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# CROSS SECTIONAL VARIATION IN RISK ARBITRAGE

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**ABSTRACT**

*In this study, we are interested in understanding the price formation process of bidders' and targets' shares after the merger announcement and seek to explore the impacts of liquidity risk, price pressure, and limited arbitrage theory on the cross sectional variation in risk arbitrage. Using a sample of 1046 merger offers and regression technique, we find that arbitrage spread is positively correlated with deal completion risk, positively correlated with liquidity risk in a concave way: arbitrage spread increases at a decreasing speed as the liquidity risk increases. This finding is consistent with the literature on stock returns. We also find that price pressure is significant in determining arbitrage spread. However, we fail to find evidence that is consistent with the limited arbitrage theory: limitation on the supply of arbitrage capital is not significantly correlated with the deviation of arbitrage spread, in either direction, from the efficient level. The risk factors and limits of arbitrage identified in the paper help explain the profits and cross sectional variation in risk arbitrage.*

**JEL:** G10, G12, G34

**KEYWORDS:** Risk Arbitrage, Deal Completion Risk, Liquidity Risk, Price Pressure, Limited Arbitrage

## INTRODUCTION

After a merger announcement, the target stock's price usually rises but not all the way to the level of the offer price. This gap creates an arbitrage opportunity, known as risk arbitrage. For cash offers, arbitrageurs simply take a long position in the target and hold it until the closing of the deal. For stock swap offers, arbitrageurs need to take a long position in the target and at the same time hedge that position by taking a short position in the bidder's shares. For stock swap offers with collars (also known as collar offers), where the exchange ratio depends on the average bidder stock's price during a pricing period, more complicated positions or option type delta hedging may be needed (see Wang and Branch 2014). When a deal succeeds according to the pre-agreed upon terms, arbitrageurs pocket the arbitrage spread, defined as the percentage difference between the bid price and the target's market price two days after the merger announcement. However, they may incur losses if a deal falls apart or is revised downward and, as a result, the initial spread fails to converge to zero.

Finance literature is almost unanimous in concluding that risk arbitrage tends to generate positive risk-adjusted returns (e.g., Mitchell and Pulvino 2001, Baker and Savasoglu 2002, Wang and Branch 2014). However, studies on what have contributed to the abnormal returns of risk arbitrage are limited. Mitchell and Pulvino (2001) suggest that transactions costs and other practical investment limits reduce the abnormal return of risk arbitrage to 4% per year. This study seeks to extend the literature by exploring factors that may help explain the cross sectional variation in risk arbitrage profits. We focus on risk arbitrage spread rather than actual risk arbitrage return because the arbitrage spread represents the expected return of risk arbitrage for each deal. We are interested in understanding the price formation process of bidders' and targets' shares after the merger announcement and hope to use existent financial theory to explain it. How are arbitrage spreads related to risk factors such as deal completion risk or liquidity risk? What are the impacts of price pressure? Does limited arbitrage theory help explain the cross sectional variation in the arbitrage spreads? We seek to answer those questions and they will help

us understand the sources for the abnormal returns of risk arbitrage. The remainder of the paper is organized as follows. The next section reviews the literature and develops hypotheses. Then, we discuss the data and methodology used in the study. The results are presented in the following section. The paper closes with some concluding comments.

## Literature Review and Hypotheses Development

The relevant literature has suggested that four major categories of variables may have an impact on the magnitude of arbitrage spreads: 1. deal completion risk; 2. liquidity risk; 3. price pressure; 4. supply of arbitrage capital. We will review the literature in each category and develop our hypotheses and models related to each factor.

### Deal Completion Risk

Intuitively, the risk arbitrage spread represents the present value of the expected spread at the closing of the deal and thus depends on the deal's outcome. We use three variables to measure deal completion risk: probability that a deal will succeed; probability that a deal will be revised upward; probability that a deal will be revised downward. If the market is able successfully to anticipate the outcome of the deal, we expect the arbitrage spreads for successful deals to be lower than for the failed deals. Since the outcome of a deal is not available at the time of the merger announcement, we use the estimated probability of success as a proxy for deal's outcome. Target shares tend to converge more to the offer price or even above the offer price in anticipation of a raised offer. In contrast, the target shares will converge less in anticipation of a revised downward offer. Therefore, our first three hypotheses are as follows.

*H1: Risk arbitrage spread is negatively correlated with the probability that a deal will succeed.*

*H2: Risk arbitrage spread is negatively correlated with the probability that a deal will be revised upward.*

*H3: Risk arbitrage spread is positively correlated with the probability that a deal will be revised downward.*

### Liquidity Risk

Jindra and Walkling (2004) argue that arbitrageurs' funds are tied up over the duration of the deal (the length of time from deal announcement to the closing of the deal), therefore we view duration as a proxy for liquidity risk. It is true that greater liquidity risk requires greater compensation. However, due to the 'clientele effect', Investors with longer investment horizon may be more inclined to hold less liquid assets than those with a shorter horizon (See Amihud and Mendelson (1986)). Accordingly, the increase in liquidity premium may decrease as liquidity risk increases and the exhibit a positive concave relationship. Therefore, we include both duration and the square of duration into our model and hypothesize that the arbitrage spread is positively correlated with deal duration and negatively correlated with the square of deal duration. Our hypothesis is specified as follows:

*H4: Risk arbitrage spread has a positive concave relationship with the deal duration.*

### Price Pressure

According to Scholes (1972), Shleifer (1986), securities without perfect substitutes can have downward sloping demand curves. Lynch and Mendenhall (1997) found that share prices and trading volumes rise dramatically when firms join the S&P 500, generating a positive abnormal returns of 3% and 4% on the first trading day post the announcement. The positive abnormal return can be a result of the upward price

pressure created by a surge in demand from the institutional investors who are trying to match the S&P 500. In the case of mergers, large amounts of trading occur after the deal announcement and may result in price pressure on the target's and the bidder's prices. Target shareholders face deal completion risk and may choose to remove this risk by selling their shares to professional risk arbitrageurs. Such selling pressure may push target's price below its efficient market level and result in greater arbitrage spread. At the same time, risk arbitrageurs may start purchasing target shares and may result in buying pressure. Which force is stronger is an empirical issue. We use abnormal trading volume on the target shares after the merger announcement as a proxy for the price pressure on the target and include it in the cross sectional regression on arbitrage spread.

In contrast, for stock swap offers and collar offers, risk arbitrageurs often hedge their positions by taking a short position in the bidder's shares. Such short selling might result in selling pressure on the bidder's shares. Therefore, for stock swap offers and collar offers, we expect the short selling to have a negative impact on arbitrage spreads. Our hypothesis is:

*H5: Arbitrage spread is negatively correlated with the abnormal trading on bidders' shares for stock offers and collar offers.*

Limitation of Supply of Arbitrage Capital

Most professional risk arbitrageurs are institutional investors who have professional skills in merger arbitrage and access to the most complete publicly available knowledge on the merger deals. They raise money from small investor who very likely, do not have the same level of skills and information. Such agency problems and information costs may limit the amount of capital that the risk arbitrageur can raise and reduce the effectiveness of arbitrageurs in removing price discrepancies (Shleifer and Vishny (1997)). For example, if a small investor sees an arbitrageur performed poorly in the past, he or she may withhold additional capital from that arbitrageur and/or may withdraw any money that he has with that arbitrageur's fund. The arbitrageurs who encounter such behavior may be forced to liquidate some of their positions even if the expected returns for their available opportunities are positive.

In addition, with such fear in mind, arbitrageurs will be more cautious in entering initial positions and thus become less effective in achieving the return levels that help achieve market efficiency. Baker and Savasoglu (2002) find that arbitrage returns are negatively correlated with previous performance of arbitrage portfolio, and are also negatively correlated with the change in institutional ownership for the target before and after the announcement. Similarly, we hypothesize that insufficient arbitrage capital may lead the arbitrage spreads to deviate from the "efficient level". We use the merger arbitrage hedge fund index returns for the three quarters prior to the merger announcement as proxies for the supply of arbitrage capital. We use the abnormal arbitrage spread, the absolute difference between the observed spread and the predicted spread from our model, as a measure of the deviation of the arbitrage spreads from the "efficient level". We hypothesize as follows:

*H6: Abnormal arbitrage spreads are negatively correlated with the lagged returns for the merger arbitrage hedge fund index.*

## DATA AND METHODOLOGY

Data/information sources utilized to obtain merger price and firm information include Thomson Financial SDC Platinum (SDC), CRSP, and Lexis-Nexis. The final sample includes 1,046 takeover offers from 1994 to 2004 period. Table 1 shows the frequency rates for various categorical variables in the analysis . Panel A shows deal completion rates. Overall, our sample has 928 completed (successful) deals and 118 failed deals, with the highest success rates for collar offers and lowest for cash offers. Panel B presents

the revision rates for the sample. The upward revision rates are 15.26%, 7.22% and 8.11% respectively for cash offers, stock swap offers and collar offers. The downward revision rates are 1.56%, 7.78% and 10.81% respectively for cash offers, stock swap offers and collar offers.

Table 1: Frequency Table of Categorical Variables

| | Cash Offer | Stock Offer | Collar Offer | Total |
|---|---|---|---|---|
| **Panel A Merger Completion Rate** | | | | |
| Success | 277 (86.29%) | 479 (88.70%) | 172 (92.97%) | 928(88.72%) |
| Fail | 44 (13.71%) | 61 (11.30%) | 13 (7.03%) | 118(11.28%) |
| Total | 321 (31%) | 540 (52%) | 185 (17%) | 1046 (100%) |
| **Panel B Merger Revision Rate** | | | | |
| Revised Up | 49 (15.26%) | 39(7.22%) | 15(8.11%) | 67(6.41%) |
| No Revision | 267(83.18%) | 459(85%) | 150(81.08%) | 876(83.75%) |
| Revised Down | 5(1.56%) | 42(7.78%) | 20(10.81%) | 103(9.85%) |
| Total | 321 | 540 | 185 | 1046 |

*This table shows the frequency rates for categorical variables. Panel A of this table shows the number and percentage of deals that are completed or failed. Panel B of this table shows the number and percentage of deals that are revised upward, downward or with no revision.*

Table 2 shows the descriptive statistics for continuous variables. The means for arbitrage spread, deal duration, transaction size and bid premium are 9.0%, 131 days, $1066 millions and 35% respectively.

Table 2: Descriptive Statistics – Continuous Variables

| | Cash Offer | Stock Offer | Collar Offer | All Offers |
|---|---|---|---|---|
| Arbitrage Spreads | | | | |
| Mean | 0.06 | 0.09 | 0.23 | 0.09 |
| Std Dev | 0.09 | 0.11 | 0.28 | 0.13 |
| Min | -0.15 | -0.75 | -0.18 | -0.76 |
| Max | 0.67 | 1.00 | 1.33 | 1.33 |
| Deal Duration | | | | |
| Mean | 108 | 138 | 146 | 131 |
| Std Dev | 89 | 79 | 88 | 85 |
| Min | 1 | 9 | 1 | 1 |
| Max | 581 | 620 | 557 | 620 |
| **Transaction Size ($millions)** | | | | |
| Mean | 551 | 1398 | 987 | 1066 |
| Std Dev | 2058 | 5902 | 1995 | 4484 |
| Min | 2.7 | 1.45 | 9.62 | 1.45 |
| Max | 28971 | 89167 | 13620 | 89167 |
| Bid Premium | | | | |
| Mean | 0.40 | 0.33 | 0.29 | 0.35 |
| Std Dev | 0.36 | 0.32 | 0.34 | 0.34 |
| Min | -0.45 | -0.86 | -0.90 | -0.90 |
| Max | 2.66 | 2.71 | 2.10 | 2.71 |
| **Abnormal Trading Volume Target** | | | | |
| Mean | 72.37 | 35.26 | 50.75 | 49.31 |
| Std Dev | 79.62 | 39.15 | 50.54 | 58.61 |
| Min | 1.32 | 0.41 | 1.79 | 0.42 |
| Max | 508.07 | 312.04 | 332.94 | 508.07 |
| **Abnormal Trading Volume Bidder** | | | | |
| Mean | 4.89 | 9.37 | 7.47 | 7.66 |
| Std Dev | 5.39 | 10.58 | 7.42 | 8.96 |
| Min | 0.44 | 0.28 | 1.04 | 0.28 |
| Max | 57.9 | 115.11 | 53.10 | 115.10 |

*This Table shows the descriptive statistics for Arbitrage spreads, deal duration, transaction size, bid premium, abnormal trading volume for target companies, and abnormal trading volume for bidding companies.*

We use the target's abnormal trading volume for the three day period (-1, +1) around the merger announcement date in SDC (day 0) as a proxy for selling pressure. Using Lakonishok and Vermaelen (1990) approach, we calculate the abnormal volume by taking the ratio of event volume relative to pre-announcement normal volume. The normal trading volume is the average daily trading volume for days –

50 to –20 relative to the announcement. The average abnormal trading volume for the target is 49.31 and 7.66 for the bidding company.

## RESULTS AND DISCUSSION

Estimation of the Probability of Deal Success

We utilize a logistic regression model to predict the probability that a deal will succeed using only information that is available shortly after the announcement and before the position is established as equation [1].

$$\text{Prob(Success)} = \frac{1}{1+\exp(-(\beta_0 + \beta_1 * \text{TR} + \beta_2\text{TS} + \beta_3\text{HM} + \beta_4\text{BP} + \beta_5\text{AbnT} + \beta_6\text{OS} + \beta_7\text{T\_runup} + \beta_8\text{SO} + \beta_9\text{CO}))} \quad (1)$$

Where Success is dummy variable for deal's outcome (1 for completed deal, 0 for failed deal); TR is target resistance (1 for friendly offers, 0 for hostile offers); TS is target size; HM is horizontal merger (1 if the target and the bidder are in the same industry); BP is bid premium; AbnT is abnormal trading volume for the target firm; OS is percentage of outstanding equities owned by the bidding firm in the target firm prior tto announcement; T_runup is percentage change in target prices twenty trading days prior to announcement; SO is1 if the deal is a stock offer, 0 otherwise; CO is 1 if the deal is a collar offer, 0 otherwise. The dependent variable is defined as 1 for successful deals; 0 for failed deals. The predictor variables are target resistance, target size, horizontal mergers or not, bid premium, abnormal trading volume on the target stocks, ownership, target price run-up and deal structures. SDC classifies deals as hostile takeover versus friendly takeover attempts. Target resistance variable is a dummy variable that equals 1 if the deal is classified as a friendly offer by SDC and 0 otherwise.

Target size is the logarithm of the ratio of the target's market size divided by the bidder's market size as a proxy for relative target size. Both market values are calculated using prices 20 days prior to merger announcement. Horizontal merger is categorical variable that is equal to 1 if the target and the bidder are in the same industry (same two digits SIC code). Bid premium is defined as the percentage difference between the offer price and the target's market price 20 trading days prior to announcement. The greater the premium, the more attractive is the offer and the greater likelihood that a deal will succeed. The variable Stock is a dummy variable that equals 1 if the deal is a fixed ratio stock swap offer and zero otherwise. The variable Collar is a dummy variable that equals 1 if the deal is a collar offer and zero otherwise. Larker and Lys (1987) hypothesize that risk arbitrageurs are better informed than the market about the takeover's probability of success. They find that takeovers in which risk arbitrageurs are involved have a higher probability of success than the average probability inferred from market price. We use the total target's abnormal trading volume for the three day period (-1, +1) around the merger announcement as a proxy for the presence of arbitrageurs.

Other control variables include Target price run-up, defined as the percentage change in target stock prices over the period (-20, -1) around the announcement. Asquith (1989) estimates 15% run-up for successful deals while 11% for unsuccessful deals. Ownership, defined as the percentage of outstanding equities owned by the bidder in the target firms prior to merger may also have an impact on the success rate of mergers and is therefore included in the model. In an efficient capital market, the probability of success should also be estimated by market participants and thus fully incorporated in the risk arbitrage spread. To explore if risk arbitrage spread has explanatory power on merger success and see how it affects the significance of other variables, we estimate the following equation [2]

$$\text{Prob(Success)} = \frac{1}{1+\exp(-(\beta_0 + \beta_1 * \text{TR} + \beta_2 \text{TS} + \beta_3 \text{HM} + \beta_4 \text{BP} + \beta_5 \text{AbnT} + \beta_6 \text{OS} + \beta_7 \text{T\_runup} + \beta_8 \text{SO} + \beta_9 \text{CO} + \beta_{10} \text{Ann\_Spread}))} \quad (2)$$

Where Ann_Spread is percentage difference between the offer price and the target's price two trading days after the announcement; TR, RS, HM, BP, AbnT, OS, T_runup, SO and CO are defined as previously. Empirical results are presented in Table 3. Panel A shows the empirical results for equation [1] where Ann_Spread is not included in the model. Dummy variables for target resistance and target size are found to be significant in determining a deal's outcome. Friendly deals (positive coefficient) are more likely to succeed compared to hostile offers. The coefficient for target size is negative, implying that larger target reduces the probability that a deal will succeed. To investigate the economic significance of the impact of those variables on deal success, we reported odds ratios. Odds ratio is defined as P(success)/P(failure): probability of success divided by probability of failure. As the odds ratio (OR = 25.71) for the target resistance variable shows, the odds of success for a friendly deal is 25.75 times as much as the odds of success for a hostile offer. As the odds ratio (OR = 1.77) for the horizontal merger variable shows, the odds of success for a horizontal merger is 1.77 times as much as the odds of success for a non-horizontal merger. In other words, the odds for a horizontal merger are 77% (1.77 – 0.77 = 0.77) higher than the odds for a non-horizontal merger. As the odds ratio (OR = 0.49) for relative target size variable shows, for one unit increase in target size, the odds of success decrease by 51%, which is 0.49 – 1 = -0.51. Panel B shows the empirical results for equation (2) where Ann_Spread is included as a predictor variables. Consistent with market efficiency theory, the coefficient for Ann_Spread is negative and is statistically significant, indicating that the market has priced in deal completion risk. In addition, adding Ann_Spread does improve the goodness of fit of the model: P-value for goodness of fit test increases from 0.14 to 0.27. Higher P-value corresponds to better goodness of fit. Adding Ann_Spread also reduces the economic significance of the impacts of other predictor variables. For example, the odds ratios for target resistance, target size and the horizontal merger dummy variable reduce from 25.75 to 24.07; 0.49 to 0.48; and 1.77 to 1.72 respectively.

However, the coefficients for those variables are still statistically significant: 3.18 for target resistance, -0.72 for target size and 0.54 for horizontal mergers. These results have some interesting implications. Given the market's expectation of the probability of deal success, hostile mergers still reduces probability of success (or increases deal failure risk), which implies that market tends to underestimate deal completion risk for hostile offer. Similarly, market tends to underestimate deal completion risk for larger target, and overestimate deal completion risk for horizontal mergers. For future research, tests can be constructed to explore the relationship of abnormal returns of risk arbitrage with those variables (target resistance, target size and horizontal mergers)

Table 3: Predicting Probability of Success

| | Panel A. Ann_Spread Not as a Predictor Variable | | | Panel B. Ann_Spread as a Predictor Variable | | |
|---|---|---|---|---|---|---|
| **Variables** | **Parameter Estimates** | **Standard Error** | **Odds Ratio** | **Parameter Estimates** | **Standard Error** | **Odds Ratio** |
| Intercept | -2.68*** | 0.50 | | -2.59 | 0.50 | |
| TR | 3.25*** | 0.38 | 25.75 | 3.18*** | 0.39 | 24.07 |
| TS | -0.71*** | 0.11 | 0.49 | -0.72*** | 0.11 | 0.48 |
| HM | 0.57** | 0.28 | 1.77 | 0.54* | 0.28 | 1.72 |
| BP | -0.04 | 0.39 | 0.96 | 0.34 | 0.43 | 1.40 |
| AbnT | 0.004 | 0.003 | 1.00 | 0.0037 | 0.003 | 1.00 |
| OS | 0.79 | 1.02 | 2.21 | 0.71 | 1.03 | 2.02 |
| T_runup | 0.43 | 0.57 | 1.55 | 0.35 | 0.57 | 1,42 |
| Stock | 0.069 | 0.34 | 1.072 | 0.16 | 0.34 | 1.17 |
| Collar | 0.20 | 0.43 | 1.22 | 0.42 | 0.45 | 1.52 |
| Ann_Spread | | | | -0.21** | 0.81 | 0.13 |
| Goodness of Fit Test | | | | | | |
| Chi-Square | 12.30 | | | 9,87 | | |
| P-Value | 0.14 | | | 0.27 | | |

*Panel A of this table shows the empirical results for estimating equation [1]Panel B of this table shows the empirical results for estimating equation [2] Success = dummy variable for deal's outcome (1 for completed deal, 0 for failed deal); TR = target resistance (1 for friendly offers, 0 for hostile offers); TS = target size ; HM = horizontal merger (1 if the target and the bidder are in the same industry); BP = bid premium; AbnT = abnormal trading volume for the target firm; OS = Percentage ownership of the bidding firm in the target firm prior to announcement; T_runup = percentage change in target prices over the announcement period (-20, -1); SO = 1 if the deal is a stock offer, 0 otherwise; CO = 1 if the deal is a collar offer, 0 otherwise. Ann_Spread = percentage difference between the offer price and the target's price two trading days after the announcement. ***, ** and * indicate significance at the 1, 5 and 10 percent levels respectively.*

Estimation of Deal's Duration

After determining the probability of deal success, arbitrageurs also need to estimate how long each deal takes to complete. We use the following model to estimate the length of deal's duration.

$$\text{Duration} = \beta_0 + \beta_1 \text{TR} + \beta_2 \text{TS} + \beta_3 \text{HM} + \beta_4 \text{BP} + \beta_5 \text{SO} + \beta_6 \text{CO} \quad (3)$$

Where Duration is number of days between deal announcement and deal completion; TR is target resistance (1 for friendly offers, 0 for hostile offers); TS is target size; HM is horizontal merger (1 if the target and the bidder are in the same industry); BP is bid premium; SO is 1 if the deal is structured as a stock swap offer, 0 otherwise; CO is 1 if the deal is financed as a stock swap offer with collars, 0 otherwise. Large companies may find small companies easier to acquire than vice versa. Thus, the deal may take less time to finish if the target size is small relative to the bidder. A horizontal merger may take longer to complete since it has more antitrust issues. A hostile offer may take longer time since the target's management may reach out to other potential bidders and start a bidding war.

Similarly, a small bid premium is more likely to lead to a bidding war than a larger bid premium and thus such a bid is more likely to lengthen the merger process. Stock offers require the approval from both the target's shareholders and the bidder's shareholders and thus are expected to have greater duration. A similar argument applies to stock swap offers with collars. However, one reason that management is inclined to use collars in the initial agreement is to speed up the negotiation process. Which force is stronger is an empirical issue. Empirical results are shown in Table 4. The horizontal merger dummy variable has a significant positive coefficient of 26.04. The stock offer dummy variable has a significant positive coefficient of 24.28. Both are consistent with our expectation. The coefficients for other variables are not significant.

Table 4: Estimating Deal Duration

| Variables | Parameter Estimates | Standard Errors |
|---|---|---|
| Intercept | 125.59*** | 24.03 |
| Target Resistance | 2.58 | 10.99 |
| Target Size | -28.04 | 18.45 |
| Horizontal Merger | 26.04*** | 6.39 |
| Bid Premium | -8.34 | 7.62 |
| Target Resistance | 2.58 | 10.99 |
| Stock Offer | 24.28*** | 6.32 |
| Collar Offer | 8.57 | 7.11 |
| Adjusted R Square | 4.54% | |

*This table shows the regression results for equation [3]. Duration = number of days between deal announcement and deal completion; TR= target resistance (1 for friendly offers, 0 for hostile offers); HM = horizontal merger (1 if the target and the bidder are in the same industry); BP = bid premium; SO = 1 if the deal is structured as a stock swap offer, 0 otherwise; CO = 1 if the deal is financed as a stock swap offer with collars, 0 otherwise.***, ** and * indicate significance at the 1, 5 and 10 percent levels respectively.*

Estimating Future Price Revision

Third, we developed two logistic regression models, one for the probability of the deal being revised up, the other for the probability of the deal being revised down, as a function of cash offer, target resistance bid premium and market performance, specified as equations [4] and [5].

$$\text{Revise Up} = \beta_0 + \beta_1 \text{Cash} + \beta_2 \text{TR} + \beta_3 \text{BP} + \beta_4 \text{Mkt} \quad (4)$$

$$\text{Revise Down} = \beta_0 + \beta_1 \text{Cash} + \beta_2 \text{TR} + \beta_3 \text{BP} + \beta_4 \text{Mkt} \quad (5)$$

Where Revise Up is 1 if the deal is revised up, 0 otherwise; Revise Down is 1 if the deal is revised down, 0 otherwise; Cash is1 if the deal is a cash offer, 0 otherwise; TR is target resistance (1 for friendly offers, 0 for hostile offers); BP is bid premium; Mkt is the value weighted CRSP index return in the month prior to the announcement Branch and Yang (2006) find acquisition type (whether the deal is a hostile cash offer or not) is the only variable that is significant in determining whether the deal will be revised or not. In addition, we added two more variables: bid premium and market performance. A smaller bid premium is more likely to attract a competing bid, thus forcing the original bidder to raise the offer. In a declining market, the bidder is more likely to face trouble financing the deal and thus revising the deal downward. Table 5 presents the parameter estimates for price revision. We find that cash offers cash offers are more likely to be revised upward and hostile offers are more likely to be revised upward, stock swap offers and collar offers, which are non-cash offers, are more likely to be revised downward.

Table 5: Estimating Future Price Revisions

| | **Revise Up** | | **Revise Down** | |
|---|---|---|---|---|
| Variables | Parameter Estimates | Standard Errors | Parameter Estimates | Standard Errors |
| Intercept | -0.2019 | 0.3558 | -2.0767*** | 0.7788 |
| Cash | 0.4262* | 0.2551 | -2.1124*** | 0.5363 |
| TR | -2.3909*** | 0.3205 | -0.2328 | 0.7701 |
| BP | -0.4178 | 0.3840 | 0.1709 | 0.3718 |
| Mkt | 9.1474 | 13.0004 | -13.0948 | 12.0977 |
| Goodness of Fit Test | | | | |
| Chi-Square | 2.3592 | | 6.9372 | |
| P-Value | 0.96 | | 0.54 | |

*This table shows the regression results for equation [4] and [5].Revise Up = 1 if the deal is revised up, 0 otherwise; Revise Down = 1 if the deal is revised down, 0 otherwise; Cash = 1 if the deal is a cash offer, 0 otherwise; TR= target resistance (1 for friendly offers, 0 for hostile offers); BP = bid premium; Mkt = the value weighted CRSP index return in the month prior to the announcement. ***, ** and * indicate significance at the 1, 5 and 10 percent levels respectively.*

Modeling Risk Arbitrage Spread

Based on the hypotheses we developed, we model risk arbitrage spreads as a function of deal completion risk and liquidity risk as equation 6.

$$\text{Arb\_Spread} = \beta_0 + \beta_1 \text{Prob} + \beta_2 \text{BP} + \beta_3 \text{Duration} + \beta_4 \text{Duration\_SQ} + \beta_5 \text{RU} + \beta_6 \text{RD} + \beta_7 \text{AbnT} + \beta_8 \text{AbnB} * \text{SO} \quad \beta_9 \text{AbnB} * \text{CO} \tag{6}$$

Where Prob is the probability that a deal will succeed Duration is number of days between the deal announcement and the deal completion; Duration_SQ is square of deal duration; RU is revise up, probability that a deal will be revised up; RD is revise down, probability that a deal will be revised down; AbnT is abnormal trading volume on target shares; AbnB*SO is abnormal trading volume on bidder's shares * stock swap offer; AbnB*CO is abnormal trading volume on bidder's shares * collar offer .

Table 6 presents the results for cross sectional arbitrage spreads. We find arbitrage spread is negatively correlated with a the probability of success, positively correlated bid premium, have a concave relationship between arbitrage spread and deal duration., positively correlated with the probability of downward revision. Those results are all consistent with our hypotheses. The coefficient for target shares' abnormal trading volume is -0.0003, significant at the level of 0.01, indicating that the buying pressure from risk arbitrageurs dominates the selling pressure from target shareholders. The variance inflation factors are also reported to check for multicollinearity. None of them is above 10 indicating that multicollinearity is not an issue.

Table 6: Cross Sectional Variation in Arbitrage Spreads

| | **Parameter Estimates** | **Standard Errors** | **Variance Inflation** |
|---|---|---|---|
| Intercept | -0.1621 | 0.1609 | 0 |
| Prob | -0.0937** | 0.0132 | 3.8639 |
| BP | 0.0889*** | 0.0132 | 1.1494 |
| Duration | 0.0043* | 0.0025 | 2.5412 |
| Duration_SQ | -0.00002* | 0.00001 | 3.4487 |
| RU | -0.0907 | 0.0811 | 4.0528 |
| RD | 0.6978*** | 0.1922 | 4.4657 |
| AbnT | -0.0003*** | 0.0001 | 1.2239 |
| AbnB * SO | -0.0013** | 0.0007 | 1.3640 |
| AbnB * CO | 0.0028 | 0.0011 | 1.0550 |
| Adj- R Square | 11.6% | | |

*This table shows the empirical results for equation [6].Prob = probability that a deal will succeed; Duration = number of days between the deal announcement and the deal completion; Duration_SQ = square of deal duration; RU= revise up, probability that a deal will be revised up; RD = revise down, probability that a deal will be revised down; AbnT = target size; AbnB*SO = abnormal trading volume bidder *stock swap offer; AbnB*CO = abnormal trading volume bidder* collar offer. ***, ** and * indicate significance at the 1, 5 and 10 percent levels respectively.*

Modeling Abnormal Risk Arbitrage Spread

We model the abnormal arbitrage spread as:

$$\text{Abn\_Spread} = \beta_0 + \beta_1 \text{LR}_1 + \beta_2 \text{LR}_2 + \beta_3 \text{LR}_3 \tag{7}$$

Where Abn_Spread is abnormal arbitrage spread, calculated using the average of the absolute difference between the observed spread and the predicted spread from our model for all deals for a particular month; LR1 is Quarterly merger arbitrage hedge fund index return one quarter prior to the merger announcement; LR2 is Quarterly merger arbitrage hedge fund index return two quarters prior to the merger announcement; LR3 is Quarterly merger arbitrage hedge fund index return three quarters prior to the

merger announcement The empirical results to test the limited arbitrage theory are presented in Table 7. The coefficients for 1 quarter, 2 quarters, 3 quarters lagged risk arbitrage index fund returns are –0.0275, -0.055, -0.00289, none of which is statistically significant. Our findings are not supportive of the limited arbitrage theory: insufficient supply of risk arbitrage capital will increase the level of abnormal arbitrage spread.

Table 7: Abnormal Arbitrage Spreads

| Variables | Parameter Estimates | Standard Errors | Variance Inflation |
|---|---|---|---|
| Intercept | 0.0619*** | 0.0076 | 0 |
| LR1 | -0.0275 | 0.1037 | 1.2328 |
| LR2 | -0.055 | 0.1070 | 1.3133 |
| LR3 | -0.00289 | 0.1027 | 1.2209 |
| Adjusted R Square | 2.7% | | |

*In this table, we show the regression results for equation [7]. Abn_Spread is abnormal arbitrage spread, calculated using the average of the absolute difference between the observed spread and the predicted spread from our model for all deals for a particular month; LR1 is Quarterly merger arbitrage hedge fund index return one quarter prior to the merger announcement;LR2 is Quarterly merger arbitrage hedge fund index return two quarters prior to the merger announcement; LR3 is Quarterly merger arbitrage hedge fund index return three quarters prior to the merger announcement. *** indicate statistical significance at the 0.01 level.*

## CONCLUSION

In this paper, we explore the relations between arbitrage spreads of merger offers and market's expectations of deal's outcome, liquidity risk, price pressure and supply of arbitrage capital. First, we use three variables to measure deal completion risk: probability of a deal to succeed, probability of a deal to be revised up, probability of a deal to be revised down. We find that arbitrage spreads are negatively correlated with the probability of success, probability of upward revision, and positively correlated with probability of downward revision. Second, we explore the relationship between risk arbitrage and liquidity risk and find that arbitrage spread is positively correlated with liquidity risk in a concave way: arbitrage spreads increase at a decreasing speed when liquidity risk increases. Third, we explore the influence of price pressure on arbitrage spread. We use abnormal trading volume as a proxy for selling pressure and find that the selling pressure on the bidders' stock for stock offers and buying pressure on target shares play significant roles in determining arbitrage spreads. Further, we explore whether the limitation on the supply of risk arbitrage capital may push on risk arbitrage spread to depart from the efficient level. We use abnormal arbitrage spreads to measure the disparity of arbitrage spread from the efficient level, and use lagged risk arbitrage hedge fund index performance to measure the supply of risk arbitrage. However, we fail to find a significant correlation. Moreover, we find market tends to underestimate deal completion risk for larger target, and overestimate deal completion risk for horizontal mergers. For future research, tests can be constructed to explore the relationship of abnormal returns of risk arbitrage with those variables such target resistance, target size and horizontal mergers

## REFERENCES

Allen, A. and E. Dyl. (1997), "Market Structure and Reported Trading Volume: NASDAQ versus the NYSE," *Journal of Financial Research* 20, 291 – 304.

Amihud, Y. and H. Mendelson, (1986), "Asset Pricing and The Bid-Ask Spread," *Journal of Financial Economics* 15, 223-249.

Asquith, P., R, Bruner, and D. Mullins (1983) "The Gains to Biding Firms From Merger," *Journal of Financial Economics* 11, 121-139.

Baker, M. and S. Savasoglu (2002) "Limited Arbitrage in Mergers and Acquisitions," *Journal of Financial Economics* 64*,* 91-115.
Branch, B. and T. Yang (2003) "Predicting Successful Takeovers and Risk Arbitrage," *Quarterly Journal of Business and Economics* 42, 3-18.

Branch, B. and T. Yang (2006) "A Test of Risk Arbitrage Profitability," *International Review of Financial Analysis* 15, 39 – 56.

Jindra, J. and R. Walkling (2004) "Speculation Spreads and the Market Pricing of Proposed Acquisitions," *Journal of Corporate Finance* 10, 495-526.

Larker, D. and T. Lys (1987) "An Empirical Analysis of the Incentives to Engage in Costly Information Acquisition: the Case of Risk Arbitrage," *Journal of Financial Economics* 18,111-126.

Lynch, A. and R. Mendenhall (1997) "New Evidence on Stock Price Effects Associated with Changes in the S&P 500 Index," *Journal of Business* 70, 351 – 383.

Mitchell, M. and T. Pulvino (2001) "Characteristics of Risk and Return in Risk Arbitrage," *Journal of Finance* 56, 2135-2176.

Mitchell, M. and T. Pulvino and Erik Stafford (2002) "Limited Arbitrage in Equity Markets," *Journal of Finance* 57, 551-584.

Scholes, M. (1972) "The Market for Securities: Substitution versus Price Pressure and the Effects of Information on Share Prices," *Journal of Business* 45, 179 – 211.

Shleifer, A. (1986) "Do Demand Curves for Stocks Slope Down?" *Journal of Finance* 41, 579 – 590.
Shleifer, A. and R. Vishny (1997) "The Limits of Arbitrage," *Journal of Finance* 52, 35 – 55.

Wang, J. and Branch, B. (2009) "Takeover Success Prediction and Performance of Risk Arbitrage," *Journal of Business and Economic Studies* 15, Fall, 10-25.

Wang, J. and Branch, B. (2014) "Is Risk Arbitrage Market Neutral: The Case of Stock Swap Offers with Collars," *Quarterly Journal of Finance and Accountin*g 54, 99-130.

Walkling, R, (1985) "Predicting Tender Offer Success: A Logistic Analysis," *Journal of Financial and Quantitative Analysis*, 20, 461-478.

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