen, Lin and Lu (2013) conduct an empirical study which finds that proxies for options trading predict corporate events including analyst forecasts and recommendation changes and earnings surprises and these proxies contain significantly less information in typical trading environments. Despite the large systematic price effects associated with merger deal announcements, there is limited research in respect to information assimilation in the options markets prior to merger events. Important exceptions include Cao, Chen and Griffin (2005) and Chan, Ge and Lin (2013). In this paper, we specify and test novel hypotheses in respect to different extents of information assimilation in the options market, according to the side of the deal and the principal finance mechanism adopted, prior to merger events. We hypothesise that the relative extents of information assimilation in the options markets, prior to merger events, can relate to the magnitude and variability of subsequent announcement period stock returns and to the characterising features of options instruments relative to the underlying stock.

3 Data and Descriptive Statistics

3.1 Data

Our dataset comprises merger event announcements from the Thompson One Banker Worldscope database. We include deals involving stocks listed on United States exchanges (AMEX, NASDAQ and NYSE) from January 1997 to August 2013. The deals are classified as disclosed value, undisclosed value, leverage buyouts, and tender offers. We discard deals where a takeover is not intended by the bidding firm (i.e. the bidding firm intends to hold less than 50% of the target firm after the proposed deal). We exclusively analyse deals with a deal value greater than or equal to 500 million United States dollars.

Our data on the prices of traded option contracts on merging firms, also sampled from January 1997 to April 2011, is sourced from the OptionMetrics IvyDB database. We filter the option prices data of merging firms, following Bali, Demirtas and Altigan (2012), DeMiguel, Plyakha, Uppal and Vilkov (2012) and Neumann and Skiadopoulous (2012), before calculating model-free implied moments. An important constraint, therefore, on our sample size is the availability of sufficient data on traded options around each merger announcement to calculate the option implied model-free moments. Only options with maturities greater than 10 days and less than 180 days are retained.[6]

Options with moneyness in the range 0.7 to 1.3 are exclusively studied due to their typically preferable liquidity and the lower possibility of early exercise issues. In addition, out-of-the-money options are used to illustrate the potential returns of informed option traders in the lead and the announcement periods. Any options with zero open interest or zero bids on a given day are also removed. Options with implied volatilities not computed by OptionMetrics or that violate put-call parity no arbitrage bounds are discarded and options with special settlement conditions are also removed.

After these filters are applied we have sufficient option price data and merger deal data to characterise the option implied distribution of the underlying equity prices for around 440 (287 bidder and 153 target firms) merger firms. Table 1 presents the descriptive statistics of the frequency of deal events from 1997 to 2011. It shows that, consistent with previous literature (Moeller, Schlingemann and Stulz 2004, 2005 and Chan, Ge and Lin, 2013), there is a relative prevalence of mergers in the late 1990s.

[Please insert table 1 about here.]

Furthermore, we split these deals by the principal financing method. Using the deal synopsis item in WorldScope each deal is analysed and listed as a primarily cash (equity) financed deal, if 60% or more of the deal is financed with cash (equity). This final 'financing method' filter leaves a sample of target firms with 53 deals financed primarily with cash and 92 deals financed primarily with equity. Likewise, bidding firms are divided into subsets of 109 deals where the bidder is financed primarily with cash and 137 deals where the bidder is financed primarily with equity.

3.2 Details of dependent, independent and control variables

Our dependent variable of primary interest is the announcement period return, BHR, from two trading days pre-announcement (t-2) to one trading day post-announcement (t+1), where day t is the announcement date. Following Bakshi, Kapadia and Madan (2003) and Diavatopoulos, Doran, Fodor and Peterson (2012), our independent variables of primary interest are the changes in option implied model-free skewness ($\Delta MFIS$), and option implied model-free kurtosis ($\Delta MFIK$), calculated between the third and the first week prior to the merger announcement. The change in option implied model-free volatility ($\Delta MFIV$) is also included in our regressions, as a control variable.

Consistent with key contributions in the literature on the information content of options trading on announcement period returns and the literature on the determination of cross-section equity returns we include in our model specifications several control variables. Firm characteristic factors are included in the form of firm Size (the market value of a stock's equity) and B/M (the ratio of the book value of a firm's common equity to its market value). Fama and French (1992) find that Size and B/M, capture relatively well a significant proportion of the variation of the cross-section of average stock returns. The deal value,

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[6] As the available options have different expiration dates we use interpolation and extrapolation to estimate a 40-day constant-horizon time to maturity. We select a 40-day as opposed to 30, 60 or 90-day constant-horizon times to maturity to preserve sample size whilst also retaining a maturity that is close to the announcement date. If the minimum moment maturity available is greater than 40 days then it is not possible to interpolate to find a value for the model-free implied skewness and the value is discarded. This approach results in a significant reduction in sample size but ensures the quality of the estimated moments.

following Andrade and Stafford (2004), is also controlled for in our specification using the logarithm of the deal value (Value). We follow Jegadeesh and Titman (1993) in respect to a stock price momentum proxy, $Momentum$, in the run-up to the announcement period. The logarithm of the option volume to the share volume traded, ($S_h(O/S)$), from the base period to the pre-announcement period is also calculated as a control variable. This variable is a measure of informed trading due to Roll, Schwartz and Subrahmanyam (2010). We extend our set of control variables to perform additional robustness tests, to include IV spread (Cremers and Weinbaum, 2010) and IV skew (Xing, Zhang and Zhao, 2010). These new variables are constructed from option implied volatilities and are expected to predict announcement returns. To control for possible industry effects we group deals by industry classification and include a dummy variable (IND = 1) for common industries. In line with Fama and French (2001), we adopt a time trend variable (Year = 1997, 1998, ..., 2011). In the appendix, we provide additional description of the variables used in our study.

3.3 Descriptive Statistics

The table 2 presents the descriptive statistics of the changes in option implied model-free implied moments, the volume on trades of the options to the underlying stock, $S_h(O/S)$, and firm characteristics (firm size, $Size$, and book-to-market, B/M) as well as deal value, $Value$, and stock price momentum, $Momentum$, in the run-up (between the third and the first week prior to deal announcements) to the announcement period. The deal announcement period is from two trading days pre-announcement (t-2) to one trading day post announcement (t+1), where day t is the announcement date. These descriptive statistics are reported in separate panels for the bidder and target firms and across primary cash and equity financing mechanisms.

It is evident that the arithmetic mean changes in option implied model free variance $\Delta MFIV$, skewness, $\Delta MFIS$ is approximately zero. The reported changes are small relative to their standard deviations. Interestingly, the proxy for informed trading, $S_h(O/S)$, due to Roll, Schwartz and Subrahmanyam (2010), is larger for equity financed deals for both bidder and target firms and is smallest in the run-up to target firm cash financed deals. Bidder firms, unsurprisingly, tend to have a considerably larger, $Size$, than target firms. Target firms have higher book-to-market ratios, B/M, than bidder firms. All firms show positive announcement returns in the run-up period before the announcement, and it is interesting to note that principally equity financed deals show the largest momentum, $Momentum$, effects.

[Please insert table 2 about here.]

table 2 (or something more concise) in respect only those deals where we have observed options trading on both bidder and target can reveal a negative correlation between the changes in implied moments of same deal firms. we could allocate the current table 2 version to appendices. A test for a negative correlation is from Stulz; a problem here can be too little data across our deal categories.

Consistent with findings in the literature (Andrade and Stafford, 2004, Jensen and Ruback, 1983, and Jarrell, Brickley and Netter, 1988) in respect to side of the deal and financing mechanism for merger deal announcement returns, our sample of target firms outperform and the announcement returns improve when the issuance of equity is not a primary means of financing the transaction. Primarily equity financed target firms yield an average return of 11.77%. The bidding firms in primarily equity financed transactions yield an average negative return of 3.96%. This outperformance is increased when the transaction is primarily cash financed, in this setting the mean target (bidder) announcement return is 21.22% (-0.66%). Furthermore, the mean announcement return on primarily cash financed targets is associated with a relatively small variation.

Its mean return (21.22%) is larger than its standard deviation (16.84%). An implication is that informed traders can take positions to avail of average returns associated with merger announcements, and this is especially the case in respect to cash financed target deals.

The principal purpose of the table, however, is to illustrate the extent to which these returns can be leveraged by taking straightforward long (or short) call and put options positions in the underlying equity. In particular, long call positions on target firm equity yield an average return of 150.47% and this percentage increases to an average return of 360.61% in the context of cash financed target firm announcements. Also, short put positions on target firm equity yield an average return of 26.33% and this percentage increases to an average return of 88.54% (standard deviation: 11.98%) in the context of cash financed target firm announcements. These distinct mean returns, especially in the context of short positions in put options on a primarily cash financed target firm, serve to highlight the additional opportunity, during the lead and in the deal announcement period, in the derivatives markets to benefit from informed trades relative to the opportunity to do so in the underlying equity market.

[Please insert table 3 about here.]

4 Hypotheses Tests and Simulation Work

4.1 Testable hypotheses

If informed traders, who have information in respect to an upcoming merger announcement, decide to trade accordingly in the option market, then there can be superior related information in option prices relative to equity prices during the pre merger announcement period. In this setting, before the announcement of merger events, changes in option implied model-free skewness can contain information concerning the subsequent announcement period stock returns. This leads to our main hypothesis test: Do changes in option implied model-free higher moments, prior to a merger announcement, contain information concerning the announcement period stock returns. To conduct our main hypothesis test and related tests we use specifications that are variants of the following form:

$$\begin{aligned} BHR_{i,t-2,t+1} = \alpha_0 + \alpha_1 DS_i + \alpha_2 C_i + \alpha_3 DS_i * C_i \\ +\beta_0 \Delta MFIM_i + \beta_1 \Delta MFIM_i\_DS_i + \beta_2 \Delta MFIM_i\_C_i \\ +\beta_3 \Delta MFIM_i\_DS_i\_C_i \\ +\sum_{j=1}^{k} \beta_j CV_{i,j} + \epsilon_t \end{aligned} \tag{1}$$

where i corresponds to the i^{th} deal firm. DS (deal side) is an indicator variable which takes a value of 1 if the deal firm is a target firm and zero otherwise and C is an indicator variable which takes a value of 1 if the deal firm is principally cash financed and zero otherwise. ΔMFIM is a change in a model free implied moment (skewness) and $CV_{i,j}$ is the j^{th} control variable in respect to the i^{th} deal firm.

To elaborate, our main hypothesis test implies a positive (negative) association between changes in option implied skewness and the subsequent announcement period stock returns of both bidder and target firms. Indeed, Bakshi, Kapadia, and Madan (2003) show that more negative option-implied model-free higher skewness is equivalent to, other things equal, a steeper slope of implied volatilities between at-the-money call options and out-of-the-money put options. Therefore, we hypothesize that option implied skewness changes account for the anticipated direction of the announcement period return and option implied kurtosis changes reflect the uncertainty of the magnitude of the announcement period return.

Due to the markedly large and less variable announcement period stock returns exhibited by target firms, in comparison to bidder firms, if there is informed trading before a merger event announcement, we expect a relatively pronounced information content of options trading in this time period. Thus, holding the deal financing constant, we expect that changes in option implied model-free higher moments can contain information concerning the announcement period stock returns to a significantly greater extent for target than for bidder firms. Chan, Ge and Lin (2014) suggest that this result may not hold due to the relative illiquidity and higher information asymmetries typically associated with target firms. As a result, we can test whether the information content in the option market varies according to deal side, which constitutes an important sub-hypothesis test.

Holding deal side constant, there are relatively large potential gains from announcement stock returns exhibited by primarily cash financed deals, relative to primarily equity financed deals. We, thus, conduct an additional sub-hypothesis test concerning whether there is a relatively pronounced information content in options trading in the run-up to the announcement of merger events for primarily cash financed deals in comparison to primarily equity financed deals. Our final sub-hypothesis test concerns an expectation of higher information content in option implied higher moments in respect to subsequent principally cash financed target firm deal announcement returns.

4.2 Simulation Work

4.2.1 Motivation

In this section we consider the motivation for examining model-free implied moments (MFIMs), Bakshi, Kapadia and Madan (2003), extracted from derivative prices *prior* to the date that a merger or acquisition event is announced to the public. A number of models have been put forth in the literature to price derivatives in the context of mergers and acquisitions, see Subramanian (2004) who considers equity mergers and Bester et al (2011) where derivatives are priced on target firms in cash mergers. These models are taken from the perspective of an M&A event that has already been publicly announced but where there is uncertainty about whether the deal will complete. In this paper we are focusing on derivatives markets prior to the announcement dates so these models are not appropriate. For motivational simplicity we will assume the underlying stock price follows Merton's (1976) jump-diffusion model. We assume that informed derivatives traders who have updated their expectations on a possible upcoming M&A announcement trade on their beliefs and that these beliefs get priced into the options markets (via changing risk neutral jump distribution parameters) prior to this information being assimilated into the stock market. We consider how these changing beliefs impact on the MFIMs and how this could potentially effect the underlying stock returns.

Before introducing the model we will differentiate our simulation study from that conducted in Diavatopoulos *et al* where changes in MFIMs are examined prior to earnings announcements. Diavatopoulos *et al* run a simulation study to examine the effect changing risk premiums have on option prices and extracted MFIMs. In the following analysis we also consider the effect of changing risk premiums on option prices and the extracted MFIMs but furthermore we link these changing risk premiums to changes in the expected return of the underlying stock under typical parameter settings. Diavatopoulos *et al* use a stochastic volatility jump-diffusion model in their simulations but we focus on the jump-diffusion model for simplicity. Another reason for focusing on jumps only is the typical time-to-maturities of options used in this study is 40 days where jump effects are much more pronounced than stochastic volatility effects. Diavatopoulos *et al* examine informed options trading around announcement dates and these event dates are known ex-ante which implies arrival rates are also known. This is not the case in the context of M&A announcements as the M&A announcement date is not known ex-ante. Diavatopoulos *et al* price options with Monte Carlo simulation whereas we use a jump-diffusion pricing model (Merton (1976)) to price options. Diavatopoulos *et al* do not compare the extracted MFIMs with the true moments of the risk neutral distribution. However we are using the Merton jump-diffusion model so the theoretical higher moments are available in closed form and we can compare the extracted MFIMs to the 'true' theoretical higher moments as function of the range of strike prices used to extract the moments.

4.2.2 Model

In this section we describe the simple jump-diffusion model used to motivate the extraction of MFIMs prior to M&A announcements. To make the model precise assume on a probability space $(\Omega, \mathcal{F}, \mathbb{P})$, where the usual notation applies and $\mathbb{P}$ is the physical probability measure, that the stock price has the following dynamics:

$$\frac{\mathrm{d}S_t}{S_t} = (r - q + \gamma - \lambda k)\,\mathrm{d}t + \sigma \mathrm{d}W_t + (y_t - 1)\,\mathrm{d}N_t$$

where S_t is a stock price, r is the risk-free rate, q is the dividend yield, γ is the equity premium, σ is the volatility of the diffusion process, W_t is a Brownian motion, $y_t - 1$ is the relative jump size and N_t is Poisson process with arrival rate λ. We also assume that W_t, y_t and N_t are independent. The relative price jump size $y_t - 1$ is assumed to be log normally distributed with $\ln y_t \sim N(\mu_j, \sigma_j^2)$ hence the expected jump size is given by $k = \exp\left(\mu_j + \frac{\sigma_j^2}{2}\right) - 1$. The term λk in the drift of the above stochastic differential equation is a compensator term to ensure that γ is the total risk premium. This jump-diffusion model is incomplete thus many equivalent martingale measures exist. One general way to change from the physical measure $\mathbb{P}$ to the risk neutral (RN) measure $\mathbb{Q}$ is to assume that the stock price follows the same stochastic process but where the RN jump arrival rate $\lambda^{\mathbb{Q}}$, the RN expected jump size $\mu_j^{\mathbb{Q}}$ and the RN volatility of the jump size $\sigma_j^{\mathbb{Q}}$ are different to their physical counterparts, for example, see Broadie, Chernov and Johannes (2007). Thus under the RN measure the stock price process is taken to be of the form:

$$\frac{\mathrm{d}S_t}{S_t} = \left(r - q - \lambda^{\mathbb{Q}} k^{\mathbb{Q}}\right)\mathrm{d}t + \sigma \mathrm{d}W_t\left(\mathbb{Q}\right) + (y_t - 1)\,\mathrm{d}N_t\left(\mathbb{Q}\right)$$

In this case the difference between the physical and risk neutral jump parameters are referred to as risk premia with $\gamma_\mu = \mu_j - \mu_j^{\mathbb{Q}}$ denoting the jump size risk premium, $\gamma_\sigma = \sigma_j^{\mathbb{Q}} - \sigma_j$ denoting the jump volatility risk premium and $\gamma_\lambda = \lambda^{\mathbb{Q}} - \lambda$ denoting the jump arrival rate risk premium. The compensator term in the risk neutral measure is analogous to its physical counterpart with $k^{\mathbb{Q}} = \exp\left(\mu_j^{\mathbb{Q}} + \frac{1}{2}\left(\sigma_j^{\mathbb{Q}}\right)^2\right) - 1$. The total risk premium can be decomposed as $\gamma = \gamma_d + \lambda k - \lambda^{\mathbb{Q}} k^{\mathbb{Q}}$ where γ_d is the diffusion risk premium and the jump contribution to the risk premium is given by $\lambda k - \lambda^{\mathbb{Q}} k^{\mathbb{Q}}$.

4.2.3 Effect of Informed Derivatives Trading on the Expected Return of the Stock

To make the motivating example concrete we will fix numerical values on the parameters and draw some conclusions. Assume the physical and risk neutral jump arrival rates are $\lambda = 0.4$ and $\lambda^{\mathbb{Q}} = 0.5$, the physical and risk neutral expected jump sizes are given by $\mu_j = -0.1$ and $\mu_j^{\mathbb{Q}} = -0.2$ and that the physical and risk neutral jump size volatility are given by $\sigma_j = 0.2$ and $\sigma_j^{\mathbb{Q}} = 0.2$. Assume that the diffusion risk premium is $\gamma_d = 0.03$. In this example $\lambda k - \lambda^{\mathbb{Q}} k^{\mathbb{Q}} = 0.0516$ and thus more than half of the total risk premium $\gamma = 8.16\%$ is due to jump risk. The physical instantaneous expected return is given by

$$\begin{aligned}\mathbb{E}^{\mathbb{P}}\left[\frac{\mathrm{d}S_t}{S_t}\right] &= \mathbb{E}^{\mathbb{P}}\left[(r - q + \gamma - \lambda k)\,\mathrm{d}t\right] + \mathbb{E}^{\mathbb{P}}\left[\sigma \mathrm{d}W_t\right] + \mathbb{E}^{\mathbb{P}}\left[(y_t - 1)\,\mathrm{d}N_t\right] \\ &= (r - q + \gamma - \lambda k)\,\mathrm{d}t + 0 + \lambda k \mathrm{d}t \\ &= (r - q + \gamma)\,\mathrm{d}t.\end{aligned}$$

Now consider an informed derivatives trader who suspects that the firm is the likely target of a takeover bid that is soon to be announced. Hence this informed trader updates their physical jump distribution parameters by assuming that if a jump occurs it is likely to be a positive jump rather than a negative jump. Assume the informed derivatives trader assigns the following value to the mean jump size, $\mu_j^{inf} = 0.2$, as opposed to the original negative mean jump size of $\mu_j = -0.1$. Assume for simplicity that the informed physical jump arrival rate and jump volatility remain the same as the uninformed parameter values[7]. The trader acts on their beliefs by purchasing options and the model used to calculate the option prices must use the risk neutral parameters. In the case of an informed trader whose actions do not impact derivatives prices the jump risk premium becomes $\lambda^{inf} k^{inf} - \lambda^{\mathbb{Q}} k^{\mathbb{Q}} = 0.1808$ hence the total informed risk premium becomes $\gamma^{inf} = 21.08\%$. As the information about the upcoming M&A announcement event becomes more certain informed traders will purchase more options to reflect their beliefs about an impending takeover thus impacting derivatives prices and causing the risk neutral jump parameter $\mu_j^{\mathbb{Q}}$ to converge towards, but not necessarily to, μ_j^{inf} (as an expected jump size risk premium may still remain). This increase in $\mu_j^{\mathbb{Q}}$ will cause a resulting increase in the risk neutral skewness. This is why we extract model-free risk neutral (implied) skewness prior to an M&A event becoming public knowledge. Furthermore this is why it is hypothesised in our paper that a significant positive change in model-free implied skewness will be associated with future positive stock returns.

A similar argument can be made regarding the risk neutral volatility $\sigma_j^{\mathbb{Q}}$. For instance if the informed trader updates their physical jump parameters by assuming, as in the previous example, that if a jump occurs it is likely to be a positive jump rather than a negative jump, $\mu_j^{inf} = 0.2$ and, unlike in the previous example, that the volatility of the jump size to the informed trader is lower $\sigma_j^{inf} = 0.1 < \sigma_j = 0.2$. In this example the risk premium increases to $\gamma = 21.70\%$ which is only a slight increase above the previous example. As the information about the upcoming M&A announcement event becomes more certain informed traders will purchase more options to reflect their beliefs thus impacting derivatives prices and causing the risk neutral jump parameter $\sigma_j^{\mathbb{Q}}$ to converge towards, but not necessarily to, σ_j^{inf} (as a jump size volatility risk premium may still remain). This decrease in $\sigma_j^{\mathbb{Q}}$ will cause a resulting decrease in the risk neutral kurtosis. This is why we extract model-free risk neutral (implied) kurtosis prior to an M&A event becoming public knowledge. Furthermore this is why it is hypothesised in our paper that a significant negative change

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[7] To generalise this example we could have assumed that $\lambda^{inf} > \lambda$ and that $\sigma_j^{inf} < \sigma_j$ i.e. the informed jump arrival intensity is greater than the uninformed jump arrival intensity and the informed jump volatility is less than the uninformed jump volatility as the informed traders are more certain that a positive jump will occur and the jump will be less uncertain.

in model-free implied kurtosis will be associated with future positive stock returns. However we also note that this relationship is expected to be weaker than the implied skewness/future stock return relationship due to the second order effect a lower jump volatility has on the risk premium relative to a first order effect that a higher jump mean has on the risk premium.

Finally a similar argument to the above two arguments can be made regarding the risk neutral arrival rate $\lambda^{\mathbb{Q}}$ where informed beliefs about an upcoming M&A announcement event will likely cause $\lambda^{\mathbb{Q}}$ to increase towards a higher informed physical jump arrival rate λ^{inf}. An increasing $\lambda^{\mathbb{Q}}$ will cause both risk neutral skewness and kurtosis to increase all else being equal.

4.3 Simulation Study

In this simulation study we price European call and put options under the jump-diffusion model considered above with a base set of risk neutral parameters given by $\left(r, q, \sigma, \lambda^{\mathbb{Q}}, \mu_j^{\mathbb{Q}}, \sigma_j^{\mathbb{Q}}\right) = (0.05, 0, 0.20, 0.5, -0.20, 0.20)$ over a varying range of available strike prices. The initial stock price is taken to be $S = 100$ and the time-to-maturity of derivatives are taken to be $T = 40$ days to agree with the maturity of options used in the empirical section. We then consider the impact a change in a risk neutral jump parameter(s) has on the extracted MFIMs as a function of the range of strike prices over which option prices are available.

This section assumes informed beliefs get reflected into risk neutral parameters and a measure of these informed beliefs can be extracted using MFIMs. However the extent to which these informed beliefs can be extracted depends on the range of strike prices over which options are available. We consider three different cases of changing risk neutral parameter values: (i) where $\mu_j^{\mathbb{Q}}$ changes from -0.2 to 0.1, (ii) where $\left(\mu_j^{\mathbb{Q}}, \sigma_j^{\mathbb{Q}}\right)$ changes from $(-0.2, 0.2)$ to $(0.1, 0.12)$ and (iii) where $\left(\mu_j^{\mathbb{Q}}, \sigma_j^{\mathbb{Q}}, \lambda_j^{\mathbb{Q}}\right)$ changes from $(-0.2, 0.2, 0.5)$ to $(0.1, 0.12, 0.8)$. For each set of parameters we calculate the theoretical jump-diffusion moments and extract the MFIMs assuming that European call and put options are available over three different ranges of moneyness levels (where moneyness is defined as $m = K/S$ where K is the strike price): (a) $m \in [0.8, 1.2]$, (b) $m \in [0.7, 1.3]$ and (c) $m \in [0.5, 1.5]$ and where it is assumed that option prices are available at all integer strike prices between the minimum and maximum strike prices: $K_{\min}$ and $K_{\max}$. As an additional benchmark we also consider Black-Scholes options where the Black-Scholes implied volatility parameter, σ_{bs}, is chosen to have the same volatility as the jump-diffusion model: $\sigma_{bs}^2 = \sigma^2 + \lambda\left(\mu_j^2 + \sigma_j^2\right)$. Furthermore we include the effect on the underlying expected returns assuming the informed option trader beliefs are correct.

It is clear from Table xxx that the MFIMs do reflect the changing risk neutral parameter values (which may be caused by informed trading) and that the accuracy of the MFIMs improves with larger moneyness ranges. However in the empirical modelling section we decide to select the moneyness range to be $m \in [0.7, 1.3]$ to reflect the fact the MFIMs are reasonable well captured and to ensure that the option prices used to extract MFIMs are not too far from the money as these options are usually less liquid that those closer to the money.

Finally we stress that the MFIMs are non-parametric risk neutral moment estimators however the simulation in this section was conducted in the context of the parametric jump-diffusion model to provide motivation for using MFIMs to predict future stock returns around an M&A announcement event.

5 Empirical Findings

In this section, the objective is to explore our detailed data set to report evidence on the pertinence of pre announcement changes in option implied model free moments in respect to information assimilation in that market prior to announcement period stock returns. Prior to a merger deal announcement, we have hypothesized that option prices, due to preferences in informed trading, can assimilate the new information content before stock prices. As a result, changes in option implied model free moments may contain information concerning stock returns prior to merger deal announcements.

In panel A and panel B of table 4, we report cross-sectional regressions of announcement stock returns (t-2 to t+1), which, following Diavatopoulos, Doran, Fodor and Peterson (2012), include in the base line model specifications changes in option implied model free moments: skewness ($\Delta MFIM$) in panel A, and kurtosis ($\Delta MFIK$) in panel B. The model specifications, due to high collinearity, do not include both changes in skewness and kurtosis implied moments in a single regression specification. We study subsets of deals for the information content, on announcement period equity returns, of prior changes in model free skewness and kurtosis. The subsets of deals are delineated using systems of dummy variables across bidder and target firms and across principal financing mechanisms, whether principally cash or equity financed. We, thus, extend the pre-announcement options market related information assimilation work of Cao, Chen and Griffin (2005) who focus exclusively on target firms and Chan, Ge and Lin (2013) who examine both bidder and target firms in disaggregating announcement return premia according to deal side *and* principal financing mechanism.

We control for well-known cross-sectional return predictors. Specifically, we account for the option/stock trading volume ratio ($S_h(O/S)$); the book-to-market ratio (B/M) and size ($Size$) characteristics of the merging firm; a momentum factor ($Momentum$); the deal value ($Value$) and four sets of dummy variables (merger deal side, principal financing mechanism, industry sector and time) [exhaustive?].

To begin, in panel A model specification (1), we account for the announcement return premia associated with changes in model free implied skewness, deal side and the principal finance mechanism adopted, while controlling for well-known equity return covariates. It is not surprising that deal side is of first order importance in respect to the magnitude of announcement period returns. The announcement period return of target firms is about 18.9% higher than that of bidder firms. The announcement period return of principally cash financed deals is about 4.8% higher than principally equity financed deals. Finally, in model specification (1) changes in model free implied skewness are substantively positively related to announcement returns (...).

To more directly address the question of causality, between deal characteristics and pre-announcement changes in implied moments, we turn to model specification 2 in panel A, where we account for the key interaction terms with model free implied skewness changes. From the coefficient on the $CashDealSide$ interaction variable, it is evident that the deal side effect is substantively larger in principally cash financed than in principally equity financed deals. The deal side effect is associated with an 8% higher announcement return premium in principally cash financed deals. Indicative of earlier findings (Andrade and Stafford, 2004), target firms in deals which have been principally cash financed are associated with substantively higher announcement period returns.

Our main finding in model specification (2), however, is that deal side and principal finance mechanism announcement return effects are substantively stronger with positive pre-announcement changes in model free implied skewness. In panel A model specification (3) we extend the model to include a triple interaction term. In line with our a priori prediction, the triple interaction term's coefficient suggests that principally cash financed target firms announcement returns are strongly positively associated with changes in model free implied skewness. This major finding is consistent with information assimilation in the options market, with respect to deal side and principal finance mechanism, prior to deal announcements.

Turning to panel B, we focus on the information content of pre-announcement changes in model free implied kurtosis with respect to announcement period stock returns. In model specification (1) of the panel it is evident that while there is a significant negative effect of model free implied kurtosis changes on deal announcement stock returns, the effect is generally very small. Nevertheless, once we examine, in model specification (2), interaction terms with the principal financing mechanism, a substantively stronger and negative coefficient is evident. Finally, our major result, in respect to model specification (3) suggests that, our a priori prediction is correct. In regard to principally cash financed target firms, pre announcement increases in model free implied kurtosis are associated with reduced announcement period stock returns.

Target firms which are principally cash financed out perform principally cash financed bidder firms by up to 25.6% in the announcement period (16.7% and 8.9%). It is also evident that for principally cash financed deals, bidder firms exhibit an announcement return premium of between 2.3% and 4.8%, relative to bidder firms that are principally equity financed. The results are similar but even more pronounced for target firms. The target firm announcement return premium, linked to a principal cash finance mechanism, rises up to 11.2% (8.9% and 2.3%).

Taking our main findings together, the announcement equity return premia magnitudes vary in accordance to the prior information content evident in options trading. In the first instance, it is noteworthy that the deal side premia is positively related to the changes in model free implied skewness (8.6%) but only marginally related in model free implied kurtosis. Notwithstanding, once we explicitly account for covariation between implied moment changes and principally cash financed target firms deal premia, it is evident that the magnitude of the estimated premia are strongly positively correlated with prior changes in model free implied skewness and strongly negatively correlated with prior changes in model free implied kurtosis. In particular, a one unit standard deviation ($\Delta MFIM\sigma = 0.254$) change in implied skewness is associated with 5.94% (100*0.254*0.234) of the principally cash financed target firm percentage announcement return. The implied kurtosis change also has a substantively information content and a single standard deviation increase is associated with a -6.49% (100*0.747*-0.087) of the principally cash financed target firm percentage announcement return.

[Please insert table 4 about here.]

5.1 Robustness check

In table 5, we provide robustness tests in regard to our findings for the relative importance of deal side effects and financing mechanism effects. We extend our set of control variables, which we have used, to include IV (implied volatility) spread (Cremers and Weinbaum, 2010) and IV (implied volatility) skew (Xing, Zhang and Zhao, 2010) of the table. These new variables are constructed from option implied volatilities and are expected to predict announcement returns. Specifically, IV spread measures the difference in call and put options implied volatilites (same underlying stock, term to maturity and strike price) and hence a larger IV spread indicates more buying pressure on call options than on put options, which corresponds to an expected increase in future stock price. IV skew measures the differences in implied volatilities of out-of-the-money puts and at-the-money calls and hence its increase indicates an expected decline in future stock price. Finally, we also include an option trading related measure of informed trading, the logarithm of the option volume to the share volume traded, ($S_h(O/S)$), from the base period to the pre-announcement period (Roll, Schwartz and Subrahmanyam, 2010). As an additional robustness check, we extend the lead period, in which we calculate the change in implied moments, to a window of time from four weeks pre-announcement to one week pre-announcement.[8]

The findings reported in table 5 are entirely consistent with the results reported in table 4. Please see in particular the triple interaction effects in the full range of model specifications.

We also propose to conduct an additional 'falsification' causality test in respect to information content on simulated pseudo-events. Our pseudo event definitions will include: (1) for each sample deal firm we will randomly select a non deal announcement date (2) for each deal announcement date we will randomly select a non-deal firm and (3) we will randomly choose a non deal announcement date and a non-deal firm. We can replicate our (table 4) regression methodology 1000 times in respect to each pseudo event definition and compute the number of key coefficients larger than those reported in table 4. This number can be reported as a pseudo test p-value. Our hypotheses imply significant information assimilation by informed options traders which would be consistent with small pseudo p values.

[**Please insert table 5 about here.**]

6 Conclusion

In the weeks prior to merger announcements we test if there is a cross-sectional predictive capacity of changes in option implied model-free skewness in respect to announcement period abnormal returns. In particular, we test if a predictive capacity differs across deal side and the principal financing mechanism adopted. A rationale for this pre-announcement option trading stems the pronounced empirical regularity that primarily cash financed target firms exhibit the largest and least variable announcement period returns together with the fact that target equity is not easily hedged when the merger deal is principally cash financed. To the best of our knowledge, this is the first paper to empirically assess different extents of predictive capacity evident in options trading across deal side and/or the principal financing mechanism adopted in a merger deals setting.

We show that changes in model-free option implied skewness provide significant explanatory power on announcement period abnormal returns, even after controlling for known cross-sectional return predictors, including implied volatility. In respect to principally cash financed deals we find a significant predictive capacity of changes in implied higher moments with respect to principally cash financed target firm announcement stock returns, and to a lesser extent in respect to bidder firms. We also validate our main findings as we show they do not substantively change when we also account for the predictive capacity of implied volatility spread (Bali and Hovakimian (2009) and Cremers and Weinbaum (2010)) or skew (Bollen and Whaley (2004) and Xing, Zhang and Zhao (2010)) or the logarithm of the option volume to the share volume traded (Roll, Schwartz and Subrahmanyam (2010) and Johnson and So (2012)) or if we vary the run-up period before the announcement of the deal.

Extensions of the present paper may prove insightful in respect to the prediction, on announcement period returns, of the option implied higher moment changes across different industries. For instance, due to the theory of 'information cascades' by Bikchandani, Sushil, Hirshleifer and Welch (1992) it will be worthwhile to explore the possibility of increased predictive capacity before a merger deal announcement which succeeds other same industry merger deal announcements. In addition, it will be of especial interest in future work to test whether changes in implied volatility skew and spread measures have significantly greater predictive

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[8] Additional robustness tests are conducted in respect to the relative predictive capacity of IV spread, IV skew and the option volume to the share volume traded, $(S_h(O/S))$ across deal side and across the principal financing methods adopted. In general, these measurements are not successful in discerning statistically significant different predictive capacities at the 5% significance level. The results are available from the authors on request.

capacity for target than for bidder firms and in accordance with the principal financing mechanism adopted, as found in this paper.

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Table 1: Frequency of Deal Events and Firms Involved over Time

The table presents the number of large bidder and target merger events and the number of firms involved in these events from 1997 to 2011. Bidder and Target deals with a deal value greater than or equal to 500 million USD are included.

Category	’97	’98	’99	’00	’01	’02	’03	’04	’05	’06	’07	’08	’09	’10	’11	’12	’13	’97-’13
Bidder Events	6	5	71	81	45	18	16	8	23	23	37	30	33	46	34	61	24	561
Bidder Firms	5	5	52	64	38	16	14	8	21	23	36	27	32	43	32	57	23	496
Target Events	0	2	27	38	7	2	8	4	7	18	18	9	6	17	30	14	1	208
Target Firms	0	2	27	38	7	2	8	4	7	18	18	9	6	17	30	14	1	208

Table 2: Descriptive Statistics for the Changes in Implied Moments and Firm Characteristics and other Control Variables.

The table presents in panels A and B descriptive statistics for bidder and target firm deals. The variables Size and Value are reported in billions of USD. The variables are defined in the appendix.

Panel A: Bidder Deals

Variable	N	Mean	Std	Min	Q1	Median	Q3	Max
$\Delta MFIV$	561	0.00	0.06	-0.50	-0.03	0.00	0.02	0.30
$\Delta MFIS$	561	-0.01	0.24	-0.96	-0.13	-0.01	0.11	1.23
$S_h(O/S)$	561	2.20	1.17	-1.34	1.39	2.05	2.83	7.83
Size	561	47.82	69.84	0.22	7.03	19.76	56.27	460.77
B/M	561	0.35	0.25	0.00	0.17	0.30	0.49	1.82
Value	561	4.16	10.67	0.50	0.76	1.40	3.48	164.75
Momentum	561	0.20	0.70	-5.60	-0.08	0.14	0.36	6.89

Panel B: Target Deals

Variable	N	Mean	Std	Min	Q1	Median	Q3	Max
$\Delta MFIV$	208	0.01	0.11	-0.22	-0.03	-0.01	0.04	0.81
$\Delta MFIS$	208	-0.03	0.28	-1.79	-0.14	0.00	0.09	0.91
$S_h(O/S)$	208	2.07	1.26	-1.48	1.13	1.96	2.76	6.11
Size	208	6.00	11.17	0.08	1.16	2.30	5.79	93.07
B/M	208	0.35	0.25	0.00	0.16	0.31	0.50	1.34
Value	208	10.32	17.40	0.51	2.15	4.22	10.33	164.75
Momentum	208	0.48	1.42	-0.93	-0.09	0.16	0.55	14.72

Table 3: Spot and Option Announcement Returns

The table presents the descriptive statistics of the equally weighted spot announcement returns of merging firms from two trading days pre-announcement (t-2) to one trading day post-announcement (t+1), where day t is the announcement date. The table also presents descriptive statistics of the equally weighted derivative contract buy-and hold returns of merging firms from 17 trading days pre-announcement to one trading day post announcement. The returns are presented for each deal side (bidder and target). The derivatives announcement return calculations are in respect to long positions in these contracts. The derivatives contracts used in the return calculations are selected according to the following filters: expiration dates are between 10 and 180 days; moneyness levels are between 0.7 and 1.3 and contracts with zero bid prices and zero open interest are excluded from the sample.

Panel A: Bidder Firm Announcement Spot and Option Returns

Type	N	Mean	Std	Min	Q1	Median	Q3	Max	Avg. Expiry
Spot	561	-0.59%	8.50%	-37.18%	-4.81%	-0.28%	3.28%	42.78%	
Calls	296	23.70%	124.76%	-91.02%	-40.06%	-11.71%	34.74%	978.81%	93
Puts	296	3.79%	81.62%	-85.99%	-40.09%	-15.56%	25.06%	805.47%	92

Panel B: Target Firm Announcement Spot and Option Returns

Type	N	Mean	Std	Min	Q1	Median	Q3	Max	Avg. Expiry
Spot	208	19.44%	19.03%	-20.92%	5.93%	15.91%	31.71%	83.21%	
Calls	197	387.56%	742.17%	-91.39%	15.39%	158.74%	494.34%	7302.31%	94
Puts	191	-70.88%	44.54%	-99.15%	-94.64%	-84.27%	-67.50%	316.83%	101

Table 4: Analysis of Deal Side Effects in Implied Moment Predictions

The table presents cross-sectional regression results to test for deal side effects on announcement returns. The dummy variable multiplying $\Delta MFIS$ to give $\Delta MFISDealside$, is 1 for targets and zero otherwise. P-values are computed using White's (1980) heteroskedasticity robust standard errors (in parentheses). *, **, and *** indicate significance at 10%, 5%, and 1% level respectively. The variables are defined in the appendix.

Model-Free Implied Skewness

	(1) Return	(2) Return	(3) Return
$\Delta MFIS$	0.033^{**}	0.036^{***}	0.011
	(0.015)	(0.013)	(0.011)
DealSide		0.205^{***}	0.208^{***}
		(0.016)	(0.016)
$\Delta MFISDealside$			0.074^{**}
			(0.036)
Size	-0.036^{***}	-0.005	-0.004
	(0.004)	(0.003)	(0.003)
BM	-0.010	-0.003	-0.002
	(0.007)	(0.006)	(0.006)
Value	0.021^{***}	-0.011^{***}	-0.012^{***}
	(0.004)	(0.004)	(0.004)
Mom	-0.007	-0.005	-0.005
	(0.007)	(0.007)	(0.007)
SIC	0.001	-0.013	-0.014
	(0.023)	(0.021)	(0.021)
Year	0.004^{***}	0.003^{***}	0.003^{***}
	(0.001)	(0.001)	(0.001)
Constant	0.171^{***}	0.096^{**}	0.094^{**}
	(0.051)	(0.043)	(0.043)
Observations	769	769	769
R^2	0.18	0.37	0.37

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Investigation of Potential Structural Break After 2008

The table presents cross-sectional regression results to test for deal side and principal finance mechanism effects on announcement returns excluding any deals after December 2008. The dummy variable multiplying $\Delta MFIS$ to give $\Delta MFISCash$, is 1 for principally cash financed deals and zero otherwise. The dummy variable multiplying $\Delta MFIS$ to give $\Delta MFISDealside$, is 1 for targets and zero otherwise. P-values are computed using White‘s (1980) heteroskedasticity robust standard errors (in parentheses). *, **, and *** indicate significance at 10%, 5%, and 1% level respectively. The variables are defined in the appendix.

Model-Free Implied Skewness

	(1) Return	(2) Return	(3) Return
$\Delta MFIS$	0.059^{***}	0.011	0.033
	(0.018)	(0.023)	(0.022)
Cash	0.024^{**}	0.008	0.007
	(0.011)	(0.008)	(0.008)
DealSide	0.211^{***}	0.193^{***}	0.193^{***}
	(0.019)	(0.023)	(0.023)
$Cash\_DealSide$		0.068^{**}	0.073^{**}
		(0.032)	(0.033)
$MFIS\_Cash$		0.022	-0.042
		(0.041)	(0.038)
$MFIS\_Dealside$		0.103^{**}	0.054
		(0.044)	(0.050)
$MFIS\_Cash\_Dealside$			0.145
			(0.090)
Size	-0.003	-0.001	-0.001
	(0.004)	(0.004)	(0.004)
BM	-0.004	-0.003	-0.003
	(0.007)	(0.007)	(0.007)
Value	-0.015^{***}	-0.015^{***}	-0.016^{***}
	(0.004)	(0.004)	(0.004)
Mom	-0.007	-0.005	-0.005
	(0.007)	(0.007)	(0.007)
SIC	-0.011	-0.014	-0.014
	(0.024)	(0.025)	(0.025)
Year	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
Constant	0.110^{**}	0.100^{**}	0.101^{**}
	(0.050)	(0.050)	(0.051)
Observations	542	542	542
R^2	0.38	0.39	0.40

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Robustness of Deal Side Effects to the Implied Volatility Spread, Implied Volatility Skew, $S_h(O/S)$ and a Different Calculation window for the Implied Moment Changes

The table presents robustness tests for deal side effects on announcement returns which includes alternative option-derived information related measures and an alternative calculation period for the implied moment measures. In column 1 regression results are reported including the implied volatility spread (IVSpread) and the option stock order imbalance $S_h(O/S)$. In column 2 regression results are reported including the implied volatility spread (IVSkew) and the option stock order imbalance $S_h(O/S)$. In column 3 regression results are reported using an alternative run up period for calculating the change in the implied moments (the change from the first week to the fourth week pre-announcement is used). A full set of control variables is used but is suppressed for clarity. P-values are computed using the Newey-West (1987) heteroskedasticity and serial correlation corrected standard errors (in parenthesis). *, **, and *** indicate significance at 10%, 5%, and 1% level respectively. The variables are defined in the appendix.

Mode-Free Implied Skewness

	(1) Return	(2) Return	(3) Return
$\Delta MFIS$	0.011	0.005	-0.002
	(0.011)	(0.011)	(0.009)
DealSide	0.212***	0.206***	0.216***
	(0.016)	(0.016)	(0.017)
$\Delta MFISDealside$	0.073**	0.058	0.124***
	(0.035)	(0.036)	(0.046)
IVSpread	0.014		
	(0.030)		
IVSkew		-0.159	
		(0.112)	
OS	0.010***	0.011***	
	(0.004)	(0.004)	
Size	-0.003	-0.002	-0.004
	(0.003)	(0.003)	(0.003)
BM	-0.003	-0.004	-0.005
	(0.006)	(0.006)	(0.007)
Value	-0.012***	-0.011***	-0.011***
	(0.004)	(0.003)	(0.004)
Mom	-0.004	-0.004	-0.006
	(0.007)	(0.006)	(0.007)
SIC	-0.012	0.002	-0.017
	(0.021)	(0.022)	(0.022)
Year	0.003***	0.004***	0.003***
	(0.001)	(0.001)	(0.001)
Constant	0.060	0.035	0.086*
	(0.047)	(0.044)	(0.046)
Observations	769	737	696
R^2	0.38	0.38	0.38

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Analysis of Deal Side Effects in Alternative Measures

The table presents cross-sectional regression results to test for deal side effects on announcement returns. The dummy variable multiplying IVSpread and IVSkew to give $IVSpreadDealside$ and $IVSkewDealside$, is 1 for targets and zero otherwise. P-values are computed using White‘s (1980) heteroskedasticity robust standard errors (in parentheses). *, **, and *** indicate significance at 10%, 5%, and 1% level respectively. The variables are defined in the appendix.

Implied Volatility Spread		Implied Volatility Skew		OS	
	(1) Return		(1) Return		(1) Return
IVSpread	-0.021	IVSkew	-0.064	OS	0.000
	(0.026)		(0.108)		(0.003)
DealSide	0.209***	DealSide	0.211***	DealSide	0.140***
	(0.016)		(0.019)		(0.026)
IVSpreadDealSide	0.338	IVSkewDealSide	-0.279	OSDealSide	0.031***
	(0.218)		(0.222)		(0.010)
Size	-0.005	Size	-0.004	Size	-0.004
	(0.003)		(0.003)		(0.003)
BM	-0.002	BM	-0.003	BM	-0.004
	(0.006)		(0.006)		(0.006)
Value	-0.012***	Value	-0.011***	Value	-0.011***
	(0.003)		(0.003)		(0.004)
Mom	-0.004	Mom	-0.005	Mom	-0.004
	(0.007)		(0.006)		(0.007)
SIC	-0.011	SIC	-0.001	SIC	-0.014
	(0.021)		(0.021)		(0.021)
Year	0.003***	Year	0.004***	Year	0.003***
	(0.001)		(0.001)		(0.001)
Constant	0.103**	Constant	0.079*	Constant	0.091*
	(0.042)		(0.041)		(0.047)
Observations	769	Observations	737	Observations	769
R^2	0.37	R^2	0.37	R^2	0.39

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

A Appendix

A.1 Calculation of the Model-free Moments

The option implied model-free moments (Bakshi, Kapadia and Madan (2003)) afford a forward-looking measure of aggregate market expectations about different characteristics of the underlying stock price distribution. These moments identify a connection between the pricing of individual stock options and the moments of the associated forward-looking risk-neutral distribution. This methodology extracts moments from option prices using model-independent equations that do not impose any assumptions on the stochastic process of the underlying. The primary disadvantage inherent in this methodology relates to the amount of information required in the calculations.

If $S(t)$ is stock price at time t and $R(t,\tau) \equiv lnS(t+\tau) - lnS(t)$ is the τ period return then the variance, cubic and quartic contracts can be expressed as an expectation at time t under risk neutral measure.

$$V(t,\tau) \equiv \mathbb{E}_t^*\big[e^{-rt}R(t,\tau)^2\big] \tag{2}$$

$$W(t,\tau) \equiv \mathbb{E}_t^*\big[e^{-rt}R(t,\tau)^3\big] \tag{3}$$

$$X(t,\tau) \equiv \mathbb{E}_t^*\big[e^{-rt}R(t,\tau)^4\big] \tag{4}$$

These contracts are defined as an integral over the strike price (K) where $C(t,\tau)$ and $P(t,\tau)$ represent the time t price of a call and put option expiring at time τ respectively. This requires a continuum of option prices of different strikes. In practise these integrals need to be approximated discretely which amounts to approximating the respective integrals by discrete sums based on the prices of the available options (see, for example, DeMiguel, Plyakha, Uppal and Vilkov (2012))

$$\begin{aligned} V(t,\tau) = & \int_{S(t)}^{\infty} \frac{2(1 - ln\big[\frac{K}{S(t)}\big])}{K^2} C(t,\tau;K)dK \\ & + \int_{0}^{S(t)} \frac{2(1 + ln\big[\frac{K}{S(t)}\big])}{K^2} P(t,\tau;K)dK \end{aligned} \tag{5}$$

$$\begin{aligned} W(t,\tau) = & \int_{S(t)}^{\infty} \frac{6ln\big[\frac{K}{S(t)}\big] - 3(ln\big[\frac{K}{S(t)}\big])^2}{K^2} C(t,\tau;K)dK \\ & - \int_{0}^{S(t)} \frac{6ln\big[\frac{K}{S(t)}\big] + 3(ln\big[\frac{K}{S(t)}\big])^2}{K^2} P(t,\tau;K)dK \end{aligned} \tag{6}$$

$$\begin{aligned} X(t,\tau) = & \int_{S(t)}^{\infty} \frac{12(ln\big[\frac{K}{S(t)}\big])^2 - 4(ln\big[\frac{K}{S(t)}\big])^3}{K^2} C(t,\tau;K)dK \\ & + \int_{0}^{S(t)} \frac{12(ln\big[\frac{K}{S(t)}\big])^2 + 4(ln\big[\frac{K}{S(t)}\big])^3}{K^2} P(t,\tau;K)dK \end{aligned} \tag{7}$$

The model-free implied moments are then expressed as combinations of the variance, cubic and quartic contracts described above and $\mu(t,\tau)$, which is the risk neutral expectation of the logarithm of the return between time t and τ defined as

$$\mathbb{E}_t^*\left[\frac{S(t_\tau)}{S(t)}\right] = e^{rt} - 1 - \frac{e^{rt}}{2}V(t,\tau) - \frac{e^{rt}}{6}W(t,\tau) - \frac{e^{rt}}{24}X(t,\tau)$$

$$MFIV(t,\tau) = e^{rt}V(t,\tau) - \mu(t,\tau)^2 \tag{8}$$

$$MFIM(t,\tau) = \frac{e^{rt}W(t,\tau) - 3\mu(t,\tau)e^{rt}V(t,\tau) + 2\mu(t,\tau)^3}{[e^{rt}V(t,\tau) - \mu(t,\tau)^2]^{\frac{3}{2}}} \tag{9}$$

$$MFIK(t,\tau) = \frac{e^{rt}X(t,\tau) - 4\mu(t,\tau)e^{rt}W(t,\tau) + 6e^{rt}\mu(t,\tau)^2V(t,\tau) - 3\mu(t,\tau)^4}{\left[e^{rt}V(t,\tau) - \mu(t,\tau)^2\right]^2} \tag{10}$$

We calculate the risk-neutral measures for all cases where at least two call and two put options are available on a given date. The first step is to divide the strike price by the closing stock price at each relevant date to identify the moneyness of each option. Cubic splines are then used to interpolate between the respective implied volatilities inside the known moneyness range of available options. Outside of this range, the implied volatilities are extrapolated horizontally using the boundary values to avoid negative or unrealistic estimates. With this method a total of 1,001 grid points are calculated in the moneyness range from 1/3 to 3. Option prices are then calculated using the implied volatilities from the previous step and the appropriate interest rate. In the final step these option prices are used in the discrete sum representations of the integral equations representing the variance, cubic and quartic contracts.

A.2 Calculation of the Implied Volatility Spread

The Implied Volatility Spread is a variable constructed to proxy price pressure in the options market and is due to Cremers and Weinbaum (2010) . It measures deviations from put call parity using the average difference in implied volatilities between call and put options for the same security with the same strike price and the same maturity. If call options become more expensive relative to put options prior to a merger announcement we would expect this variable to be positively related to announcement period returns. In particular we calculate the IV Spread as;

$$IVSpread_{i,t} = \sum_{j=1}^{N_{i,t}} w_{j,t}^i (IV_{j,t}^{i,CALL} - IV_{j,t}^{i,PUT}) \tag{11}$$

where we represent the IVSpread for firm i on day t with j representing options paired by strike price and maturity, $N_{i,t}$ is the number of valid pairs and the weights $w_{j,t}$ are based on the average open interest of the call and the put options. IV, represents the Black-Scholes (1973) implied volatility for each call and put option. We filter options for inclusion in the calculation using conventions in the literature; options with zero open interest or zero bid price are removed as are options with a time-to-maturity greater than than 60 days.

A.3 Calculation of the Implied Volatility Skew

Negative price pressure in the options market can be proxied using the Implied Volatility Skew. This is done by calculating the difference between the implied volatilities of an OTM put and an ATM call. We follow the method of Xing, Zhang and Zhao (2010) closely. The IV Skew for firm i on day t is calculated as;

$$IVSkew_{i,t} = IV_{i,t}^{OTM_{put}} - IV_{i,t}^{ATM_{call}} \tag{12}$$

The options used in this calculated are determined using the following rules; option time to maturity is between 10 and 60 days, option open interest is positive, implied volatility of the options is between 3% and 200%.

As only one call and put option is used in each calculation we need a selection criteria for the options used. First, we define as the ratio of strike price to stock price. OTM puts are defined as put options with moneyness between 0.80 and 0.95 and ATM calls are defined as call options with moneyness between 0.95 and 1.05. In cases where we have multiple OTM puts and ATM calls, we select one OTM put with moneyness closest to 0.95 and one ATM call with moneyness closest to 1. We follow the same selection criteria for ATM calls.

Table A1: Description of variables

Variable	***Definition***
announcement return (BHR)	The announcement return on a merging firm's share is calculated from two days pre-announcement to one day post-announcement (BHR(t-2,t+1)).
$\Delta MFIM$ [a]	The average level of the model-free implied moment (volatility, skewness or kurtosis) in the first week pre-announcement minus the same measurement in the third week pre-announcement. Three weeks pre-announcement refers to the period from 17 days to 13 trading days pre-announcement. One week pre-announcement refers to the period from 7 days to 3 days pre-announcement. A 5 day trading interval is used to proxy for a trading week. The number of moments sampled in each trading week is a function of option contract availability.
$\Delta MFIMCash$	The $\Delta MFIM$ variable multiplied by a dummy variable. When an investigation is conducted in respect to financing mechanism effects the dummy variable is 1 for principally cash financed deals and zero otherwise.
$\Delta MFIMDealside$	The $\Delta MFIM$ variable multiplied by a dummy variable. When an investigation is conducted in respect to deal side effects the dummy variable is 1 for target firms and zero otherwise.
$S_h(O/S)$	The level of the option/stock trading volume ratio ($S_h(O/S)$) on the day preceding the first announcement return calculation date. The natural logarithm of this variable is used in regressions.
IV Spread	The Implied Volatility Spread on the day preceding the first announcement return calculation date.
IV Skew	The Implied Volatility Skew on the day preceding the first announcement return calculation date.
Size of firm ($Size$)	The firm size is the equity market capitalization of a merging firm on the announcement date. It is calculated as the market value of the firm in United States dollars in the fiscal year t-1. The natural logarithm of this variable is used in regressions. (Source: IvyDB.)
Book to Market Value (B/M)	The book to market ratio (B/M) of a merging firm. The B/M is calculated dividing book value per share times shares outstanding by 'Size'. The natural logarithm of this variable is used in regressions. (Source: Compustat.)
Value	The Value is the deal value denominated in United States dollars. The natural logarithm of this variable is used in regressions. (Source: WorldScope.)
Industry effects	The industry effects are accounted for by a dummy variable which is 1 for for common industries and zero otherwise. Firms are grouped by common industry using their primary SIC code.
Cash	The deal is indicated as primarily financed with cash if 60% or more of the deal is financed by cash. A dummy variable is 1 for deals which are primarily cash financed and zero otherwise.
DealSide	A dummy variable is 1 for target deals and zero otherwise.
Year	Year of observation.
Momentum	The return of a share in the merging firm for one year prior to the calculation of the announcement period return (i.e. BHR(-254,-3)).
Constant	The intercept of the regression equation.

Table A2: Analysis of Deal Side and Financing Mechanism Effects in Implied Moment Predictions

The table presents cross-sectional regression results to test for deal side and principal finance mechanism effects on announcement returns. The dummy variable multiplying $\Delta MFIS$ to give $\Delta MFISCash$, is 1 for principally cash financed deals and zero otherwise. The dummy variable multiplying $\Delta MFIS$ to give $\Delta MFISDealside$, is 1 for targets and zero otherwise. P-values are computed using White‘s (1980) heteroskedasticity robust standard errors (in parentheses). *, **, and *** indicate significance at 10%, 5%, and 1% level respectively. The variables are defined in the appendix.

Model-Free Implied Skewness

	(1) Return	(2) Return	(3) Return
$\Delta MFIS$	0.038^{***}	0.016	0.029^{*}
	(0.013)	(0.019)	(0.017)
Cash	0.027^{***}	0.012^{*}	0.012^{*}
	(0.009)	(0.007)	(0.007)
DealSide	0.199^{***}	0.175^{***}	0.175^{***}
	(0.016)	(0.021)	(0.021)
$Cash\_DealSide$		0.060^{**}	0.063^{**}
		(0.027)	(0.027)
$MFIS\_Cash$		-0.006	-0.033
		(0.028)	(0.022)
$MFIS\_Dealside$		0.089^{**}	0.049
		(0.037)	(0.047)
$MFIS\_{}_{C}ash\_Dealside$			0.083
			(0.073)
Size	-0.005^{*}	-0.004	-0.004
	(0.003)	(0.003)	(0.003)
BM	-0.003	-0.003	-0.003
	(0.006)	(0.006)	(0.006)
Value	-0.009^{**}	-0.009^{**}	-0.009^{**}
	(0.004)	(0.004)	(0.004)
Mom	-0.005	-0.002	-0.003
	(0.007)	(0.007)	(0.007)
SIC	-0.013	-0.016	-0.016
	(0.021)	(0.021)	(0.021)
Year	0.002^{**}	0.002^{*}	0.002^{*}
	(0.001)	(0.001)	(0.001)
Constant	0.079^{*}	0.070	0.071
	(0.043)	(0.044)	(0.044)
Observations	769	769	769
R^2	0.38	0.39	0.39

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A3: Robustness of Deal Side Effects to the Implied Volatility Spread, Implied Volatility Skew, $S_h(O/S)$ and a Different Calculation window for the Implied Moment Changes

The table presents robustness tests for deal side and financing mechanism effects on announcement returns which includes alternative option-derived information related measures and an alternative calculation period for the implied moment measures. In column 1 of panel A regression results are reported including the implied volatility spread (IVSpread) and the option stock order imbalance $S_h(O/S)$. In column 2 of panel A regression results are reported including the implied volatility spread (IVSkew) and the option stock order imbalance $S_h(O/S)$. In column 3 of panel A regression results are reported using an alternative run up period for calculating the change in the implied moments (the change from the first week to the fourth week pre-announcement is used). A full set of control variables is used but is suppressed for clarity. P-values are computed using the Newey-West (1987) heteroskedasticity and serial correlation corrected standard errors (in parenthesis). *, **, and *** indicate significance at 10%, 5%, and 1% level respectively. The variables are defined in the appendix.

Mode-Free Implied Skewness

	(1) Return	(2) Return	(3) Return
MFIS	0.026	0.023	0.016
	(0.018)	(0.018)	(0.015)
Cash	0.011	0.009	0.014*
	(0.007)	(0.007)	(0.007)
DealSide	0.178***	0.167***	0.189***
	(0.021)	(0.020)	(0.022)
Cash_DealSide	0.066**	0.079***	0.054*
	(0.027)	(0.027)	(0.032)
MFIS_Cash	-0.028	-0.034	-0.033*
	(0.023)	(0.022)	(0.018)
MFIS_Dealside	0.054	0.039	0.111*
	(0.048)	(0.047)	(0.061)
MFIS_Cash_Dealside	0.071	0.072	0.063
	(0.074)	(0.074)	(0.101)
IVSpread	0.012		
	(0.029)		
IVSkew		-0.159	
		(0.113)	
OS	0.010***	0.011***	
	(0.004)	(0.004)	
Size	-0.002	-0.001	-0.004
	(0.003)	(0.003)	(0.003)
BM	-0.004	-0.005	-0.005
	(0.006)	(0.006)	(0.007)
Value	-0.009**	-0.008**	-0.009**
	(0.004)	(0.004)	(0.004)
Mom	-0.001	-0.001	-0.004
	(0.007)	(0.006)	(0.007)
SIC	-0.015	-0.000	-0.020
	(0.022)	(0.022)	(0.022)
Year	0.002**	0.003***	0.002*
	(0.001)	(0.001)	(0.001)
Constant	0.034	0.011	0.066
	(0.048)	(0.045)	(0.048)
Observations	769	737	696
R^2	0.40	0.40	0.39

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A4: Analysis of Deal Side and Financing Mechanism Effects in Alternative Measures

The table presents cross-sectional regression results to test for deal side and principal finance mechanism effects on announcement returns. The dummy variable multiplying IVSpread and IVSkew to give *IVSpreadCash* and *IVSkewCash*, is 1 for principally cash financed deals and zero otherwise. The dummy variable multiplying IVSpread and IVSkew to give *IVSpreadDealside* and *IVSkewDealside*, is 1 for targets and zero otherwise. P-values are computed using White‘s (1980) heteroskedasticity robust standard errors (in parentheses). *, **, and *** indicate significance at 10%, 5%, and 1% level respectively. The variables are defined in the appendix.

Implied Volatility Spread

	(1) Return	(2) Return	(3) Return
IVSpread	0.011	-0.012	-0.019
	(0.029)	(0.026)	(0.027)
Cash	0.026***	0.011	0.012
	(0.009)	(0.007)	(0.007)
DealSide	0.199***	0.181***	0.182***
	(0.016)	(0.021)	(0.021)
Cash_DealSide		0.050*	0.046*
		(0.027)	(0.027)
IVSpread_Cash		-0.089	-0.006
		(0.127)	(0.083)
IVSpread_DealSide		0.312	0.408*
		(0.217)	(0.245)
IVSpread_Cash_DealSide			-0.377
			(0.510)
Size	-0.005	-0.004	-0.004
	(0.003)	(0.003)	(0.003)
BM	-0.003	-0.002	-0.002
	(0.007)	(0.006)	(0.006)
Value	-0.009**	-0.010***	-0.010***
	(0.004)	(0.004)	(0.004)
Mom	-0.004	-0.002	-0.001
	(0.007)	(0.007)	(0.007)
SIC	-0.015	-0.013	-0.013
	(0.022)	(0.022)	(0.022)
Year	0.002**	0.002**	0.002**
	(0.001)	(0.001)	(0.001)
Constant	0.081*	0.082*	0.081*
	(0.043)	(0.043)	(0.043)
Observations	769	769	769
R^2	0.37	0.38	0.38

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Implied Volatility Skew

	(1) Return	(2) Return	(3) Return
IVSkew	-0.216**	-0.098	-0.114
	(0.106)	(0.160)	(0.173)
Cash	0.028***	0.004	0.003
	(0.009)	(0.012)	(0.012)
DealSide	0.192***	0.176***	0.175***
	(0.015)	(0.022)	(0.025)
Cash_DealSide		0.071***	0.075**
		(0.027)	(0.035)
IVSkew_Cash		0.107	0.146
		(0.218)	(0.205)
IVSkew_DealSide		-0.330	-0.295
		(0.224)	(0.322)
IVSkew_Cash_DealSide			-0.080
			(0.447)
Size	-0.005	-0.004	-0.004
	(0.003)	(0.003)	(0.003)
BM	-0.004	-0.003	-0.003
	(0.006)	(0.006)	(0.006)
Value	-0.008**	-0.008**	-0.008**
	(0.004)	(0.004)	(0.004)
Mom	-0.004	-0.002	-0.002
	(0.006)	(0.006)	(0.006)
SIC	-0.001	-0.002	-0.002
	(0.022)	(0.022)	(0.022)
Year	0.003***	0.003***	0.003***
	(0.001)	(0.001)	(0.001)
Constant	0.067	0.060	0.060
	(0.041)	(0.042)	(0.042)
Observations	737	737	737
R^2	0.37	0.39	0.39

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

OS

	(1) Return	(2) Return	(3) Return
OS	0.010***	0.003	-0.001
	(0.004)	(0.005)	(0.005)
Cash	0.026***	0.026	0.006
	(0.009)	(0.016)	(0.013)
DealSide	0.203***	0.100***	0.058
	(0.016)	(0.028)	(0.037)
Cash_DealSide		0.059**	0.128***
		(0.026)	(0.048)
OS_Cash		-0.006	0.003
		(0.007)	(0.005)
OS_DealSide		0.034***	0.054***
		(0.010)	(0.017)
OS_Cash_DealSide			-0.032
			(0.021)
Size	-0.004	-0.004	-0.004
	(0.003)	(0.003)	(0.003)
BM	-0.004	-0.004	-0.004
	(0.006)	(0.006)	(0.006)
Value	-0.009**	-0.008**	-0.008**
	(0.004)	(0.004)	(0.004)
Mom	-0.003	-0.001	-0.001
	(0.007)	(0.007)	(0.007)
SIC	-0.012	-0.017	-0.017
	(0.022)	(0.022)	(0.022)
Year	0.002**	0.002*	0.002*
	(0.001)	(0.001)	(0.001)
Constant	0.044	0.060	0.070
	(0.048)	(0.049)	(0.049)
Observations	769	769	769
R^2	0.38	0.40	0.40

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$