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ESSAYS ON HEDGE FUND INVESTMENT

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Abstract

This dissertation contains two essays on hedge fund investment. In the first I study the implementation of risk (or merger) arbitrage by hedge funds and other institutional arbitrageurs and document the increasing role of hedge funds in the takeover process. I find evidence of superior performance by hedge fund arbitrageurs compared to non-hedge fund institutional arbitrageurs. Specifically, within merger arbitrage, hedge funds significantly outperform other institutional arbitrageurs by 4% annually on a risk-adjusted basis. The superior performance does not reflect hedge fund managers' ability to predict or affect the outcome of merger and acquisition deals; rather, my findings suggest that it is attributed to hedge fund managers' ability to avoid deals with the largest downside when deals are withdrawn. Hedge fund and non-hedge fund investments in target shares are both associated with a higher probability of deal completion and shorter deal duration. I also study the relationship between hedge funds and investment banks within the context of mergers and acquisitions, and find that when hedge funds' prime brokers also serve as advisors in merger deals, hedge funds are significantly more likely to invest in risk arbitrage. This is consistent with an information updating model of risk arbitrage investment. I also find that hedge funds are willing to invest in deals that appear to bear greater idiosyncratic risk when their prime brokers are advisors in the deals. I find that hedge funds only outperform when their prime brokers work as advisors in deals. There is evidence that hedge funds are using their relationships with investment banks to gain informational advantages, while investment banks are incentivized by large hedge fund brokerage fees, and the desire for increased presence of arbitrageurs in merger deals, which increases their expected completion fees from merger advisory roles.

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Preface

The first chapter is based on work that is coauthored with my advisor Charles Cao, Bing Liang and Lubo Petrasek

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Dedication

This is dedicated to my wife Bekah.

Chapter 1

Risk Arbitrage and the Information Content of Hedge Fund Trading

1.1 Introduction

Risk (or merger) arbitrage activities have grown exponentially during the past three decades. The risk arbitrage strategy attempts to capitalize on the spread between the share prices of target firms following the announcement of merger deals and the final takeover price. This strategy has the potential to generate significantly positive returns with low correlation to market returns. In this paper, we examine how risk arbitrage is implemented by institutional investors such as hedge funds, broker-dealers, banks, and mutual funds. Specifically, we focus on the role played by hedge funds in mergers and acquisitions (M&A) and evaluate the performance of risk arbitrage hedge funds against that of other financial institutions. Whereas previous research on risk arbitrage focuses on returns to a naive strategy that purchases shares in all target firms, we analyze the actual holdings of hedge fund and non-hedge fund institutions. The institutional holdings of target shares allow us to examine how hedge funds and other institutions invest in risk arbitrage and their achievable level of returns.

The performance evaluation literature generally finds that hedge funds are able to outperform risk-adjusted benchmarks (e.g., Ackermann, McEnally, and Ravenscraft (2002); Agar-

wal, Daniel, and Naik (2009)), while other institutional investors, such as mutual funds and pension funds, are not (e.g., Carhart (1997); Busse, Goyal, and Wahal (2010)), based on self-reported returns. Griffin and Xu (2009), in contrast, compare the holdings of hedge fund companies to those of mutual fund companies and conclude that "hedge funds seem to be no better at long-equity investment than mutual funds."[1] We reconcile the conflict between the findings based on self-reported hedge fund returns and those based on hedge fund portfolio holdings by focusing on a single investment strategy, the risk arbitrage strategy. Examining portfolio holdings related to the risk arbitrage strategy allows us to measure the performance of a focused hedge fund group more accurately and compare it with the performance of non-hedge fund institutions that follow the same investment strategy.

Our research design expands on prior studies that examine the equity positions of equity-oriented hedge funds (e.g., Brunnermeier and Nagel (2004); Griffin and Xu (2009)). By focusing on hedge funds that pursue a specific investment strategy with a given time horizon, we can measure hedge fund performance more precisely. The investment horizon in the risk arbitrage strategy is clearly defined by the deal announcement date and the completion (or withdrawal) date. In contrast, prior studies evaluate hedge fund performance using the end date of each quarter as the investment horizon of hedge funds. However, many hedge funds pursue dynamic investment strategies with high portfolio turnover rates (e.g., Bollen and Whaley (2009)), making it difficult to capture hedge funds' true performance from snapshots on quarterly holdings. In addition, reported quarterly holdings capture only long equity positions, providing an incomplete picture of hedge fund performance. We overcome these shortcomings of the hedge fund holdings data by examining the portion of hedge fund portfolio holdings that is related only to risk arbitrage with predictable investment horizons and short positions in merger deals.

We identify a sample of financial institutions pursuing the risk arbitrage strategy from the changes in their holdings of target shares after deal announcements. Most institutional

[1] Jiang, Yao, and Yu (2007) use a holding-based market-timing measure to document mutual fund managers' timing skills, while previous studies using return-based measures fail to find any such evidence.

investors decrease their holdings of target shares following the announcements of M&As because they do not want to bear the risk in case the deals do not close. In contrast, risk arbitrageurs are defined as institutional investors that typically increase their target share holdings from zero to a positive number following deal announcements. We then divide risk arbitrageurs into hedge funds and non-hedge funds to compare M&A-oriented hedge funds to other institutional investors pursuing the same strategy. Comparing the performance of M&A-oriented hedge funds with that of non-hedge fund arbitrageurs, we find both the cross-sectional and time series evidence that hedge funds significantly outperform other institutions following a similar investment strategy.

Analyzing target returns in the cross section, we find that the actual source of hedge fund outperformance is not a hedge fund's ability to identify the best deals in which to invest but, rather, its ability to avoid the worst deals. Completed deals have, on average, the same excess returns, regardless of hedge fund involvement. In contrast, returns for deals that are subsequently withdrawn are significantly more negative if hedge funds are not involved. This result is consistent with the findings for institutional investments in initial public offerings (IPOs) of Aggarwal, Prabhala, and Puri (2002), who document that "institutions appear to be adept at avoiding 'lemons' in the IPO market." Similar to institutional investors in IPO deals, hedge funds are able to outperform in risk arbitrage by avoiding the worst deals.

We further analyze the impact of arbitrageurs' holdings on the probability of deal completion and on deal duration to uncover alternative sources of hedge fund outperformance. Hsieh and Walkling (2005) find a causal relationship between arbitrageur investment and positive deal outcomes. We expand their work by testing for differences between the impact of hedge funds and other arbitrageur's investments. We estimate the ex ante probability of deal completion and find arbitrageurs' holdings to be positively related thereto. Increased holdings in target firm stocks by either hedge funds or non-hedge funds are also related to a shorter deal duration. Our conclusion related to deal dynamics is that arbitrageurs, whether they hedge funds or other institutional arbitrageurs, have a positive impact on deal dynamics. This is consistent with Cornelli and Li (2002), who argue that arbitrageurs, regardless

of skill, should impact the likelihood of deal completion in takeovers. However, this probability does not explain the performance differential between hedge funds and non-hedge fund arbitrageurs.

The rest of the paper is organized as follows: Section 1.2 describes the data on hedge fund and non-hedge fund risk arbitrage holdings. Section 1.3 shows the level of risk arbitrageur investment and deal characteristics correlated with investments. Section 1.4 presents returns to target firms and compares the investment performance of hedge funds and non-hedge fund institutions in both the time series and cross section of deals. Section 1.5 explores the connection between hedge fund performance in risk arbitrage and the downside risk associated with the investment strategy. Section 1.6 presents the results related to deal dynamics and measures the relation between hedge fund holdings and deal outcomes. Section 1.7 concludes the paper.

1.2 Data

1.2.1 Acquirers and Targets

Merger targets typically trade at a discount to the announced merger price because of the risk of the deal not completing and the target stock price subsequently dropping. Risk arbitrage is an investment strategy that involves taking a long position in target firm stock following the announcement of a takeover. For stock deals, a short position in the acquirer stock can be used to hedge against stock price changes that are unrelated to deal completion risk. We measure institutional investors' returns from risk arbitrage using the institutional ownership (13F) holding data for deals spanning the end of a quarter between the announcement date and completion date. To estimate arbitrageurs' returns from each deal we assume that they maintain long positions in target shares from deal announcement until deal completion or withdrawal.

Risk arbitrageurs attempt to capture the spread between the post-announcement and

final prices paid by the acquirer through purchasing targets after the announcement of M&As. We identify all M&A offers recorded by Securities Data Company (SDC) from 1994 to 2008 and examine those offers where both the target and acquirer firms are listed by the Center for Research in Security Prices (CRSP) and the target firms are listed by Compustat. We exclude deals classified as leverage buyouts, spin-offs, recapitalizations, self-tenders, exchange offers, repurchases, minority stake purchases, acquisitions of remaining interests, and privatizations. We also exclude rumors and deals still pending final outcome. Next, we merge the M&A data with information on institutional holdings from 13F reporting. To accommodate the holdings data, we only examine offers where the duration of the deal, the time from announcement to either completion or withdrawal, spans the end of a quarter.

When multiple bidders are listed for a single target, we extend the time from deal announcement to deal completion until the final offer is either completed or withdrawn. We consider a deal successful if one of the overlapping offers is completed. When there are multiple takeover attempts of the same target firm that are not simultaneous we exclude the announced deals from the sample if a previous offer had been made within the last two years, thus removing deals where holdings information would have been impacted by previous announcements.

1.2.2 Risk Arbitrageurs

We identify risk arbitrageurs as institutions that typically increase their holdings of target shares from zero to a positive number upon the announcement of merger deals. Specifically, risk arbitrageurs are defined as institutions that (1) increase their holdings of target shares from zero to a positive number following at least 20 deal announcements out of our 1,990 deals during 1994-2008 and (2) increase their holdings in at least 50% of all deals in which they are invested between the quarter prior to the announcement to the quarter-end following the announcement. The first requirement, which is that arbitrageurs invest in at least 20 deals, helps us identify institutional investors that typically invest in target shares after deal

announcements and is adopted from Baker and Savasoglu (2002). The second requirement relates the increase in target share holdings to an institution's total target share holdings and allows us to exclude from the sample of arbitrageurs large institutions that do not normally act as arbitrageurs but that invest in 20 targets after announcement by chance. Thus, institutions that are typically net sellers of target stock are not classified as arbitrageurs. Taken together, these requirements ensure that our metric of the change in risk arbitrage holdings from the quarter prior to the announcement until the quarter following the announcement represents the actions of risk arbitrageurs. Risk arbitrageurs are further subdivided into 108 M&A hedge funds and 57 non-hedge funds, such as broker-dealers, banks, and mutual funds.

Figure 1.1 plots the value of risk arbitrage stock holdings against the total market value of all outstanding targets from 1994 to 2008. Risk arbitrage holdings are measured by the total market value of all the long-equity positions of the arbitrageurs in our sample. Figure 1.1 shows the gradual buildup in risk arbitrage until 2007 and its subsequent fall in 2008. In contrast, target equity value peaks during the merger wave from 1998 to 2001 and remains at a relatively low level for several years preceding 2008.

1.2.3 Hedge Funds

We hand-collected a unique data set of hedge fund ownership on individual stocks. The data are based on the institutional holdings of 13F reports from Thomson Financial, but we refine the institutional classifications to separate hedge fund management companies from mutual fund managers and other investment advisors. In addition to identifying hedge fund companies among other institutional investors, we examine separately the holdings of hedge funds that focus on M&A arbitrage (M&A hedge funds).[2]

Although some hedge funds are not required to register with the U.S. Securities and Exchange Commission (SEC) as an investment company[3], they must report their holdings

[2]This paper uses the terms M&A hedge funds and risk arbitrage funds interchangeably.

[3]The Dodd-Frank Act of 2010 requires that all hedge fund advisors with assets under management of more than $150 million register with the SEC.

quarterly with the SEC as long as they have more than $100 million of assets under discretionary management. Subject to reporting are all equity positions greater than 10,000 shares or $200,000 in market value. Holdings are reported at the fund manager level as of the end of each calendar quarter.

We use multiple data sources, including TASS, HFR, and CISDM, to identify M&A hedge funds and hedge fund management companies. We then match hedge fund managers with companies reporting their holdings on Form 13F. Similar to Brunnermeier and Nagel (2004) and Griffin and Xu (2009), we further exclude matched companies whose holdings are not representative of hedge fund activities. Specifically, we manually cross-check the registration documents (Form ADV) of all registered investment advisors and classify them as hedge fund managers only if they indicate that more than 50% of their clients are high net worth individuals and that they charge performance-based. About one-third of previously matched registered investment advisors, including Blackrock Advisors LLC and First Quadrant LP, are removed from the category of hedge fund managers because most of their clients are non-hedge fund institutions. Finally, all unregistered institutions that report to hedge fund databases are classified as hedge funds because they are not allowed to advise registered investment companies or other non-hedge fund clients.

To verify that hedge funds classified as risk arbitrageurs based on their holdings indeed pursue a risk arbitrage strategy, we examine their self-reported investment strategies in the hedge fund databases. We find that our sample of risk arbitrage hedge funds corresponds to funds that pursue "event driven" or "merger arbitrage" as their primary or secondary strategies listed in TASS, HFR, or CISDM.[4] Overall, our sample of risk arbitrageurs includes 108 hedge fund management companies and 57 non-hedge fund companies, with fund risk arbitrageurs including a number of different financial institutions such as broker-dealers, banks, and mutual funds.

[4]The findings remain unchanged if we use the self-reported strategies from the hedge fund databases to identify M&A arbitrage hedge funds.

1.2.4 Changes in the Ownership of Target Firms

We calculate the ownership fractions of different types of institutions by summing the shares held by the different types in each quarter and then dividing by the total number of shares outstanding at the end of that quarter. The detailed classification of institutional investors allows us to identify the types of institutions that invest in takeover targets. For all takeover attempts spanning at least one reporting quarter, we examine the changes in the ownership structure of target companies after the takeover announcement.

Table 1.1 shows the average percentage of M&A target shares held by institutions in the quarter prior to the deal announcement and the quarter following the deal announcement. Institutional investors hold, on average, 40.2% of target shares in the pre-announcement quarter, with 6.3% held by risk arbitrageurs, among which 3.8% is held by M&A hedge funds. Total institutional ownership drops to 36.4% in the quarter following the deal announcement. This drop is due to an 8.9% decrease in target share holdings by non-arbitrageurs, mitigated by a 5.1% increase in holdings by risk arbitrageurs, an increase mostly driven by M&A hedge funds, which increase their holdings by 3.2%. Table 1.1 also shows that, on average, 73.4 institutions report target share holdings in the pre-announcement quarter, of which 9.6 institutions are classified as risk arbitrageurs. In the post-announcement quarter, the number of institutions that maintain holdings in target firm stock drops to 72.2. This drop is the result of a decrease in the number of non-arbitrage institutions holding shares of 8.9, whereas the number of risk arbitrageurs holding target shares increases by 7.6 after an announcement.

Table 1.2 further displays remarkable changes in ownership structure upon deal announcement. We find that arbitrageurs in the aggregate increase their holdings in 79% of announced deals in our target sample. Any one of the 165 institutional arbitrageurs in our sample, on average, invests in 6% of the deals, with an average increase in target stock holdings of $1.6 million. Arbitrageurs that increase their holdings after announcements (81.1% of the time) typically have zero target share holdings in the pre-announcement quarter. For the 1,990

deal announcements in our sample, the 108 risk arbitrage hedge funds increase their holdings in 1,401 target firms, while the 57 non-hedge fund arbitrageurs increase their holdings in 1,341 deals.

The level of investment by risk arbitrageurs substantially increased over the sample period. Figure 1.2 shows the average level of investment in target stock by M&A hedge funds, divided into five equal sub-periods. In the earliest period, from 1994 to 1996, hedge fund risk arbitrageurs did not increase their holdings in over 45% of deals. They increased their holdings by more than 5% of target stock in less than 10% of deals. By the most recent period, from 2006 to 2008, risk arbitrage hedge funds increased their holdings by over 5% of target stock in more than 60% of deals and did not increase their holdings in target stock in less than 10% of deals. There is a clear upward trend over time in the percentage of hedge funds that increase their holdings of target firms by more than 5%. Figure 1.3 shows a similar but less dramatic increase in risk arbitrage holdings for non-hedge fund arbitrageurs. Taken together, our sample of 165 risk arbitrage companies purchases 11.9% of target stock for deals announced between 2006 and 2008. Thus, risk arbitrageurs play an increasing and impactful role in the M&A market.

1.3 Risk Arbitrageurs' Investments

1.3.1 Target and Deal Characteristics

We examine the portfolios of risk arbitrageurs to determine which targets are purchased and what characteristics lead to an increase in hedge fund involvement. Table 1.3 reports summary statistics for the following merger deal characteristics in our M&A sample, sorted on changes (increase or no increase) in arbitrageur investment. Here Attitude is the percentage of hostile deals as defined by SDC; Log Cash is the natural logarithm of target firm cash holdings; Block holder is an indicator variable that equals one when a target firm has a single institutional shareholder that owns more than 5% of the firm in the quarter prior to the

announcement, and zero otherwise; Industry is a dummy variable that equals one if both the target and acquiring firms are listed in the same Fama-French industry classification, and zero otherwise ; Stock is a dummy variable that equals one if the announced offer involves stock consideration, and zero otherwise; Log Size is the natural logarithm of a target firm's market capitalization; Market-to-book is the ratio of the market-to-book value of assets; ROA is the return on assets (ROA) ratio; Leverage is the book debt to assets ratio for the target firm; and Premium is the offer price minus the price 20 days prior to the takeover announcement standardized by the target price two days after the announcement.

We find that investment by hedge fund and non-hedge fund arbitrageurs is correlated with many target and deal characteristics. Both types of arbitrageurs tend to increase their holdings in deals with large block holders, which is consistent with the idea that large block holders are able to facilitate deal completion. They are also more likely to increase holdings in deals in which the target and acquirer are in the same industry. Arbitrageurs are less likely to increase their holdings in stock deals, which is potentially related to the costs associated with shorting acquirer stock. They also tend to invest in healthier firms, namely, firms with higher market-to-book ratios and ROAs.

1.3.2 Investment Timing

Risk arbitrage entails investing in target stock following the announcement of a merger or acquisition. Institutional holdings are released quarterly. Since we are unable to observe the exact timing of hedge fund trading, we measure arbitrageurs' returns from the close of the market in the day following a deal announcement until it is resolved by either completion or withdrawal. This assumption is used for all arbitrageurs, regardless of type, and represents the investment horizon for a typical risk arbitrage investment.

Since our focus is on risk arbitrage, our sample of arbitrageurs excludes institutions that frequently report positive holdings of target shares before deal announcements. To further confirm that our measures of risk arbitrage holdings are not driven by insider trading prior

to deal announcements, we regress the change in risk arbitrageurs' holdings on run-up period returns in the pre-announcement period. The run-up excess returns are measured from 20 days prior to the announcement until two days prior to the announcement. The regression model is the following:

$$(R_i - R_{MKT})_{-20to-2} = \alpha + \beta_1 \Delta HFhldgs_i + \beta_2 \Delta NonHFhldgs_i + \Sigma_{j=1,k} \gamma_j control_{i,j} + e_i \quad (1.1)$$

where R_i is the target firm's run-up period return in the pre-announcement period, $\Delta HFhldgs_i$ is the change in hedge fund risk arbitrageurs' holdings in the target firm, $\Delta NonHFhldgs_i$ is the change in non-hedge fund risk arbitrageurs' holdings, and the subscript i refers to the ith deal. The set of control variables includes a number of target and deal characteristics that could affect run-up period returns. These variables are defined in Section 1.3.1.

Table 1.4 provides the results of these regressions. We find no significant relation between hedge fund arbitrageurs' trading and the run-up returns, while the coefficient for non-hedge fund trading is significant. We repeat this process for the announcement returns from day -1 to day +1 around deal announcements. In contrast to the pre-announcement returns, we find that risk arbitrage trading by both hedge funds and non-hedge funds is significantly and positively correlated with announcement returns. The positive relation between arbitrageurs' holdings and announcement returns provides evidence that the arbitrageurs are entering the bulk of the positions observed in the quarterly filings around the announcement dates rather than trading on rumors in the pre-announcement period.

1.4 Risk Arbitrage Returns

We examine both the cross section and time series of risk arbitrage returns, which are measured daily from the close of the market on the day following a deal announcement until

deal resolution. Deals are considered resolved either on the day they are completed or on the day following the announcement that the offer has been withdrawn. If multiple bidders are present, we maintain the active status of the deal until the resolution of the final offer. This insures that our measure of returns captures the effect of any information relative to deal completion or withdrawal until the last outstanding offer is resolved. Target returns are included beginning on the second post-announcement day to insure that the returns to risk arbitrage are not influenced by announcement returns. Our primary measure of risk arbitrage returns is based only on the long position in a target firm's shares. However, risk arbitrage returns for stock deals can also be affected by a short position in the acquiring firm's shares. While the actual short positions are not disclosed in regulatory filings, their optimal size is determined by the need to provide a hedge against movements in the acquirer's share price. For a subset of our sample deals with sufficient information available to recreate the optimal short positions, we calculate hypothetical risk arbitrage returns that take into account both the arbitrageur's actual long positions in target shares and the optimal hedge positions in acquirer shares. We then compare the long-only returns with those from the long-short positions and find that the long position in target shares is the main determinant of risk arbitrage returns. Thus, our results are not sensitive to the use of long-only positions to measure risk arbitrage returns. A further discussion on the different measures of risk arbitrage returns can be found in Appendix A.

1.4.1 Time Series of Risk Arbitrage Returns

To evaluate the performance of hedge fund and non-hedge fund risk arbitrageurs, we evaluate the performance of arbitrageurs' portfolios against that of a benchmark portfolio consisting of all sample targets. The benchmark portfolio returns are calculated daily as a market value-weighted average of the returns on the target firm stocks in our sample. Targets are considered active and included in the portfolio from two days following the announcement, until the deal is either completed or withdrawn. The daily returns to target i (r_{it}) are then

compounded within each month to create a time series of monthly benchmark returns.

$$R = \Pi(1 + \Sigma_{i=active} w_{it} r_{it}) - 1 \tag{1.2}$$

The benchmark represents returns to a naive risk arbitrage strategy of investing in all targets in proportion to their market value. Next, we create two portfolios based on arbitrageurs' net purchases of target shares, and use the arbitrageur investment for portfolio weights (w_{it}). The first portfolio replicates the investments of M&A hedge funds, and the second the investments of non-hedge fund arbitrageurs. Both portfolios are formed based on changes in the institutional holdings of target shares from the quarter prior to the deal announcement to the quarter following. The positions are entered two days following deal announcements and are held until deals are either completed or withdrawn.

Figure 1.4 plots the time series of the cumulative returns for the value-weighted risk arbitrage portfolio, hedge fund risk arbitrage portfolio, and non-hedge fund risk arbitrage portfolio. The returns on the CRSP value-weighted index are also shown for comparison. Figure 1.4 illustrates that each of the risk arbitrage portfolios outperforms the market over our sample period. This finding is consistent with prior research on the risk arbitrage strategy (e.g., Mitchell and Pulvino (2001); Baker and Savasoglu (2002). Figure 1.4 also reveals a striking difference between hedge fund and non-hedge fund arbitrageurs. While the cumulative returns to the non-hedge fund risk arbitrage are very similar to those of the naive strategy of investing in all deals after announcement, the hedge fund risk arbitrage portfolio outperforms both the naive and non-hedge fund portfolios. For example, the terminal value of investing \$1 in the CRSP value-weighted index at the beginning of 1994 through the end of 2008 is \$1.47, while the terminal values of investing \$1 in the naive and non-hedge fund risk arbitrage strategies are \$8.59 and \$11.17, respectively. All these numbers pale, however, in comparison to the terminal value of investing \$1 in the hedge fund risk arbitrage strategy, which is \$17.47.

We further examine the time series of the risk arbitrage returns of each portfolio to

investigate whether there is a significant difference in risk-adjusted returns (alphas) between the hedge fund and non-hedge fund portfolios and between the hedge fund and naive risk arbitrage portfolios. Specifically, we regress risk arbitrage returns on the Fama-French-Carhart four factors:

$$R_{pt} - R_{ft} = \alpha + \beta_{MKT}(R_{MKT,t} - R_{f,t}) + \beta_{SMB}R_{SMB,t} + \beta_{HML}R_{HML,t} + \beta_{MOM}R_{MOM,t} + \epsilon_t \quad (1.3)$$

where R_{MKT} is the monthly return on the CRSP value-weighted portfolio of all New York Stock Exchange, American Stock Exchange, and NASDAQ stocks; R_{SMB}, R_{HML}, and R_{MOM} are returns on value-weighted, zero-investment, factor-mimicking portfolios for size, book-to-market equity, and one-year momentum in stock returns, respectively; and R_f is the risk-free rate.

Table 1.5 presents the coefficient estimates from the time series regressions and shows that all three risk arbitrage portfolios deliver positive and significant alphas over our sample period. This agrees with the findings of prior research on the risk arbitrage strategy. However, we find that the hedge fund portfolio delivers the highest risk-adjusted return, 1.24% per month (14.9% annually), followed by the non-hedge fund portfolio (0.92% per month, or 11.0% annually) and the naive risk arbitrage portfolio (0.87% per month, or 10.4% annually). The difference between the hedge fund and non-hedge fund returns from risk arbitrage is positive and significant at the 5% level, showing that M&A hedge funds significantly outperform non-hedge funds pursuing the risk arbitrage strategy by 0.32% per month (3.9% annually).

1.4.2 Cross Section of Risk Arbitrage Returns

In addition to the time series analysis of risk arbitrage returns, we compare the performance of hedge fund and non-hedge fund arbitrageurs in the cross section of merger deals. This test allows us to measure the impact of the level of arbitrageur holdings on deal returns

and to understand why hedge fund arbitrageurs are able to outperform non-hedge fund arbitrageurs. The excess returns used for the cross-sectional regressions are measured while the deal is active, which spans from the end of the day following the deal announcement until deal resolution, through either completion or withdrawal. As a result, the returns span different periods and extend over different event window lengths. We use two alternative methods to create an appropriate risk-adjusted return benchmark for each event window and ensure a meaningful comparison across deals: the risk arbitrage model and the Fama-French-Carhart four-factor model.

The first method relies on a simple model of risk arbitrage from Baker and Savasoglu (2002) with two potential outcomes: success (deal completion) or failure (deal withdrawal). If the probability of deal completion is one, target stock returns are discounted at the risk-free rate. In the case of certain failure, or offer withdrawal, the market price reflects all relevant information already at the deal announcement and the appropriate discount rate for target returns is the market return. Thus the benchmark for risk arbitrage returns is the average of the risk-free rate and market returns weighted by the ex ante probability of deal completion:

$$R_{bt} = R_{f,t} + (1 - \pi)(R_{MKT,t} - R_{f,t}) \tag{1.4}$$

where R_{bt} is the benchmark return over the entire event window and R_{MKT} and R_f are defined as in Equation 1.3. Our measurement of the ex ante probability of deal completion is π, which is estimated using information on target and deal characteristics (see Section 1.6). The benchmark is established for each individual deal relative to the event timing of each merger period. The second approach to calculating excess returns from risk arbitrage uses the Fama-French-Carhart four-factor model as the benchmark. We estimate the daily risk exposures to a value-weighted portfolio of all target firms in our sample from the beginning of 1994 until the end of 2008. This results in the following coefficient estimates:

$$R_{bt} = 0.0007 + 1.07(R_{MKT} - R_{ft}) + 0.09R_{SMBt} + 0.37R_{HMLt} - 0.12R_{MOMt} \qquad (1.5)$$

where R_{bt} is the daily benchmark return calculated using the Fama-French-Carhart four-factor model. The excess returns used in the analysis are calculated relative to this model and are cumulated over each deal's investment horizon. Thus the benchmark used represents the average risk exposures for all the target firms in our sample. This allows us to create excess returns for all deals, including those with short event windows.

Table 1.6 presents the returns to risk arbitrage in the cross section of merger deals. Returns are represented on a per deal basis and are measured as cumulative target firm excess returns from two days following the announcement of a deal until the deal is either completed or withdrawn. The cross-sectional averages are sorted by the increase in investment by both hedge fund and non-hedge fund institutions. Panels A and B of Table 1.6 show, respectively, returns benchmarked against the risk arbitrage model in (3) and the Fama-French-Carhart four-factor model in (4). Both panels demonstrate that deals with an increase in hedge fund investment have significantly higher returns than deals where hedge funds do not increase their holdings. In contrast, when deals are sorted by changes in non-hedge fund arbitrageurs' holdings, there is no significant difference in performance between the deals with increased non-hedge fund ownership and other deals. An implication of these results is that hedge fund involvement in a deal is strongly positively related to excess returns from arbitrage, whereas non-hedge fund ownership is not. Thus, hedge fund arbitrageurs invest in deals that have significantly higher excess returns than the deals in which hedge fund arbitrageurs do not invest.

Next, we test the hypothesis that hedge fund (non-hedge fund) investment is associated with higher returns from risk arbitrage. Specifically, we estimate the following cross-sectional regression model for the cumulative returns to each target over the risk arbitrage investment period in excess of the given benchmark:

$$R_i - R_b = \beta_1 + \beta_2 HFInvDum_i + \beta_3 \Delta NonHFInvDum_i +$$
$$\beta_4 \Delta HFHldgs_i + \beta_5 \Delta NonHFHldgs_i + \Sigma_{j=1,k} \gamma_j control_{ji} + e_i \quad (1.6)$$

where the hedge fund and non-hedge fund investment dummy variables equal one when hedge fund (non-hedge fund) arbitrageurs increase their holdings in target stock after deal announcement, and zero otherwise. The continuous variables for changes in arbitrageur holdings are $\Delta HFHldgs_i$ and $\Delta NonHFHldgs_i$. The set of control variables, tabulated in Section 1.3.1, includes a number of target and deal characteristics that can affect returns to risk arbitrage. Excess returns are measured against either the risk arbitrage benchmark or the Fama-French-Carhart four-factor model.

The results presented in Table 1.7 confirm the earlier findings that hedge funds outperform non-hedge fund arbitrageurs. When hedge funds increase their holdings in target stocks, risk arbitrage excess returns are significantly higher, by 4.23%, and the returns measured relative to the Fama-French-Carhart benchmark are 4.74% higher; the corresponding univariate estimates in Table 1.6 are 3.52% and 4.92%, respectively. Most interestingly, we find no significant difference in risk arbitrage excess returns between when non-hedge fund arbitrageurs increase their holdings in target stocks and when they do not, relative to either benchmark.

The specification in Table 1.7 includes both dummy variables for arbitrageurs' investment and continuous variables for the magnitude of the increase. It distinguishes between the effects of involvement by arbitrageurs and their level of investment. We find that risk arbitrage excess returns are significantly higher when hedge fund arbitrageurs are invested in the deal, but the level of their investment is unrelated to the excess returns. A possible explanation for this finding is that the limits to arbitrage set in as the risk arbitrage strategy becomes increasingly crowded (Mitchell, Pulvino, and Stafford (2002)). Anecdotal evidence suggests that arbitrageurs' equity capital has grown faster than the number of merger deals,

until 2008, and many deals have become crowded (see Figure 1.1). In accordance with the limits to arbitrage, the level of non-hedge fund investment in merger deals is marginally negatively related to risk arbitrage excess returns.

1.5 Downside Risk in Risk Arbitrage

Mitchell and Pulvino (2001) argue that excess returns to risk arbitrage could compensate investors for downside risk. The downside risk stems from withdrawn deals, when the target stock price drops to the target's standalone value. To determine the relation between superior hedge fund performance and downside risk, we measure the downside risk faced by hedge fund and non-hedge fund arbitrageurs for failed deals.

To better understand the relation between downside risk exposure and hedge fund performance, Table 1.8 presents the risk arbitrage returns of withdrawn deals sorted by the current CRSP delisting status of the target firms. We find that among the 249 firms with withdrawn offers in our sample, 64 firms were currently listed as active. There are 124 firms that were subsequently delisted due to M&As (delisting codes 200 and 299), and 61 firms were delisted due to bankruptcy or insufficient float (delisting codes between 500 and 599). The excess returns to the target firms of withdrawn deals in Table 1.8 are highly correlated with their future delisting status. In other words, the market appears to correctly estimate the standalone value of targets at the time when merger deals are withdrawn. Currently active firms have a negative excess return of -16.4%, while firms that become a target again and are eventually taken over have a much higher excess returns of -1.0%. Firms that are eventually delisted due to bankruptcy or other similar outcomes have risk arbitrage excess returns of -36.4%. The average excess returns to all target firms during the takeover period of withdrawn deals are -13.6%. Table 1.8 shows that hedge fund institutional arbitrageurs invest more heavily in deals that, upon offer withdrawal, do not face the same downside as the typical withdrawn deal. The fact that takeover period returns strongly indicate the future viability of target firms indicates that information is revealed about the target firm

during attempted mergers. The investment performance of hedge funds in merger arbitrage indicates that they are informed investors prior to the information revelation in the takeover process. Once we weight the investment in withdrawn deals by the level of arbitrageur investment, we find that hedge funds outperform average risk arbitrage returns for withdrawn deals, while non-hedge fund arbitrageurs do not.

In sum, these results suggest that the source of hedge funds' outperformance of non-hedge funds is not their ability to select the best deals to invest in but, rather, their ability to avoid the deals with the greatest downside risk in case of failure. Excess returns captured by hedge funds in risk arbitrage do not appear to be compensation for the downside risk borne by hedge funds. Instead, our findings show that hedge funds achieve superior performance in risk arbitrage by capturing similar returns on completed deals as other arbitrageurs, without facing the same downside risk. This finding resonates well with the finding of Aggarwal, Prabhala, and Puri (2002), where "institutions appear to be adept at avoiding 'lemons' in the IPO market," which explains why they outperform retail investors. Similar to institutional investors in IPO deals, hedge funds are able to outperform other investors in risk arbitrage by avoiding the worst deals.

1.6 Alternative Explanations of Investment Performance: Outcomes of Merger Deals

The return-based evaluation of risk arbitrageurs' investments shows that hedge funds outperform other financial institutions. This section examines whether the superior performance of hedge funds can be explained by their ability to predict or affect the outcome of merger deals. Hsieh and Walkling (2005) find a causal relationship between arbitrageur investment in target firms and deal completion, while Larcker and Lys (1987) attribute the relationship between arbitrageur investment and deal outcome to information acquisition by arbitrageurs. Cornelli and Li (2002) predict that even uninformed arbitrageurs will impact the probability

of deal completion because they will tender their shares and thus increase the probability of a successful deal completion. We study the relation between arbitrageurs' holdings and deal completion probability or duration to test their prediction. Furthermore, we test whether hedge fund and non-hedge fund arbitrageurs have a differential impact on the probability of deal completion.

We estimate a probit model for the probability of deal completion (Comp) with a dependent variable equal to one for completed deals and equal to zero for withdrawn deals. The estimated model is

$$Comp_i = \beta_1 + \beta_2 \Delta HFHldgs_i + \beta_3 \Delta NonHFHldgs_i + \Sigma_{j=1,k} \gamma_j control_{i,j} + e_i \qquad (1.7)$$

where the continuous variables for changes in arbitrageur holdings are $\Delta HFHldgs_i$ and $\Delta NonHFHldgs_i$. Table 1.9 presents the probit regression results with standard errors robust to heteroskedasticity and shows that hostility has a significant impact on deal completion. Consistent with Baker and Savasoglu (2002) and Walkling (1985), we find that managerial attitude measured by SDC as either hostile or friendly is the best predictor of deal completion. Most interestingly, we find that increases in both hedge fund and non-hedge fund holdings are associated with an increase in the probability of deal completion, controlling for other deal and target characteristics. A change of one standard deviation in M&A hedge fund holdings yields a similar change in the probability of deal completion as a change of one standard deviation in non-hedge fund arbitrageurs' holdings. For example, a one standard deviation increase in hedge fund arbitrageur holdings is related to a 1.8% increase in the probability of deal completion, while a one standard deviation increase in holdings for non-hedge fund arbitrageurs is related to a 1.6% increase in the probability of completion. We find no statistical difference between hedge fund and non-hedge fund arbitrageurs.

Another way hedge funds can achieve superior performance with their risk arbitrage portfolios is to invest in deals that are resolved more quickly. We consider a deal resolved

when it is either completed or after the withdraw announcement. In the case of multiple bidders, the duration period extends until the resolution of the final offer. Deal duration is measured in two different ways: The first method relies on the number of days between the deal announcement date and the resolution date. However, we also measure duration as the time between the quarter-end following the announcement and deal resolution to make sure that the relation between arbitrageurs' investment and deal duration is not driven by the quarterly frequency at which we observe arbitrageurs' holdings.

One concern is that the deals in our sample must span a quarter's end to accommodate the quarterly holdings data. While this requirement increases the average deal duration, it has minimal impact on the overall distribution of deals. We find that 90% of deals take 61 days or more to be completed. Given that deal announcements are evenly distributed throughout any given quarter, the distribution of deal durations in our sample closely resembles the distribution of all deals in the SDC database.

We use an exponential duration model to measure the impact of hedge fund ownership on deal completion duration:

$$S(t)_i = exp(\beta_1 + \beta_2 \Delta HFHldgs_i + \beta_3 \Delta NonHFHldgs_i + \Sigma_{j=1,k} \gamma_j control_{j,i}) + u_i \qquad (1.8)$$

where $S(t)_i$ denotes the survival time of deal i, or the time from the announcement until deal resolution, and the continuous variables for changes in arbitrageur holdings are $\Delta HFHldgs_i$ and $\Delta NonHFHldgs_i$.

Table 1.10 shows the estimated marginal effects of arbitrageur investment on deal duration. For both hedge fund and non-hedge fund arbitrageurs, we find that increased investment leads to shorter deal durations. A one standard deviation change in the holdings of both types of institutions has a similar effect. Deals with large block holders have shorter deal durations, suggesting that large block holders are able to facilitate deal completion. We also find that deal duration is related to several measures of the target's financial health.

The results presented in Table 1.10 indicate that both hedge fund and non-hedge fund holdings are correlated with deal outcome. When arbitrageurs have greater increases in target share holdings, merger deals are resolved more quickly. There is a larger marginal effect for non-hedge fund arbitrageurs, but it is mitigated by the larger variation in hedge fund holdings resulting in a similar impact of a one standard deviation change in holdings for both sets of arbitrageurs. When hedge fund arbitrageurs have a one standard deviation increase in target stock holdings, deals are completed 4.2 days faster, and 5.2 days faster for non-hedge fund arbitrageurs.

The results in this section indicate that the superior performance by hedge funds in merger arbitrage relative to other institutional investors does not lie in their ability to predict or affect deal dynamics. While arbitrageur investment is correlated with both the probability of deal completion and deal duration, we do not find evidence that there is a differential impact between hedge fund and other institutional arbitrageurs. This finding supports the idea in the previous section that the main source of hedge funds' superior performance in merger arbitrage is their ability to avoid deals with the greatest downside.

1.7 Conclusions

The hedge fund literature finds evidence of superior performance based on self-reported returns, while tests using holdings data fail to find evidence that hedge funds outperform other institutional investors. The return-based data is not only self-reported but also subject to a number of potential biases, such as return smoothing, back-filling bias, and hedge funds' endogenous selection when reporting returns to data vendors. This paper reconciles the conflicting findings from two strands of the literature and evaluates the performance of hedge funds against that of other institutional investors, using the holdings data on a single investment strategy that requires long positions as the primary investment for implementation. This allows us to use the more reliable holdings data to provide a better-suited comparison of the investment performance of hedge funds and other institutional arbitrageurs.

Previous research on risk arbitrage examines returns to investing in a broad risk arbitrage portfolio of all announced merger deals. In contrast, we use detailed information on arbitrageurs' holdings of target shares to study how risk arbitrage is implemented by institutional investors such as hedge funds, broker-dealers, banks, and mutual funds. We find that hedge funds significantly outperform non-hedge fund institutions by about 4% annually on a risk-adjusted basis, suggesting that hedge funds are among the most sophisticated investors. Extant studies based on the aggregate equity holdings by all types of hedge funds provide no support for the hypothesis that hedge funds outperform non-hedge fund institutions. To gain further insight into performance difference between hedge funds and non-hedge fund institutions, we examine the portfolio holdings of hedge funds and other institutional investors that only pursue the risk arbitrage strategy and find that, within the context of risk arbitrage, hedge funds outperform non-hedge fund institutions by a significant margin.

We further examine the sources of hedge funds' superior performance and find that hedge funds are not able to predict or affect the probability of a successful deal completion any better than non-hedge fund institutions. Furthermore, hedge funds' excess returns from risk arbitrage are not compensation for bearing greater investment risk. Contrary to the view that hedge funds earn abnormal returns by taking more risk than other investors, hedge funds' risk arbitrage portfolios exhibit significantly less downside when deals are withdrawn than non-hedge funds' risk arbitrage portfolios. We conclude that hedge funds outperform other institutional arbitrageurs not by their ability to select the best deals but, rather, by their ability to avoid the deals that experience the most negative returns in case of failure.

Our findings also shed light on the importance of hedge funds and other risk arbitrageurs in facilitating M&As. We find that the presence of risk arbitrageurs in the merger market has increased dramatically over the last decade and that the capital available to risk arbitrageurs peaked in 2007. We also find that both hedge fund and non-hedge fund investment is based on a large number of target and deal characteristics, such as firm size, deal consideration, the presence of large block holder investors, and firm ROA. Nevertheless, the size of the takeover premium is unrelated to arbitrageur investment.

Finally, our results reconcile the different results between return-based evaluations of hedge fund performance and holdings-based evaluations regarding hedge funds' ability to outperform non-hedge fund institutions. This paper also contributes to the literature on risk arbitrage by showing that hedge funds play an increasing and important role in M&As; however, contrary to conventional wisdom, their role in risk arbitrage is not limited to accepting the downside risk that other investors avoid. While hedge funds invest in target firms after announcements of mergers and takeovers, they eschew targets with the greatest downside risk. These findings call into question our understanding of the risk-bearing function of hedge funds in risk arbitrage activities.

Figure 1.1: Target Equity and Total Risk Arbitrageur Stock Holdings

This figure shows the total value of all the long equity holdings of the 165 risk arbitrage financial institutions in our sample and the total market value of target equity for all outstanding deals during our sample period. Target equity is for the 1,990 merger deals announced between January 1994 and December 2008 included in our sample.

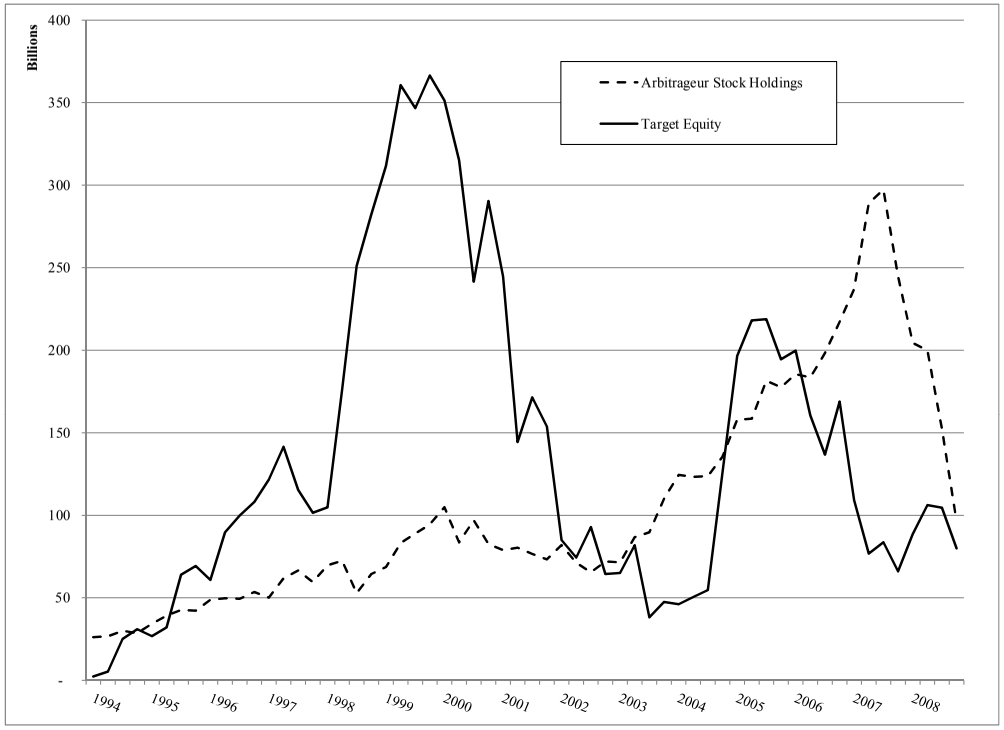

Figure 1.2: Change in Holdings of Target Shares after Deal Announcements by Risk Arbitrage Hedge Funds

This figure plots the distribution over time of the changes in target share holdings by 108 risk arbitrage hedge funds from the quarter prior to deal announcement to the quarter following deal announcement. Holdings are measured as the percentage of outstanding shares and changes in target share holdings are averaged during each period. The entire sample is comprised of 1,990 merger deals announced between January 1994 and December 2008.

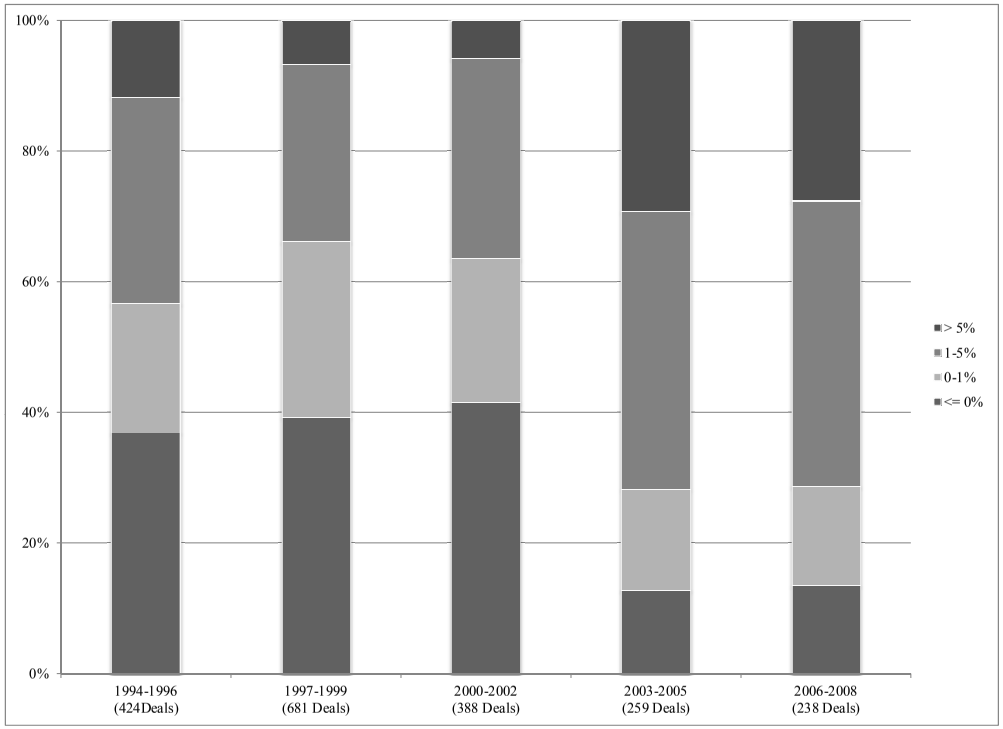

Figure 1.3: Change in Holdings of Target Shares after Deal Announcements by Non-Hedge Funds Arbitrageurs

This figure plots the distribution over time of the changes in target share holdings by 57 non-hedge fund arbitrageurs from the quarter prior to deal announcement to the quarter following deal announcement. Holdings are measured as the percentage of outstanding shares and changes in target share holdings are averaged during each period. The entire sample is comprised of 1,990 merger deals announced between January 1994 and December 2008.

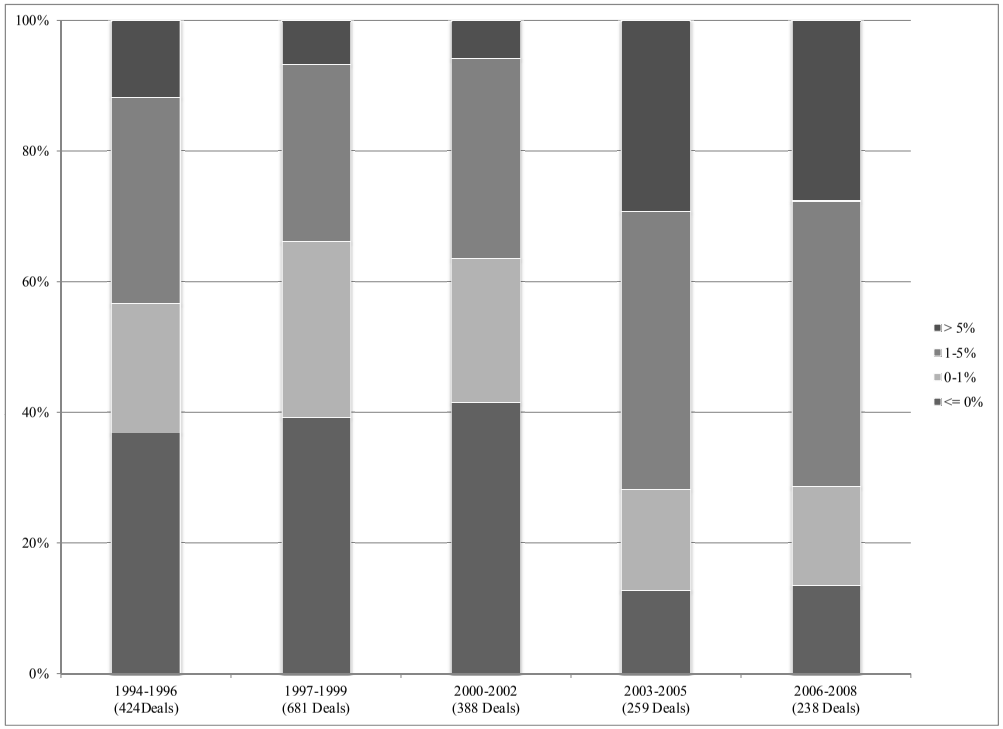

Figure 1.4: Cumulative Returns from Risk Arbitrage

This figure plots the value of $1 invested at the beginning of 1994 through December 2008 in four different long-only portfolios: (1) a value-weighted risk arbitrage portfolio, (2) a hedge fund risk arbitrage portfolio, (3) a non-hedge fund risk arbitrage portfolio, and (4) a CRSP value-weighted index. The hedge fund and non-hedge fund risk arbitrage portfolios are replicated based on their holdings of target stocks from quarterly 13-F reports. It is assumed that arbitrageurs invest in targets two days after a deal announcement and hold target shares until the deals are either completed or withdrawn. The portfolios are rebalanced quarterly.

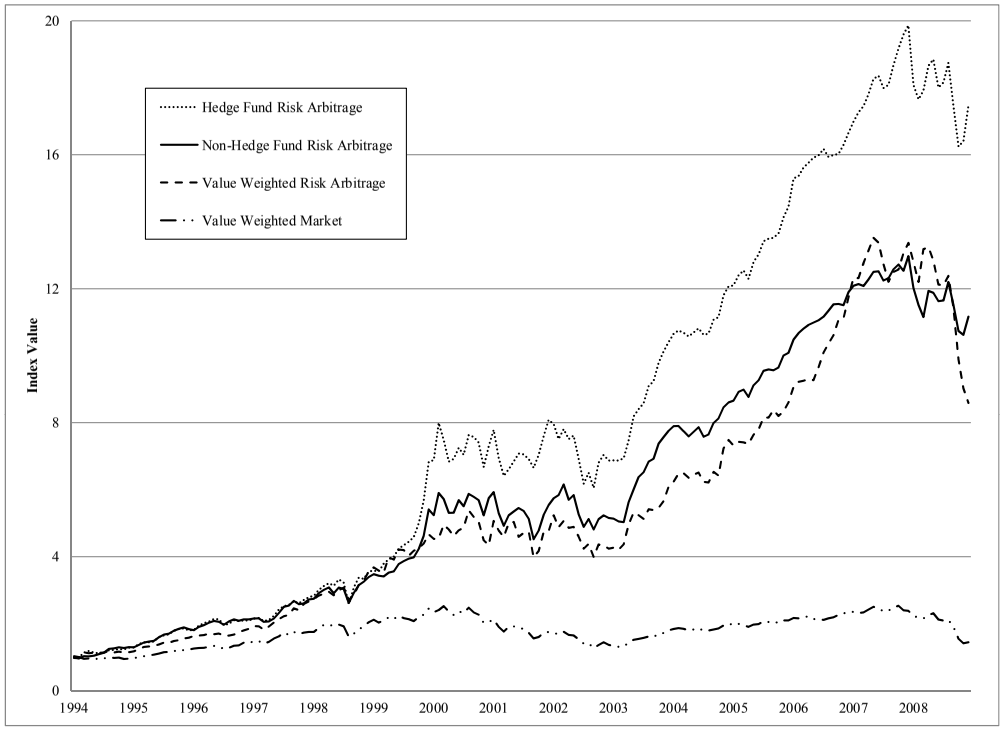

Table 1.1: Institutional Holdings of Target Shares

This table presents the average percentage of M&A target shares held by institutions in the quarters before and after deal announcement. Institutional holdings are shown separately for 165 risk arbitrageurs and 3,840 other institutional investors. Risk arbitrageurs are defined as institutions that (1) increase their target share holdings from zero to a positive amount following at least 20 deal announcements during 1994-2008 and (2) acquire at least 50% of the deals held by increasing their holdings from zero to a positive number after an announcement. Risk arbitrageurs are further subdivided into M&A hedge funds (108) and non-hedge fund (57) arbitrageurs, such as broker-dealers, banks, and mutual funds. The sample is made up of 1,990 merger deals announced between January 1994 and December 2008. The superscripts ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Percentage of Target Shares Held by Institutional Investors

	Quarter Before	Quarter After	Difference	t-Statistic
Hedge Fund Arbitrageurs	3.76%	6.99%	3.23%	29.9***
Non-Hedge Fund Arbitrageurs	2.49%	4.38%	1.89%	28.0***
Other Institutions	33.92%	25.02%	-8.90%	25.1***
All Institutions	40.17%	36.39%	-3.78%	11.3***
All Arbitrageurs	6.25%	11.37%	5.12%	32.9***

Panel B: Number of Institutions Holding Target Shares

	Quarter Before	Quarter After	Difference	t-Statistic
Hedge Fund Arbitrageurs	5.7	10.3	4.6	32.0***
Non-Hedge Fund Arbitrageurs	4.0	6.9	3.0	36.0***
Other Institutions	63.8	54.9	-8.9	17.3***
All Institutions	73.4	72.2	-1.2	2.4**
All Arbitrageurs	9.6	17.2	7.6	35.9***

Table 1.2: Summary Statistics for Risk Arbitrageurs

This table provides descriptive statistics on risk arbitrageurs' investments in merger deals. Risk arbitrageurs are defined as institutions that (1) increase their holdings of target shares from zero to a positive number following at least 20 deal announcements during 1994-2008 and (2) acquire at least 50% of the deals held by increasing their holdings from zero to a positive number after an announcement. Risk arbitrageurs are further subdivided into M&A hedge funds and non-hedge fund arbitrageurs. Non-hedge fund arbitrageurs are institutions such as broker-dealers, banks, and mutual funds.

	Hedge Funds	Non-Hedge Funds	All
Number of Institutions	108	57	165
Total Number of Deals	1,990	1,990	1,990
Deals with Increased Holdings	1,401	1,341	1,579
Percentage of Deals with Increased Holdings	70%	67%	79%
Deals Held per Institution	105	142	118
Percentage of Deals Held per Institution	5%	7%	6%

Table 1.3: Summary Statistics for Risk Arbitrageurs

This table reports descriptive statistics of deal characteristics for announced M&As during 1994-2008, partitioned by changes in risk arbitrageurs' positions from the quarter prior to announcement to the quarter after. Panel A splits the statistics based on changes in M&A hedge fund holdings, and Panel B based on changes in non-hedge fund arbitrageur holdings. Completed is the percentage of announced deals that are subsequently completed; HF (Non-HF) Invest indicates the percentage of deals invested in by hedge funds (non-hedge funds); Attitude is the percentage of deals considered hostile, as measured by SDC; Log Cash is the logarithm of cash and short-term investments; Block Holder is the percentage of deals that have a single institutional shareholder that owns more than 5% of the firm in the quarter previous to the announcement; Industry is the percentage of deals where both the target and acquiring firms are listed in the same Fama-French industry classification; Stock Deal is the percentage of announced deals that are 100% stock based; Size is the target firm's market capitalization (in millions of dollars); Market-to-book is the market-to-book value of assets; Leverage is the book debt to asset ratio; ROA is the return-on-asset ratio; and Premium is equal to the offer price minus the price 20 days prior to the takeover announcement divided by the target price two days after the announcement. All accounting variables are measured at the end of the accounting year immediately preceding the deal announcement. The superscripts ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Hedge Fund Arbitrageurs			Non-Hedge Fund Arbitrageurs			
	Increase	No Increase	t-statistic	Increase	No Increase	t-statistic	Total
Completed	88.8%	84.4%	2.72***	89.3%	83.8%	3.45***	87.5%
HF Investment				86.7%	36.7%	26.72***	70.4%
Non-HF Investment	83.0%	30.2%	26.72***				67.4%
Attitude (Hostile)	4.5%	1.4%	3.45***	4.3%	2.0%	2.62***	3.6%
Log Cash	16.0	15.7	3.64***	15.9	15.9	0.63	15.9
Block Holder	78.9%	61.1%	8.34***	79.6%	61.3%	8.82***	73.6%
Industry	66.2%	57.2%	3.80***	65.8%	58.7%	3.11***	63.5%
Stock Deal	34.9%	48.2%	5.60***	34.8%	47.1%	5.32***	38.8%
Log Size	19.6	18.1	19.36***	19.7	18.1	20.81***	19.2
Market-to-Book	2.3	2.0	2.51**	2.3	2.0	2.71***	2.2
Leverage	0.21	0.22	0.90	0.21	0.21	0.19	0.21
ROA	-0.03	-0.11	5.75***	-0.02	-0.13	7.78***	-0.05
Premium	0.27	0.26	0.32	0.27	0.28	0.39	0.27
Number of Deals	1,401	589		1,341	649		1,990

Table 1.4: Pre- and Post-Announcement Excess Returns

This table presents cross-sectional regressions of target equity run-up excess returns and announcement excess returns on changes in target holdings by merger arbitrageurs and on other deal characteristics. The dependent variable in the left column is the run-up excess return, measured as the return in excess of the market return from 20 days prior to the announcement to two days prior. The dependent variable in the right column is the announcement excess returns, measured as the return in excess of the market return from one day prior to the announcement to one day following it. All control variables are defined in Table 3. The coefficient estimates are presented with heteroskedasticity-robust standard errors in parentheses. The superscripts ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Run-up Excess Returns	Announce Excess Returns
Change in Hedge Fund Hldgs	0.506	59.492***
	-10.19	-15.016
Change in Non-Hedge Fund Hldgs	36.07**	82.277***
	-15.224	-26.418
Premium	11.093**	18.413***
	-5.492	-6.706
Attitude (Hostile)	-7.806***	10.209***
	-1.634	-2.512
Log Cash	-0.005	0.433
	-0.303	-0.415
Block Holder	-0.337	0.902
	-1.098	-1.281
Industry	-0.444	0.016
	-0.925	-1.12
Stock Deal	-0.227	-6.109***
	-1.067	-1.2
Log Size	-1.127***	-2.468***
	-0.331	-0.405
Market-to-Book	0.171	-0.085
	-0.262	-0.23
Leverage	1.621	2.131
	-1.899	-4.057
ROA	0.831	-0.639
	-2.213	-4.262
Year Dummies	Yes	Yes
R^2	0.11	0.201
N	1990	1990

Table 1.5: Time Series Regression of Target Returns on Common Risk Factors

This table shows the results from time series regressions of risk arbitrage excess returns to targets from two days post-announcement until either deal completion or withdrawal on common risk factors. The Fama-French-Carhart four-factor model used is

$$R_{pt} - R_{ft} = \alpha + \beta_{MKT}(R_{MKT,t} - R_{f,t}) + \beta_{SMB}R_{SMB,t} + \beta_{HML}R_{HML,t} + \beta_{MOM}R_{MOM,t} + \epsilon_t$$

The hedge fund arbitrage returns replicate the performance of the target portfolio held by hedge funds as measured by their holdings disclosed in 13F filings. The non-hedge fund arbitrage returns replicate the target portfolio held by non-hedge fund arbitrageurs. All portfolios are weighted by the change in arbitrageur holdings in the target firm from the quarter before deal announcement until the quarter following announcement. The coefficient estimates are presented in the table, with Newey-West standard errors in parentheses. Seven lags are used to determine reported standard errors. α is measured in percentages per month. The superscripts ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Raw Returns		Excess Returns		Sharpe	
	Mean	St Dev	Mean	St Dev	Ratio	N
Hedge Fund Arb Rets	1.73	5.05	1.42	5.05	0.28	180
Non-HF Arb Rets	1.49	4.48	1.14	4.47	0.26	180
	a	β_{MKT}	β_{SMB}	β_{HML}	β_{MOM}	$AdjR^2$
Hedge Fund Arb Rets	1.24***	0.67***	0.23***	-0.33***	0.05	0.62
	-0.23	-0.09	-0.05	-0.1	-0.05	
Non-HF Arb Rets	0.92***	0.69***	0.22***	-0.19**	0.04	0.68
	-0.22	-0.08	-0.05	-0.09	-0.04	
Spread: HF - Non-HF	0.32**	-0.02	0.02	-0.14***	0.01	0.04
	-0.15	-0.06	-0.05	-0.05	-0.04	

Table 1.6: Arbitrageurs' Involvement and Target Stock Returns

This table shows returns on target shares from two days post-announcement until deal completion or withdrawal. The benchmark returns used in the calculation of merger arbitrage excess returns in Panel A are created using the model $R_b = R_f + (1-\pi)(R_{mkt} - R_f)$, where R_f is the risk-free rate, R_{mkt} is the return on the market, and π is an ex ante estimate of the probability of deal completion. Mean is the average target return per deal and St Dev is the cross-sectional standard deviation of target returns. Panel B uses the Fama-French four-factor model as the benchmark. Its betas are estimated from a regression of daily value-weighted target returns on the Fama-French factors over 1994-2008. Increase (no increase) refers to deals for which arbitrageurs increase (do not increase) their holdings from zero to a positive amount after announcement. The superscripts ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Merger Arbitrage Excess Returns

	Hedge Fund Arbitrageurs			Non-Hedge Fund Arbitrageurs		
	Mean	St Dev	N	Mean	St Dev	N
Increase	5.33	29.25	1401	4.78	28.49	1341
No Increase	1.81	35.32	589	3.27	36.16	649
Spread	3.52**			1.52		
(Std Error)	-1.53			-1.49		

Panel B: FamaFrench-Carhart Four-Factor Excess Returns

	Hedge Fund Arbitrageurs			Non-Hedge Fund Arbitrageurs		
	Mean	St Dev	N	Mean	St Dev	N
Increase	3.9	27.64	1401	3.09	27.05	1341
No Increase	-1.02	34.23	589	1.11	34.84	649
Spread	4.92***			1.98		
(Std Error)	-1.46			-1.43		

Table 1.7: Cross-Sectional Regressions of Target Stock Return on Arbitrageurs' Investment

This table provides the results from the cross-sectional regressions of target excess returns from two days post-announcement until either deal completion or withdrawal on changes in target holdings by risk arbitrageurs and on other deal characteristics. The Hedge Fund (Non-Hedge Fund) Increase Dummy equals one when hedge funds (non-hedge funds) increase their target share holdings after deal announcement, and zero when they do not. Premium is the offer price minus the price two days after the announcement divided by the price 20 days prior. The first model uses excess returns relative to the risk arbitrage benchmark, whose returns are given by the model $R_{b,t} = R_{f,t} + (1 - \pi)(R_{mkt} - R_f)$, where R_f is the risk-free rate, R_{mkt} is the return on the market, and π is the ex ante probability of deal completion. The second model uses the Fama-French four-factor model as a benchmark. Its betas are estimated from a regression of daily value-weighted target returns over 1994-2008 on the four Fama-French factors. Descriptions of other variables are provided in Table 3. Heteroskedasticity-robust standard errors are recorded in parentheses. The superscripts ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Risk Arbitrage Excess Returns	FF 4-Factor Excess Returns
Hedge Fund Increase Dummy	4.23**	4.74***
	-1.88	-1.84
Increase in Hedge Fund Holdings	10.15	5.91
	-15.92	-15.18
Non-Hedge Fund Increase Dummy	-0.34	0.82
	-1.88	-1.87
Increase in Non-Hedge Fund Holdings	-40.74*	-25.09
	-23.85	-23.71
Premium	2.26	1.96
	-3.62	-2.93
Attitude (Hostile)	1.24	3.01
	-2.77	-2.77
Log Cash	0.2	0.48
	-0.5	-0.49
Block Holder	-0.82	-0.89
	-1.75	-1.7
Industry	1.3	1.04
	-1.38	-1.33
Stock Deal	0.31	1.03
	-1.63	-1.56
Log Size	0.31	-0.01
	-0.48	-0.47
Market-to-Book	-0.39	-0.43
	-0.45	-0.41
Leverage	2.04	1.62
	-4.07	-3.99
ROA	-0.18	0.92
	-3.62	-3.37
Year Dummies	Yes	Yes
R^2	0.052	0.034
N	1990	1990

Table 1.8: Excess Returns and Arbitrageur Investment Based on Current Target Status

Panel A presents average returns for withdrawn deals sorted by their current CRSP delisting codes. A code of 100 means that the target firm is currently active. Codes in the 200's are firms delisted due to M&As. Firms with a code in the 500's are no longer active due to bankruptcy, being delisted, or insufficient float or assets. Average excess returns are created using the model $R_{b,t} = R_{f,t} + (1 - \pi)(R_{mkt} - R_f)$, where R_f is the risk-free rate, R_{mkt} is the return on the market, and π is an ex ante estimate of the probability of deal completion. Panel B shows average excess returns for withdrawn deals weighted by the levels of investment for hedge funds and non-hedge funds, respectively. The spread is the difference between the investment-weighted measure and the average excess returns in Panel A.

Panel A: Average Returns		
Delisting Code	N	Average Returns
100 Active Firms	64	-16.40%
200 Merged Firms	124	-1.00%
500 Delisted Firms	61	-36.40%
All	249	-13.60%

Panel B: Investment Weighted Returns of Withdrawn Deals		
	Hedge Funds	Other Institutions
Inv. Weighted Returns: Withdrawn Deals	-7.30%	-12.80%
(Standard Error)	-0.02	-0.02
Spread: Inv. Weighted Average Returns	6.30% ***	0.80%
(Standard Error)	-0.03	-0.03

Table 1.9: Deal Completion Probability

This table presents the estimation results of probit regressions of the merger outcome on changes in target holdings by risk arbitrageurs. The dependent variable equals one if the announced deal is completed, and zero otherwise. All estimated marginal effects are in percentages. A change in holdings is the difference between the percentages of target shares held in the quarter-ends following and prior to the deal announcement. All control variables are described in Table 3. The estimated marginal effects for each variable are presented in the table, with heteroskedasticity-robust standard errors recorded in parentheses. The superscripts ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)
Attitude (Hostile)	-52.5***	-52.1***	-47.2***	-49.9***	-49.7***
	-6.0	-6.0	-6.0	-6.0	-6.0
Δ Hedge Fund Arb Hldgs	45.2**			56.3**	
	-21.0			-23.0	
Δ Non-Hedge Fund Arb Hldgs	88.4***			84.6***	
	-33.0			-32.0	
Δ in Arb Hldgs		61.3***			67.4***
		-13.0			-15.0
Log Cash			0.9*	0.8	0.8
			-0.5	-0.5	-0.5
Block Holder			-0.5	-1.2	-1.2
			-2.0	-2.0	-2.0
Industry			1.3	1.7	1.7
			-2.0	-1.0	-2.0
Stock Deal			-0.6	0.2	0.2
			-2.0	-2.0	-2.0
Log Size			0.5	0.2	0.2
			-0.5	-0.5	-0.5
Market-to-Book			0.7	0.5	0.5
			-0.5	-0.4	-0.4
Leverage			0.9	1.3	1.3
			-3.0	-3.0	-3.0
ROA			-0.5	-1.5	-1.5
			-2.0	-2.0	-2.0
Premium (%)			1.2	0.8	0.8
			-1.0	-1.0	-1.0
Year Fixed Effects	No	No	Yes	Yes	Yes
Pseudo-R^2	0.115	0.114	0.123	0.145	0.145
N	1,990	1,990	1,990	1,990	1,990

Table 1.10: Deal Completion Probability

This table presents exponential duration model regressions of deal duration on changes in target holdings by our sample of merger arbitrageurs and other deal characteristics. Models (1) and (2) measure duration as the number of days from deal announcement to deal completion. Models (3) and (4) measure duration as the number of days from the quarter-end following the announcement, corresponding to the holdings report date, to deal completion. A change in holdings is the difference between the percentages of target shares held in the quarter-ends following and prior to the deal announcement. The control variables are described in Table 3. The estimated marginal effects for each variable are presented, with heteroskedasticity-robust standard errors recorded in parentheses. The superscripts ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Announced to Completed		Quarter-End to Completed	
	(1)	(2)	(3)	(4)
Δ Hedge Fund Arb Hldgs	(130.58)***	(130.02)***	(182.27)***	(195.47)***
	(32.82)	(33.24)	(35.94)	(35.93)
Δ Non-Hedge Fund Arb Hldgs	(273.55)***	(272.69)***	(363.41)***	(362.16)***
	(58.11)	(53.57)	(68.74)	(59.79)
Attitude (Hostile)		16.13		20.32*
		(10.10)		(10.48)
Log Cash		(4.83)***		(4.73)***
		(0.99)		(0.92)
Block Holder		(15.06)***		(12.28)***
		(3.96)		(3.68)
Industry		6.68**		6.07**
		(2.75)		(2.65)
Stock Deal		2.27		(0.02)
		(3.14)		(2.94)
Log Size		7.10***		6.20***
		(0.84)		(0.76)
Market-to-Book		(2.05)***		(1.66)***
		(0.43)		(0.45)
Leverage		20.02***		17.73***
		(6.65)		(6.24)
ROA		(3.41)		(3.44)
		(4.16)		(3.99)
Premium (%)		2.36		1.74
		(2.89)		(2.10)
Year Fixed Effects	No	Yes	No	Yes
Pseudo-R^2	0.01	0.043	0.034	0.092
N	1,990	1,990	1,990	1,990

Chapter 2

Prime Brokers and Hedge Fund Investment Decisions

2.1 Introduction

The growth of the hedge fund industry has led to enormous profits for investment banks. A 2005 estimate by Credit Suisse First Boston claims that 1 in every 8 dollars of investment bank revenue comes from hedge fund clients[1]. Hedge funds generate more revenue for investment banks than traditional investment managers due to the higher turnover in their portfolios, and the prime brokerage fees for lending money and securities to facilitate leveraged and short positions. Bodnaruk, Massa, and Simonov (2009) and Haushalter and Lowry (2011) show that within the context of mergers and acquisitions (M&A), valuable private information is passing between different divisions of large investment banks. Hedge funds use these investment banks as prime brokers. The prime broker relationships with hedge funds creates a potential channel for information to pass from investment banks to their hedge fund customers. I study the connections between these financial institutions to determine if investment banks provide private investment information to hedge funds, and what impact that information has on hedge fund investment decisions and performance.

Investment banks work as advisors in mergers and acquisitions and also as prime brokers to hedge funds. I look at hedge fund investment in merger targets to determine if there is a

[1]"Investment banks are too dependent on hedge funds," *Bloomberg News*, 23 March 2005, sec. FP, FP13

change in hedge fund investment behavior when their prime broker is and is not an advisor in merger deals. When investment banks are advisors in merger deals they possess private information that could be valuable to hedge fund clients. This setting allows for a clear test of how prime broker relationships affects hedge fund investment behavior. I use hedge fund investment performance in merger arbitrage to measure the economic significance of these relationships.

Risk (or merger) arbitrage is an investment strategy of investing in a target company's stock following M&A announcements. This strategy allows investors to capture the spread between the stock price of the target following the announcement and the final offer price for the stock in the takeover. This setting allows for a clear test of how relationships with other financial institutions impact investment decisions by hedge funds. Investment banks often provide brokerage services to hedge funds, and also advise firms in merger deals. I identify hedge funds that pursue merger arbitrage and determine what impact having a prime broker relationship with advising investment banks has on the hedge fund investment decision. Recently, the SEC has become concerned, and warned investment banks about meetings that would provide private information to hedge funds surrounding merger deals[2].

Investment banks receive increased fees when merger deals are completed because their fee contracts typically include success fees. Both theoretical (Cornelli and Li (2002)) and empirical (Hsieh and Walkling (2005)) research show that greater arbitrageur investment leads to an increase in the probability that deals are completed. Given this relationship, investment banks would want greater involvement from arbitrageurs and might be willing to provide information to their hedge fund clients that would lead to an increased frequency of hedge fund investment when they advise in merger deals. On the other hand if the information that flows to hedge funds is compensation for their prime brokerage fees to banks, they might receive information that allows them to concentrate investment in the best deals, which would result in investment in a smaller percentage of deals.

I find that when merger arbitrage hedge funds have a prime broker relationship with

[2]"Special Access: Banks Woo Funds with Private Peeks," *Wall Street Journal*, 16 May 2011: .1

advising investment banks in M&A they are more likely to invest in target stock. Individual hedge funds invest in less than 10% of merger deals when their prime broker is not an advisor, and greater than 15% of deals when they are. This represents a 60% unconditional increase in the likelihood of hedge fund investment when their prime brokers work as advisors in merger deals. The conditional probit estimates for hedge fund investment controlling for other factors that affect arbitrage investment show that prime broker relationships are associate with an over 20% increase in the likelihood of hedge fund investment in merger arbitrage. 50 of the 57 hedge funds in the sample have an increase in the frequency of investment in merger deals when their prime brokers are advisors in merger deals.

Shleifer and Vishney (1999) argue that idiosyncratic risk matters to specialized arbitrageurs because of underdiversification. I show that greater expected idiosyncratic risk in merger deals causes a decrease in the likelihood of hedge fund investment. To test how information sharing between financial institutions impacts investment decisions, I compare the level of expected idiosyncratic risk of merger arbitrage for deals with hedge fund investment when their prime brokers are and are not advisors in the merger deals. I find that connected hedge funds invest in deals with significantly greater levels of idiosyncratic risk. This indicates that information sharing alleviates concerns about idiosyncratic risk leading hedge fund to invest in deals that they might otherwise not invest.

Information sharing between hedge funds and investment banks explains increased hedge fund investment when their prime brokers are advisors in merger deals and their propensity to bear idiosyncratic risk. I examine the returns to hedge fund investments in risk arbitrage to determine the economic significance of information sharing. If investment banks provide valuable investment information to hedge funds, then hedge funds should exhibit superior investment performance in merger arbitrage when their prime brokers are advisors in deals. Alternatively, if investment banks are not providing private information then hedge fund performance in risk arbitrage should be unaffected by their prime broker relationships. Creating hedge fund risk arbitrage portfolios from 1994-2008, I find that hedge funds significantly outperform naive risk arbitrage portfolios on a risk adjusted basis when their prime

brokers are advisors, but not when they have no connection to the deals. This is consistent with the information sharing hypothesis.

When investment banks are advisors in mergers and acquisitions their hedge fund clients are significantly more likely to invest in merger arbitrage and are willing to bear more idiosyncratic risk than other hedge funds. Hedge funds also exibit superior investment ability in merger arbitrage over naive portfolios when their investment banks are advisors in merger deals. This is consistent with an information updating model of risk arbitrage investment, and is evidence that there is information sharing between financial institutions. Hedge funds gain private information advantages that lead to superior returns, and investment banks benefit from the high hedge fund fees to prime brokerage services, and increased expected completion fees in merger advising. Research, such as Baker and Savasoglu (2002) and Mitchell and Pulvino (2001), has gone into understanding the returns to merger arbitrage, but relatively few studies have attempted to actually understand who follows this strategy, and what is the basis for their investment decisions. This paper fills that gap and contributes to our understanding of information sharing between financial institutions.

The rest of the paper proceeds out as follows: Section 2.2 lays out an information updating model of risk arbitrage investment; Section 2.3 discusses the role of prime brokers and the identification of hedge funds and investment banks; Section 2.4 describes the merger data; Section 2.5 estimates the likelihood of hedge fund investment in mergers and acquisitions; Section 2.6 measures the risk and returns to merger arbitrage when hedge funds have connections to merger deals; and Section 2.7 concludes the paper.

2.2 A Model of Merger Arbitrage Investment

To model the investment decision in risk arbitrage I use a simple single asset model. When merger deals are announced hedge funds must decide if they want to add that particular deal to their investment portfolio. New deals are announced stochastically, and a static model that represents multiple merger deals as investment opportunities in a single decision

framework appears unintuitive for this enviornment.

In reality there are a number of potential outcomes following a merger announcement, including multiple bidders, revisions, and other potential changes in the original conditions to the deal. Following the model of risk arbitrage in Baker and Savasoglu (2002), I begin with a stylized model of mergers with only two outcomes. When a merger is completed shareholders receive a payoff of $1+\delta$, and when a deal fails the target shares are worth 1. A merger is completed with probability π and fails with probability $(1-\pi)$. The difference in this model is that the true value of π is unknown. Following the announcement of a merger, investors can infer the market consensus estimate of the probability of completion, π_o, from the post-announcement target stock price P, which is defined as:

$$P = \pi_o(1+\delta) + (1-\pi_o) = 1 + \delta\pi_o \tag{2.1}$$

In the model the arbitrageur uses information to determine merger deal quality measured by θ, which is used to estimate the probability of deal completion by:

$$\pi_a = \frac{e^{\bar{\theta}}}{1+e^{\bar{\theta}}} \tag{2.2}$$

where π_a is the arbitrageur's estimate of the probability of completion. Using public information, the arbitrageur's prior distribution for information relating to merger deal quality, θ, is assumed to be normal with mean $\bar{\theta}_o$ and variance σ_o^2. The mean of the prior deal quality variable is dependent on the public estimate of the probability of deal completion and is defined as:

$$\bar{\theta}_o = log\Big(\frac{\pi_o}{1-\pi_o}\Big) \tag{2.3}$$

Arbitrageurs use private information signals to update their prior estimates of deal quality. Arbitrageurs aggregate their private information about deal quality into a signal s, that is equal to:

$$s = \theta + \epsilon \tag{2.4}$$

The signal, s, is equal to the true value of θ plus some error ϵ. The distribution of ϵ is assumed to be normal with mean 0 and variance σ_s^2. Using Bayes' rule, the arbitrageur's posterior belief about merger deal quality is normally distributed with mean $\bar{\theta}_p$ and variance σ_p^2, where $\bar{\theta}_p$ and σ_p^2 are equal to:

$$\bar{\theta}_p = \bar{\theta}_o \frac{\frac{1}{\sigma_o^2}}{\frac{1}{\sigma_o^2} + \frac{1}{\sigma_s^2}} + s \frac{\frac{1}{\sigma_s^2}}{\frac{1}{\sigma_o^2} + \frac{1}{\sigma_s^2}} \tag{2.5}$$

$$\sigma_p^2 = \frac{1}{\frac{1}{\sigma_o^2} + \frac{1}{\sigma_s^2}} \tag{2.6}$$

The posterior mean is the weighted average of the prior estimate and the private signal. The weights are determined by the precision of the estimates. If arbitrageurs face positive transaction costs, c, and are risk neutral then they will invest if the expected payoff to risk arbitrage is positive[3]. Using the arbitrageurs posterior beliefs about π, and substituting equation 2.1 for the target stock price, P, the expected payoff is equal to:

$$\begin{aligned} E(payoff) &= \pi_a(1+\delta) + (1-\pi_a) - c - P \\ &= (\pi_a - \pi_o)\delta - c \end{aligned} \tag{2.7}$$

I also impose the restriction that $1 + \delta > c + P$. This restriction requires that the payout to investment is large enough to cover the price of the investment and the transaction costs when deals are completed. Otherwise, the arbitrager would never invest regardless of the signal received. Substituting Equation 2.2 for the posterior probability of completion, π_p, the arbitrageur investment rule requires the following:

$$\bar{\theta}_p > log\left(\frac{c/\delta + \pi_o}{1 - (c/\delta + \pi_o)}\right) \tag{2.8}$$

[3]The assumption of risk neutrality is not required for the model predictions. A model that generalizes to any standard utility function is available upon request

The value of $\bar{\theta}_p$ is defined in Equation 2.5. The private signal that is received by arbitrageurs is the sum of two random variables, θ and ϵ, and is observable to the arbitrageur, but is unobservable to the econometrician. For the econometrician, this leads to a distribution for the mean of the posterior, $\bar{\theta}_p$ that is normal with mean $\bar{\theta}_o$ and a variance equal to the sum of the variances of θ and ϵ times the squared weight given to the signal.

$$Var(\pi_p) = (\sigma_o^2 + \sigma_s^2)\left(\frac{\frac{1}{\sigma_s^2}}{\frac{1}{\sigma_o^2} + \frac{1}{\sigma_s^2}}\right)^2 \tag{2.9}$$

Given the expected payoffs from equation 2.7, and the distribution of the posterior mean, the probability of arbitrageur investment can be defined as:

$$Prob(Inv) = 1 - \Phi\left(\frac{log\left(\frac{c/\delta+\pi_o}{1-(c/\delta+\pi_o)}\right) - log\left(\frac{\pi_o}{1-\pi_o}\right)}{\sqrt{(\sigma_o^2 + \sigma_s^2)\left(\frac{\frac{1}{\sigma_s^2}}{\frac{1}{\sigma_o^2}+\frac{1}{\sigma_s^2}}\right)^2}}\right) \tag{2.10}$$

Where $\Phi(.)$ is the cumulative standard normal distribution.

Prediction: The likelihood of arbitrageur investment is increasing in the precision of their private signals.

While we cannot observe the information signals received by hedge funds Equation 2.10 shows that the precision of information signals is a determinant of the likelihood of arbitrageur investment. Figure 2.1 shows numerically that the likelihood of arbitrageur investment is decreasing(increasing) in the variance(precision) of their private signal. The chain rule can be used to show that the derivative of the probability of investment with respect to the variance of the private signal is negative, which again implies that the probability of investment is decreasing in the variance of their private signal. Empirically we are not able to

observe the precision of the private signals received by hedge funds from their prime brokers, but we can observe when hedge fund prime brokers also act as advisers in the merger. In this setting we would assume that prime brokers are able to provide more precise estimates of the probability of deal completion. This leads to the testable implication of the model that hedge funds are more likely to invest in risk arbitrage when their prime brokers also act as advisers in merger deals.

2.3 The Role of Prime Brokers

Brokerage divisions of investment banks traditionally engage in various functions including: execution, clearing, and prime brokerage. Execution and clearing primarily entail the front and back office work related to enacting trades for commissions. Prime brokerage consists of a number of different functions such as holdings assets, record keeping and lending money or securities to facilitate leveraged and short positions. While hedge funds will often have many transaction brokers that provide investment information in compensation for commission fees, hedge funds typically only have one prime broker that generates higher fees from lending money and securities for financed positions. Due to more active trading hedge funds typically have more turnover in their portfolios and generate higher fees for investment banks than other institutional investment managers.

In recent years prime brokers have begun to provide other non-traditional services to hedge fund managers such as providing office space and capital induction. Major prime brokerage firms often provide office space and servicing for their hedge fund clients. They have floors of their offices dedicated to their hedge fund clients and provide access to receptionists, conference rooms, and technological support. Along with office space prime brokers also assist new hedge fund clients in gathering initial investment assets from their wealthy investor contacts and other financial institutions. The relationships between hedge funds and the prime brokers are further complicated when fund-of-hedge funds ran by the brokers financial institution are also invested in the hedge funds themselves.

The result of the services provided by prime brokers leads to a structure where hedge funds are assisted in capital induction, housed in brokerage office space, have record keeping performed by brokers, fund assets are in brokerage custody, and brokerage institutions hold positions in the funds through their fund-of-funds. While these hedge fund institutions may be independent financial institutions, they often appear and operate as a subsidiary of the prime broker investment banking institution. The close integration of these financial institutions raises the question of how these relationships affect the firms underlying investment decisions, and with all of the services provided to hedge funds, are they also able to use their relationships with these large financial institutions to generate informational advantages in investment markets?

Large investment banking financial conglomerates have two distinguishable incentives when considering their hedge fund clients and their investment banking operations in mergers and acquisitions. Previous research, such as Bodnaruk, Massa, and Simonov (2009) and Haushalter and Lowry (2011), has shown that information passes amongst divisions of large investment banks. The author is unable to identify any existing literature that tests if there is also information sharing between investment banks and other financial institutions. The expanding list of services provided to hedge funds from their prime brokers shows the profitability of hedge fund clients. It is estimated that annual revenue from hedge fund business to investment banks is $25 billion, or more than an eighth of total investment banking industry revenue[4]. Private information is a potential way in which investment banks could be compensating hedge funds for those large fees. If investment banks are providing private information to hedge funds there is still the question of what type of information is provided, and what impact that private information has on hedge fund investment decisions.

In mergers and acquisitions investment banks typically receive fees for two different services. The first is fairness opinions. Investment banks analysts provide a report detailing the fairness of the offered acquisition price in mergers and acquisitions. The fees for the fairness opinion are typically fixed and moderate relative to the total potential fees from M&A

[4]"Investment banks are too dependent on hedge funds," *Bloomberg News*, 23 March 2005, sec. FP, FP13

transactions. Remuneration for services in M&A is primarily success fee based[5] These are the fees that based upon the successful completion of the merger and can range from 1-6% of the total price of the transaction. Cornelli and Li (2002) provide a theoretical framework that shows that the presence of arbitragers in M&A increases the likelihood of a successful takeover because arbitrageurs combine to represent a large institutional block holder that is willing to tender their shares and facilitate the transaction process. Hsieh and Walking (2005) test this theory empirically and show that there is a causal relationship between the level of arbitrageur investment in M&A and the probability of a successful deal. Given that investment banks are predominantly compensated in M&A through success fees, and the causal relationship between arbitrageur investment and the probability of success, investment banks would want more investment by hedge funds in deals which would increase their expected fees in those deals.

2.3.1 Identification of Hedge Fund and Prime Brokers

This study utilizes a data set of hedge fund ownership. The data is based on institutional holdings from 13F reports from Thomson Financial, but I refine the institutional classifications to separate hedge fund management companies from mutual fund managers and other investment advisors. In addition to identifying hedge fund companies among other institutional investors, I examine separately the holdings of hedge funds that focus on merger and acquisition arbitrage.

Although hedge funds are not required to register with the Securities and Exchange Commission (SEC) as an investment company, they must report their holdings quarterly with the SEC as long as they have more than $100 million of assets under discretionary management. Financial Institutions are required to report are all equity positions greater

[5]A May 7, 2007 article in *Investment Dealers Digest* documents cases in Delaware where the court found that success fees in mergers and acquisitions are contingent compensation for certain investment banks fairness opinions. The success fees were found to be more than 10 times the compensation for fairness opinions for the cases in the article. "Fairness Opinions and Success Fees Can Make for Volatile Mix," *Investment Dealers Digest*, 7 May 2007.

than 10,000 shares or $200,000 in market value. Holdings are reported at the fund manager level as of the end of each calendar quarter. I use multiple sources, including Barclay Hedge, CISDM, and HFR, to identify M&A arbitrage hedge funds and hedge fund management companies. I then match hedge fund managers with companies reporting their holdings on Form 13F. Similar to Brunnermeier and Nagel (2004) and Griffin and Xu (2009), I further cross-check each of the companies to be certain that their holdings are from to hedge fund activities. Specifically, the registration documents of all registered investment advisers are manually cross-checked, and classified as hedge fund managers only if they indicate that more than 50% of their clients are hedge funds or high net worth individuals, and that they charge performance-based fees. Finally, I classify managers as hedge funds if they are not registered as investment advisers because institutions are not allowed to advise registered investment companies or other non-hedge fund clients.

The reason that Barclay Hedge, CISDM, and HFR are used as the primary identification databases for hedge funds is that they also list hedge funds prime brokers. This field is used to identify the investment bank associated with each hedge fund. Some hedge funds list more than one prime broker, and in these instances I include all identified prime brokers for that fund. The prime broker identification is at the hedge fund level, while the holdings data is at the company level. For some hedge funds within the same financial institution, different hedge funds are listed. When this occurs, I use all identified investment banks as prime brokers for the hedge fund company. The data is survivorship bias free as the hedge fund firms enter and leave the throughout the sample. Hedge funds could also change their prime brokers over time. To account for this, I also use the prime broker listings for hedge funds from the "dead" databases of fund that have closed. Some institutions have "live" and "dead" funds. If the different funds report different prime brokers then both are used as prime broker connections. For a further discussion of prime broker turnover please see Appendix A.

2.3.2 Risk Arbitrageurs

Risk arbitrageurs are identified as institutions that increase their holdings of target shares from zero to a positive number upon the announcement of merger deals. Specifically, risk arbitrageurs are defined as institutions that (1) increase their holdings of target shares from zero to positive following at least 20 deal announcements out of the 1,954 deals during the sample period 1994 to 2008, and (2) increase their holdings in at least 50% of all deals in which they are invested between the quarter prior to the announcement to the quarter end following the announcement. The requirement of risk arbitrage investment in at least 20 deals is consistent with Baker and Savasoglu (2002), but they were only concerned with the amount of capital available to potential arbitrageurs. I seek to understand how risk arbitrage is implemented by financial institutions. This requires that I exclude institutions that are typically sellers of target stock and only occasionally invest in risk arbitrage, because their holdings most often represent institutions that are on the other side of risk arbitrage transactions. For this reason I have included the second criteria that requires institutions to increase their holdings in target equity for the majority of deals in which they hold any target stock in either the quarter before or after announcement. These requirements ensure that the investment metric of the change in holdings from the quarter prior to announcement until the quarter following announcement represents the actions of risk arbitrageurs and not financial institutions that are selling to risk arbitrageurs.

Table 2.1 shows the distribution of the identified risk arbitrage hedge funds and prime brokers. 57 hedge funds are identified. Of the 57 hedge fund companies 38 have only one or two prime brokers identified, while only 5 hedge funds list five or more prime brokers, with the maximum being nine. There are 25 investment banks identified as prime brokers for the hedge fund sample. 18 of the prime brokers are listed for five or fewer hedge funds, while there are two investment banks listed for more than twenty of the hedge funds.

2.4 Mergers and Acquisitions Data

Risk arbitrageurs attempt to capture the spread between post announcement price and the final price paid by the acquirer by purchasing target equity after the announcement of mergers and acquisitions. I identify all mergers and acquisition offers recorded by Securities Data Company (SDC) from 1994 to 2008, and examine the offers where both the target firm and the acquirer firm are listed by the Center for Research on Security Prices (CRSP), and target firms are listed by COMPUSTAT. I exclude deals classified as leverage buyouts, spin-offs, recapitalizations, self-tenders, exchange offers, repurchases, minority stake purchases, acquisition of remaining interests, and privatizations. I also exclude rumors and deals that are still pending final outcome. Next, I merge the M&A data with information on institutional holdings. To accommodate the holdings data I only examine offers where the duration of the deal, the time from announcement to either completion or withdraw, spans the end of a quarter. In order to measure how relationships between financial institutions impact arbitrageur investment, I only use deals that SDC identifies at least one advising investment bank, 38 deals are excluded for this reason. A final sample of 1,954 total deals are used.

When multiple bidders are listed for a single target I extend the time from deal announcement to last until the final offer is either completed or withdrawn. I consider a deal successful if one of the overlapping offers is completed. When there are multiple takeover attempts of the same target firm that are not simultaneous I exclude announced deals when a previous offer has been made within the last two years. This is to remove deals where the holdings information would be impacted by previous announcements.

Table 2.2 provides descriptive statistics for the sample merger deals. The deals are split into two categories: deals that are advised by at least one of the 25 prim broker investment banks; and those that are not. Of the 1,954 deals 1,335 are advised by one of the prime broker investment banks. For the reported statistics *Completed* is the percentage of announced deals that are subsequently completed; *Attitude* is the percentage of deals that are considered hostile as measured by SDC; *Premium* is equal to the offer price minus the

price 20 days prior to the takeover announcement divided by the target price two days after announcement; *Large Block Holder* is the percentage of deals that have a single institutional share holder that owns greater than 5% of the firm in the quarter previous to announcement; *Stock Deal* is the percentage of announced deals that are 100% stock based; *Industry Match* is the percentage of deals that have both the target and acquiring firm listed in the same Fama French industry classification; *Market-to-book* is the ratio of market-to-book value of assets; *Leverage* is the book debt to asset ratio; *ROA* is the return on assets ratio; *Target Size* is the target firm's market capitalization ($millions) and *Acquirer Size* is the acquirer firm's market capitalization ($millions).

For all of the descriptive statistics there is a significant difference between the deals that have prime broker advisors and hose that do not. The deals that are advised by the large investment banks that also act as prime brokers involve both larger targets ($1,697 M v. $180 M) and acquirers ($16,134 M v. $6,203 M). The deals are also more likely to be completed and involve healthier target firms with higher market-to-book ratios and return-on-assets. The characteristics of deals and target firms when there are prime broker advisors involved are clearly a different sample of merger deals. For this reason it is important to control for the type of advisors involved in each deal when measuring hedge fund investment because the type of advisor proxies for other deal characteristics.

2.5 Prime Brokers and Investment in Risk Arbitrage

Relationships between prime brokers and hedge funds could potentially have different impacts on the investment decisions of hedge funds. As previously discussed, when investment banks are advisors in merger deals they have an incentive to increase the likelihood that hedge funds invest in those merger deals. The model presented in Section 2.2 predicts that hedge funds will be more likely to invest in risk arbitrage investment when their prime brokers also work as advisors in merger deals. If information sharing between financial institutions is merely compensation for large hedge fund fees then it is possible the information would lead

to concentrated hedge fund investment in the best merger deals and a decreased likelihood of investment in any one particular deal.

There are 1,952 merger deals in the sample and 57 hedge funds. An investment decision is only considered when the hedge fund is active. A hedge fund is considered active when they have positive equity holdings reported on the 13F filings in both the quarter prior and the quarter following deal announcement. A hedge fund is marked as having invested in a deal if their holdings in the target firm equity increases from the quarter prior to announcement until the quarter following. The resulting sample is 42,933 investment decisions by the 57 hedge funds. Table 2.3 shows the univariate statistics for hedge fund investment in merger deals when their prime brokers are and are not advisors. Over the entire sample period there are an average 22 hedge fund investors active for each deal, 5 of which are connected to the deal through their prime broker. Of the 42,933 investment decisions 9,903 (23.1%) are instances where the hedge fund's prime broker is also an advisor in the merger deal, and 33,030 (76.9%) are not. When hedge funds prime brokers are advisors in merger deals they invest in 15.6% of deals and only 9.8% of deals when their prime brokers are not advisors. This represents a nearly 60% increase in the likelihood of hedge fund investment in merger deals.

I measure the multivariate conditional likelihood of hedge fund investment using a probit regression model and report results in Table 2.4. The dependent variable in the probit regression is defined as one when the number of shares of target stock held by hedge fund increases, and zero when the number of shares decreases or remains the same. *Prime Broker/Advisor* takes a value of one when the hedge fund's prime broker is also an advisor in the merger deal and zero otherwise. *Target Advisor* takes a value of one when the hedge fund's prime broker is an advisor to the target firm and zero otherwise. *Acquirer Advisor* takes a value of one when the hedge fund's prime broker is an advisor to the acquirer and zero otherwise. *Top Investment Bank* takes a value of one when at least one advisor to the merger is also a prime broker to a hedge fund in the sample[6]. *Premium* is equal to the offer price minus

[6]Other specifications for this variable such as the largest 3 or 10 investment banks do not change the

the price 20 days prior to the takeover announcement divided by the target price two days after announcement. *Probability of Completion* is the fitted value from a probit regression in Appendix B for the ex ante probability that a deal will be completed. For more discussion of the probability of deal completion please see Appendix B. *Idiosyncratic risk* is $\pi(1-\pi)$, where π is the ex ante probability of merger success from Appendix B. *Fund Equity Assets* ($100 M) is the total value of all hedge fund long equity positions in the quarter prior to deal announcement. Control variables include: *Market-to-book*; *Leverage*; *ROA*; *Target Size* and *Acquirer Size*. All accounting variables are measured at the end of the fiscal year preceding the deal announcement. Hedge fund level fixed effects are also used to control for different average likelihoods of investment for each fund.

In all specifications of the model hedge funds are more likely to invest in merger deals when their prime brokers are also advisors in the merger deals. The .020 marginal effect for the prime broker/advisor variable in the full model (4) implies a roughly 20% increase in the conditional likelihood of hedge fund investment. All of the variables listed in Table 2.4 significantly impact the likelihood of hedge fund investment except the size of the risk arbitrage premium, and the ex ante estimated probability of deal completion. While the probability of completion (π) does not appear to impact the likelihood of hedge fund investment in merger arbitrage, the idiosyncratic risk measure by $\pi(1-\pi)$ does. Hedge funds are significantly less likely to invest in merger arbitrage the higher the expected idiosyncratic risk.

The merger deals that are advised by the investment banks in the sample are clearly different from deals in which they do not advise. As a result, it is important to control for this effect in any model of risk arbitrage investment. It is possible that the any change in hedge fund investment would be unrelated to their specific prime broker, and only related to the type of deals that their prime broker would be an advisor in. In all specifications of the model, even after controlling for deals advised by all prime brokers in the sample, hedge funds are significantly more likely to invest in merger deals when their prime brokers are advisors

statistical significance of the result that when hedge fund's prime brokers are advisors in deals they are more likely to invest in those deals

in the deals. The specification in model (5) splits the prime broker relationships between advisors to target firms and acquiring firms. Both types of relationships show a significant increase in the likelihood of hedge fund investment. The marginal effect for target advisors is larger than, but not statistically different from that of acquirer advisors.

While prime broker relationship significantly affect the likelihood of hedge fund investment in risk arbitrage, there appears to be little impact on the actual magnitude of that investment. The change in hedge fund investment is measured by the difference in the percentage of the target firm equity held in the quarter preceding merger announcement and the quarter following announcement. Table 2.5 shows a regression of the change of the ownership in target firm equity from the quarter prior to announcement until the quarter following announcement, as a percentage of target size. The first two specifications show a significant positive relationship between prime broker advisors and the size of hedge fund investment, but once I control for deals that are advised by any investment bank in the sample, the prime broker advisor relationship is no longer significant. This suggests that the relationships between investment banks and hedge funds lead hedge funds to invest more frequently, but not to invest in larger positions.

To insure that the results are not driven by a single or small number of hedge funds I measur the change in the likelihood of hedge fund investment when their prime brokers are advisors in merger deals for all 57 funds. A histogram of the changes are graphed in Figure 2.3. The measured increase is the difference between the likelihood of hedge investment when their prime brokers are and are not advisors in merger deals. 50 of the 57 hedge fund have an increase in the likelihood of hedge fund investment when their prime brokers are advisors. The model in Section 2.2 predicts that the more precise the private information that hedge funds possess, the more likely they are to invest in merger arbitrage.

To determine what influences the quality of the private information received by hedge funds from their prime brokers I regress the change in hedge fund frequency of investment when their prime brokers are merger advisors on a number of fund characteristics. The first is their base investment rate when their prime brokers are not advisors. If investment banks

want hedge funds to invest in merger arbitrage they may provide information to funds that are most likely to invest to ensure their investment. Fund age could also be a determinant, because older funds may have more established relationships with their prime brokers. The largest investment banks may have more hedge fund connections and receive more benefit to providing private information to hedge funds. To measure this I use a dummy variable for the three largest investment banks as measured by the number of hedge fund clients they have in the sample. Fund size could also be a determinant. The fund size may be related to the amount of fees they pay to investment banks, and to the amount of information they are provided with. To measure fund size I use the total 13F equity assets and then inflation adjust all asset values to 1994 using the CPI. I then use the average asset value for each hedge fund firm. The last variable of interest is the prime broker count. If funds use multiple prime brokers then they may not be as valuable of customers and not receive as much information. Table 2.6 shows the coefficient estimates from this regression. The signs of the coefficients are all consistent with the stated hypothesis, but only the base investment rate measure is statistically significant. With a sample size of only 57 funds it is difficult to determine the validity of the other hypotheses individually, but the table supports the idea that the quality of the information private information shared with hedge funds is influenced by investment bank incentives.

2.6 Risk and Returns in Merger Arbitrage

2.6.1 Idiosyncratic Risk

While there are many possible outcomes in merger deals, they can be generalized to two states, completion or failure. If the probability of deal completion is measured by π, then the variance of deal outcomes is measured by $\pi(1-\pi)$. The expected merger outcome variance is not systematic and is an ex ante measure of expected idiosyncratic risk relative to the merger outcome. The ex ante estimate of π comes from the fitted value of a probit

model for the probability of merger success estimated in Appendix B. For further discussion on the estimation of π please see Appendix B.

Shleifer and Vishny (1997) argue that idiosyncratic risk matters to arbitrageurs due to under diversification. If arbitrageurs are under diversified then they are exposed to idiosyncratic risk and will consider that risk when creating their portfolios. Table 2.4 shows the relationship between the likelihood of hedge fund investment in risk arbitrage and ex ante measures of both π and $\pi(1-\pi)$. Consistent with Shleifer and Vishny (1997), I find that the likelihood of hedge fund investment is unrelated to an ex ante measure of π, but is negatively related to the measure of expected idiosyncratic variance $\pi(1-\pi)$. This means that hedge funds are less likely to invest in risk arbitrage when there is greater idiosyncratic risk.

With the importance that arbitrageurs place on idiosyncratic risk, I test to see how prime broker relationships impacts hedge funds willingness to bear idiosyncratic risk. If investment banks are providing private information to hedge funds, then it may allow hedge funds to invest in deals with greater idiosyncratic risk than they otherwise would. Table 2.7 shows tests of the level of expected idiosyncratic risk in hedge fund merger arbitrage portfolios depending on wether their prime brokers are also advisors in merger deals. Panel A shows the results of a univariate t-test for the level of expected idiosyncratic risk for deals with hedge fund investment. In total there are 4,777 sample hedge fund investments in risk arbitrage. The first test in Panel A shows that hedge funds invest in deals with significantly higher idiosyncratic risk when their prime brokers are also advisors in merger deals. In Table 2.2 it is apparent that deals that are advised by the prime brokers in the sample are different than deals with other advisors. For this reason I also test if the type of advisor affects the level of idiosyncratic risk in deals that hedge funds are invested in. The second test in Panel A compares the level of idiosyncratic risk in hedge fund risk arbitrage investment when any of the investment banks in the sample are advisors in the merger deal. There is no statistical relationship between the type of advisor and the level of idiosyncratic risk.

Panel B of Table 2.7 shows the results of a regression of the level of idiosyncratic risk in hedge fund merger arbitrage investment on variables that might affect the willingness

of hedge funds to bear idiosyncratic risk. The multivariate test also shows that hedge funds invest in deals with significantly greater idiosyncratic risk when their prime brokers are also advisors in merger deals. Hedge funds invest in deals with lower expected levels of idiosyncratic risk when they are stock deals. If there are greater costs to investing in stock deals due to the need for short positions in acquirer stock, then hedge funds may be willing to bear less risk. Hedge funds are also willing to invest in deals with greater idiosyncratic risk when there are large institutional block holders in target stock prior to deal announcement. This is consistent with the idea that large block holder facilitate merger transactions, decreasing the perceived level of risk.

Hedge funds invest in deals with significantly higher levels of expected idiosyncratic risk when their prime brokers are advisors in merger deals. If hedge funds receive private information about merger deals from their prime brokers, then they would also be willing to invest in deals with greater idiosyncratic risk. There are other potential explanations for the investment behavior of hedge funds relative to their prime broker relationships. To distinguish between them I explore the returns to hedge fund investment in risk arbitrage.

2.6.2 Prime Brokers and Merger Arbitrage Returns

Given that prime broker relationships affect hedge fund investment behavior, there are different possible impacts that these relationships could have on the performance of hedge fund investment. The stylized model of risk arbitrage investment in Section 2.2 shows that if investment banks provide private information to arbitrageurs, arbitrageurs would be more likely to invest when their prime broker is also an advisor in merger deals. If the information provided to hedge funds is valuable, then hedge funds should exhibit superior investment performance in risk arbitrage when their prime brokers are also advisors in merger deals. On the other hand, if there are information asymmetries between hedge funds and investment banks or if the information is not valuable to investment then prime broker relationships should have not impact on hedge fund risk arbitrage performance.

Risk arbitrage portfolios typically entail a long position in target stocks following the announcement of a cash merger deal, and a long position in target equity and a short position in acquirer equity for stock deals. The ratio of long to short positions in cash deals are determine by the exchange ratio in merger offers. The actual exchange ratio is often not available for deals in SDC, and short positions in hedge fund portfolios are not observable in the 13F holdings, so to compare portfolios returns, only long positions in target stock are used. To test the impact of prime broker relationships of returns to hedge fund risk arbitrage portfolios I create four portfolios of merger arbitrage.

Target stock is included in each risk arbitrage portfolio beginning two days following the announcement of merger deals, and remain in portfolios until all active offers for target stock are resolved by either being withdrawn, or by deals being completed. The first two portfolios are naive risk arbitrage portfolios of all merger deals that are value-weighted and equal-weighted. The third portfolio simulates the aggregate investment of the hedge funds in the sample, when their prime brokers work as advisors in merger deals, and the last portfolio is the aggregate hedge fund investment portfolio when their prime brokers have no connection to merger deals. The hedge fund portfolios are weighted by the total change in the size of the position taken in target stock from the quarter prior to announcement to the quarter following announcement. All risk arbitrage portfolios are rebalanced daily as deals are announced or resolved. The risk arbitrage returns are calculated as follows:

$$R = \Pi \left(1 + \sum_{i=active} w_{it} r_{it} \right) - 1 \tag{2.11}$$

where deals become "active" two days following announcement and are removed from the portfolio when the deal is resolved. The portfolio weights, w_{it} are equal and value weights for the naive risk arbitrage portfolios. For the hedge fund investment portfolio the weights are based on the change in hedge fund investment from the quarter preceding announcement to the quarter following announcement. Figure 2.2 shows the merger timeline and the timing

of the investment measurement.

Figure 3 shows the cumulative returns to the four risk arbitrage portfolios and to the value weighted market return from 1994-2008. Consistent with Mitchell and Pulvino (2001) the risk arbitrage portfolios clearly outperform the value weighted market return. The hedge fund portfolio of investment in deals with prime broker/advisors clearly outperforms the other three investment portfolios. Table 2.8 shows the result of regressions of the excess returns to risk arbitrage on the Fama-French 4-factor model.

$$r_t = \alpha + \beta_M r_{m,t} + \beta_{SMB} SMB_t + \beta_{HML} HML_t + \beta_{MOM} MOM_t + \epsilon_t \tag{2.12}$$

where on Day t, r_t, is the excess risk arbitrage portfolio return, $r_{m,t}$ is the excess return to the value-weighted CRSP market index, and SMB_t, HML_t, and MOM_t are the returns to the Small-minus-Big (SMB), High-minus-Low (HML), and Momentum (MOM) portfolios meant to capture size, book-to-market, andreturn momentum effects, respectively.

While all four portfolios have significantly positive alphas, only the connected hedge fund portfolio outperforms the naive investment potfolios. Panel B shows that hedge funds only outperform when their prime brokers are also advisors in the merger deals. The spread alphas in Panel B are only significant at the 10% level, but they are clearly economically significant. The connected hedge fund portfolio has a annualized spread alpha of roughly 8% on the value weighted portfolio and more than 4% on the equal weighted portfolio. The estimates for the non connected portfolio are not statistically significant for either spread portfolio.

These results are inconsistent with the idea that hedge funds are more likely to invest in deals when their prime brokers are advisors in deals due to favors for their investment banks, and support the idea that hedge funds use their relationships with prime brokers as a source of superior private information. Superior hedge fund performance in risk arbitrage investment only appears to be evident when their prime brokers are also advisors in merger deals. Hedge funds appear to benefit from their relationships with investment banks through

increased investment performance.

2.7 Conclusions

Recent research such as Bodnaruk, Massa, and Simonov (2009) and Haushalter and Lowry (2011) has shown that there is information sharing among different division of large financial conglomerates. These large investment banks play many different roles in the financial sector, and the current research examines how those different roles affect their internal actions. This paper studies how the varying roles of investment banks in different sectors affect their external actions with their other clients.

Hedge funds are a source of enormous profits for investment banks, and increased scrutiny has been paid to their dealings with their hedge fund clients and what they are willing to do to secure their business. In their role as merger advisors investment bank's primary compensation comes from completion fees. Hsieh and Walkling (2005) show that arbitrager involvement in merger deals increases the likelihood that merger deals will be completed. This leads to incentives for investment banks to increase arbitrager involvement in deals they advise.

Merger arbitrage investment by hedge funds provides a clear test to determine how relationships with investment banks impact hedge fund investment decisions. Investment banks have private information about merger deals when they are advisors in deals. If these relationships impact hedge fund investment then their investment behavior should change when their prime brokers are advisors in merger deals and in the best opportunity to posses private information. I find that when hedge fund's prime brokers also act as advisor in deals, they are significantly more likely to invest in those deals than when their prime broker has no connection to the merger. This is consistent with a Bayesian information updating model of risk arbitrage investment. I also find that when hedge fund's prime brokers are connected to merger deals as advisors, hedge funds are willing to bear more idiosyncratic risk in their risk arbitrage investments.

I show that hedge funds only outperform naive risk arbitrage portfolios when their prime brokers also act as advisors in merger deals, implying that investment banks are providing informational advantages to their hedge fund clients. Hedge funds benefit from their relationships with hedge funds, by gaining informational investment advantages, and investment banks benefit from the large fees generated by hedge funds, and higher expected fees generated from their advisory roles in mergers due to higher arbitrageur involvement.

These results support the hypothesis of information sharing between investment banks and hedge funds. With growing SEC attention to investment bank and hedge fund relationships, this paper provides evidence that those relationships do affect hedge fund investment behavior in merger arbitrage and that both hedge funds and investment banks are benefiting from those relationships.

Figure 2.1: The Probability of Risk Arbitrage Investment

Probability of investing in risk arbitrage as a function of signal volatility as computed in Equation 2.10 under differing parameter estimates.

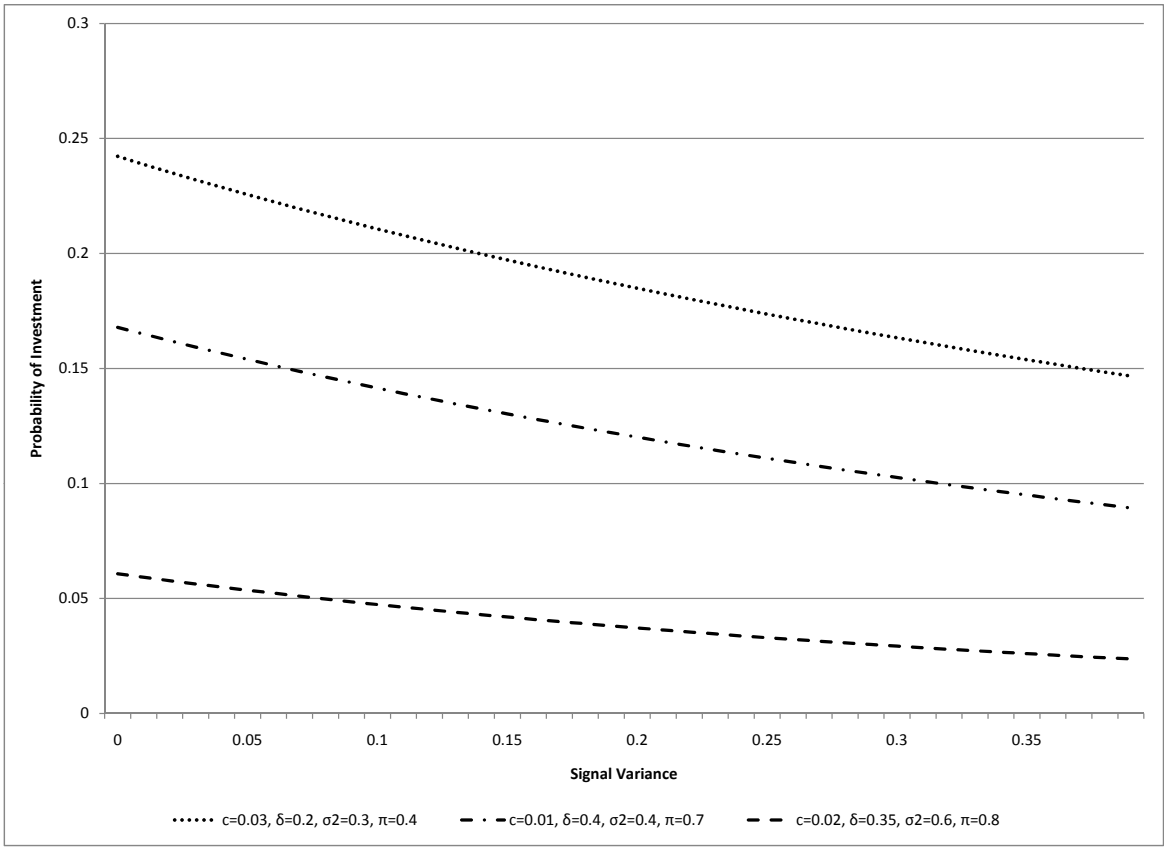

Figure 2.2: Merger Timeline

This figure shows the timeline of M&A announcements and the measurement of arbitrageur holdings. Deals are announced through out a given quarter. The arbitrager holdings are measured at the quarter end proceeding and following the initial announcement of the merger deal.

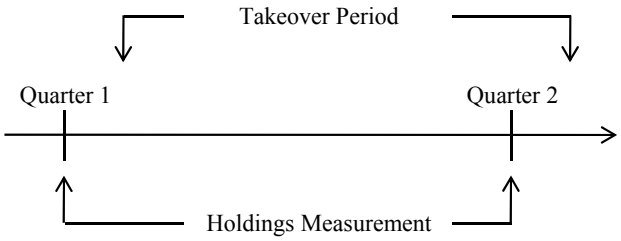

Figure 2.3: Changes in Hedge Fund Risk Arbitrage Investment

This graph presents a histogram of the change in the frequency of hedge fund investment when their prime brokers are advisors in merger deals versus when they are not. The 57 hedge fund firms are identified from the Barclay Hedge, CISDM, and HFR databases.

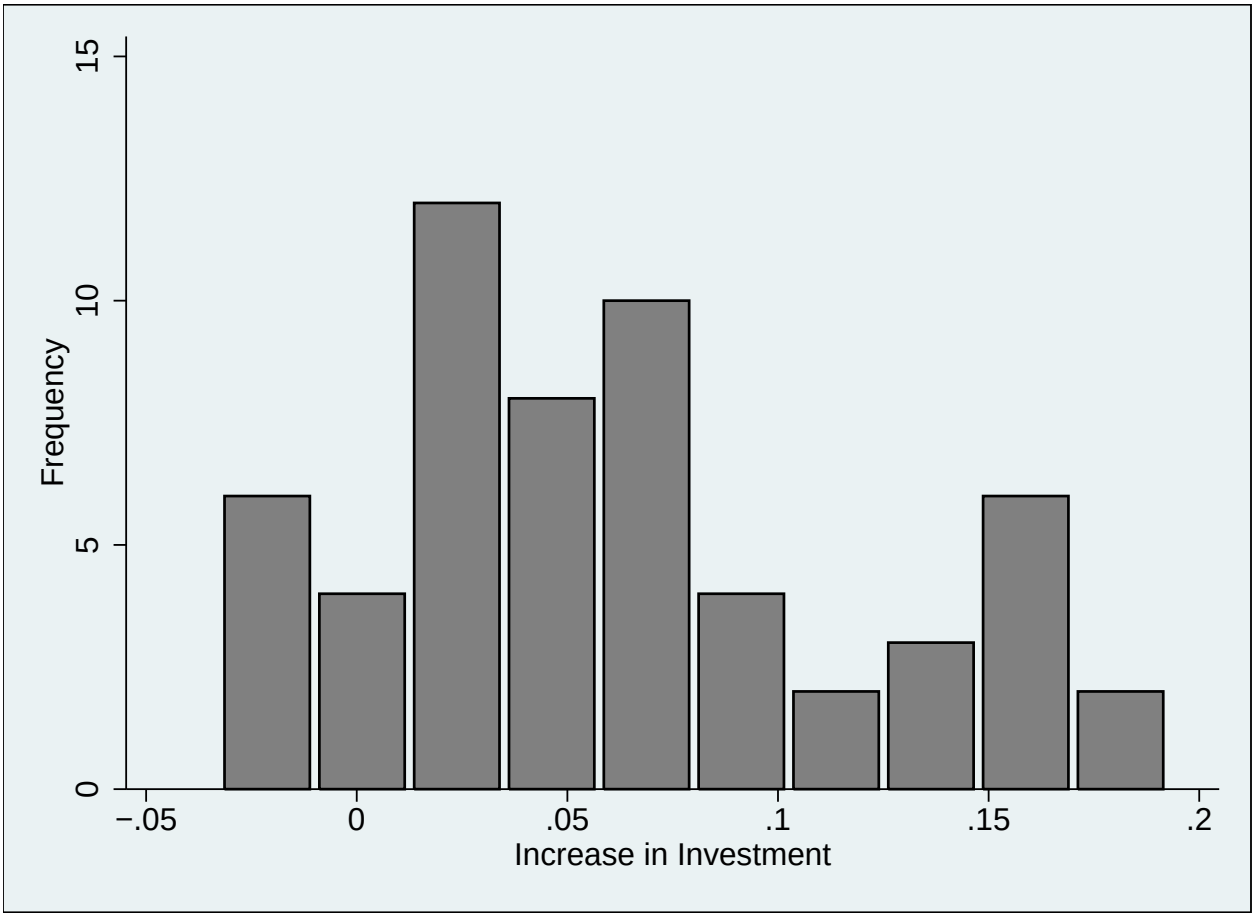

Figure 2.4: Cumulative Returns to Risk Arbitrage Investment

This figure plots the value of $1 invested at the beginning of 1994 through December 2008 in three different portfolios of target merger firms and the CRSP value-weighted index: (1) the value-weighted risk arbitrage portfolio, (2) the hedge fund risk arbitrage portfolio when their prime brokers are advisors in merger deals, (3) the hedge fund risk arbitrage portfolio when their prime brokers are advisors in merger deals. The hedge fund risk-arbitrage portfolios are based on hedge fund holdings of target stocks from quarterly 13F reports. It is assumed that arbitrageurs invest in targets 2 days after deal announcement and hold target shares until deals are either completed or withdrawn. The portfolios are rebalanced quarterly.

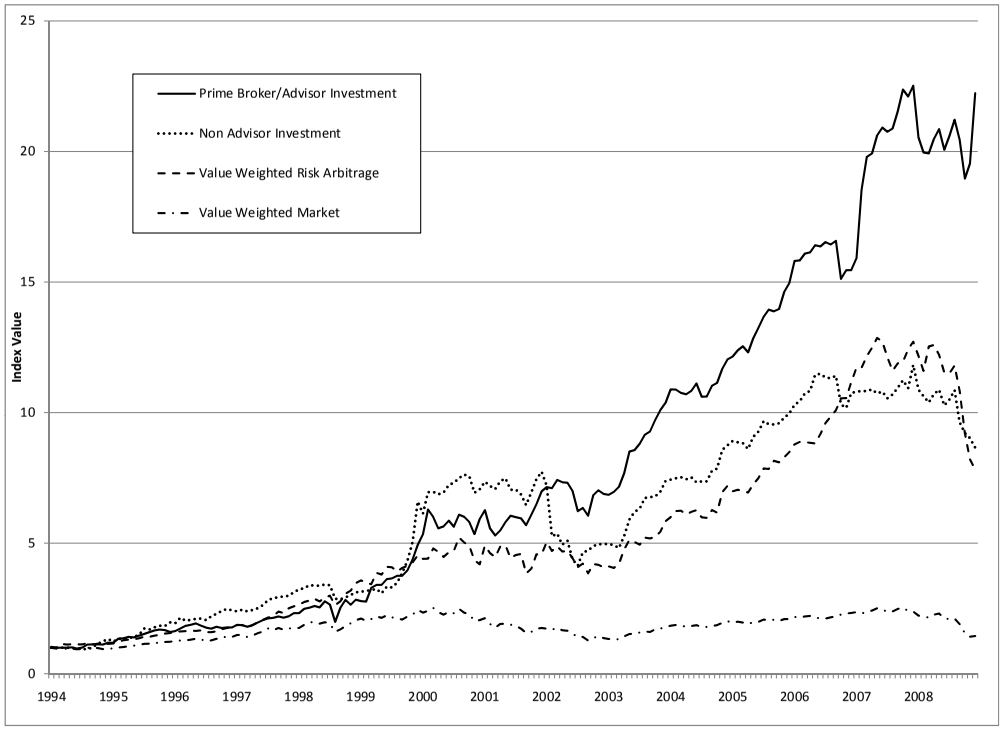

Table 2.1: Distribution of Prime Brokers and Hedge Funds

This table shows this distribution of hedge funds by the number of prime brokers identified for each hedge fund, and the distribution of prime brokers by the number of hedge funds identified for each prime broker. The risk arbitrage hedge funds in this table are identified from the Barclay Hedge, CISDM, and HFR databases.

Prime Broker Count	Hedge Funds	Hedge Fund Count	Prime Brokers
1	22	1-5	18
2	16	6-10	2
3	9	11-15	2
4	5	16-20	1
5+	5	20+	2
Total	57	Total	25

Table 2.2: Merger Descriptive Statistics

This table reports descriptive statistics of deal characteristics for 1,952 announced mergers and acquisitions during 1994-2008, partitioned by the deals advisors. The statistics in Panel A are for merger deals with at least one advisor that also acts as a prime broker for a hedge fund in the sample. The statistics in Panel B are for deals without any advisors that also act as prime brokers for the sample hedge funds. Completed is the percentage of announced deals that are subsequently completed; Attitude is the percentage of deals that are considered hostile as measured by SDC; Premium is equal to the offer price minus the price 20 days prior to the takeover announcement divided by the target price two days after announcement; Block Holder is the percentage of deals that have a single institutional share holder that owns greater than 5% of the firm in the quarter previous to announcement; Stock Deal is the percentage of announced deals that are 100% stock based; Industry Match is the percentage of deals that have both the target and acquiring firm listed in the same Fama French industry classification; Market-to-book is the ratio of market-to-book value of assets; Leverage is the book debt to asset ratio; ROA is the return on assets ratio; Target Size is the target firm's market capitalization ($millions) and Acquirer Size is the acquirer firm's market capitalization ($millions). All accounting variables are measured at the end of the accounting year immediately preceding the deal announcement. Standard errors are listed below mean estimates. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Top Inv Bank	Other Inv Bank	*t-stat* Diff
Completed	0.903	0.859	2.86***
	(0.008)	(0.014)	
Attitude	0.037	0.018	2.25**
	(0.005)	(0.005)	
Premium	0.256	0.301	2.00**
	(0.014)	(0.015)	
Large Block Holder	0.784	0.626	7.48***
	(0.011)	(0.019)	
Stock Deal	0.37	0.442	3.05***
	(0.013)	(0.02)	
Industry Match	0.662	0.583	3.37***
	(0.013)	(0.02)	
Market-to-Book	2.394	1.76	5.14***
	(0.08)	(0.051)	
Leverage	0.226	0.18	3.86***
	(0.007)	(0.009)	
ROA	-0.035	-0.093	3.99***
	(0.008)	(0.014)	
Target Size ($1 M)	1,697.4	180.4	7.21***
	(142.5)	(26.9)	
Acquirer Size ($1 M)	16,133.6	6,203.0	5.54***
	(1,147.0)	(885.4)	
N	1335	617	

Table 2.3: Prime Broker Relationships and Hedge Fund Investment Decisions

This table shows the total number of hedge fund risk arbitrage investment decisions in the sample of 1,952 announced merger deals. The decisions are split between instances when hedge fund prime brokers also act as advisors in the merger deal, and when they are not. The risk arbitrage hedge funds in this table are identified from the Barclay Hedge, CISDM, and HFR databases.

	Prime Broker/Advisor	No Prime Broker/Advisor	Total
Investment Decisions	9,903	33,030	42,933
	23.1%	76.9%	
Investment	1,548	3,229	4,777
	32.4%	67.6%	
Potential Investors per Deal	5.1	16.9	22.0
Investment Percentage	15.6%	9.8%	11.1%

Table 2.4: Probability of Hedge Fund Investment and Prime Broker Relationships

This table reports estimated marginal effects from probit regressions of hedge fund investment in target equity following deal announcement. The dependent variable takes a value of one when hedge funds increase their holdings in target equity from the quarter prior to merger announcement to the quarter following announcement and zero otherwise. Prime Broker/Advisor takes a value of one when the hedge fund's prime broker is also an advisor in the merger deal and zero otherwise. Target Advisor takes a value of one when the hedge fund's prime broker is an advisor to the target firm and zero otherwise. Acquirer Advisor takes a value of one when the hedge fund's prime broker is an advisor to the acquirer and zero otherwise. Top Investment Bank takes a value of one when at least one advisor to the merger is also a prime broker to a hedge fund in the sample. Premium is equal to the offer price minus the price 20 days prior to the takeover announcement divided by the target price two days after announcement. Probability of Completion is the fitted value from a probit regression in Appendix B for the ex ante probability that a deal will be completed. Idiosyncratic risk is $\pi(1-\pi)$, where π is the ex ante probability of merger success. Fund Equity Assets ($100 M) is the total value of all hedge fund long equity positions in the quarter prior to deal announcement. Attitude is the percentage of deals that are considered hostile as measured by SDC; Block Holder is the percentage of deals that have a single institutional share holder that owns greater than 5% of the firm in the quarter previous to announcement; Stock Deal is the percentage of announced deals that are 100% stock based; Control variables not included in the table include: Market-to-book which is the ratio of market-to-book value of assets; Leverage is the book debt to asset ratio; ROA is the return on assets ratio; Target Size is the target firm's market capitalization ($millions) and Acquirer Size is the acquirer firm's market capitalization ($millions). All accounting variables are measured at the end of the accounting year immediately preceding the deal announcement. Merger deal level clustered standard errors are listed below marginal effects. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)
Prime Broker - Advisor	0.071***	0.039***		0.020***	
	(0.006)	(0.005)		(0.004)	
Target Advisor					0.022***
					(0.005)
Acquirer Advisor					0.019***
					(0.004)
Top Investment Bank			0.059***	0.055***	0.055***
			(0.004)	(0.004)	(0.003)
Premium		-0.001	0.000	0.000	0.000
		(0.001)	(0.001)	(0.001)	(0.001)
Probability of Completion		0.150	0.475	0.456	0.457
		(0.756)	(0.696)	(0.697)	(0.697)
Idiosyncratic Risk		-0.020	-0.023*	-0.023*	-0.023*
		(0.013)	(0.012)	(0.012)	(0.012)
Fund Equity Assets ($100M)		-0.036***	-0.036***	-0.037***	-0.037***
		(0.013)	(0.013)	(0.012)	(0.013)
Attitude		0.885	0.945	0.945	0.945
		(0.344)	(0.019)	(0.021)	(0.021)
Large Block Holder		0.03***	0.023***	0.023***	0.023***
		(0.005)	(0.005)	(0.005)	(0.005)
Stock Deal		-0.022***	-0.021***	-0.020***	-0.020***
		(0.005)	(0.005)	(0.005)	(0.005)
Controls	No	Yes	Yes	Yes	Yes
Fund Fixed Effects	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.145	0.254	0.266	0.268	0.268
N	42,933	42,933	42,933	42,933	42,933

Table 2.5: Level of Hedge Fund Investment and Prime Broker Relationships

This table reports coefficient estimates from regressions of the change in hedge fund investment in target equity following deal announcement. The dependent variable is the change in the percentage of target firm equity owned by a particular hedge fund in the quarter proceeding announcement until the quarter following announcement. Prime Broker/Advisor takes a value of one when the hedge fund's prime broker is also an advisor in the merger deal and zero otherwise. Target Advisor takes a value of one when the hedge fund's prime broker is an advisor to the target firm and zero otherwise. Acquirer Advisor takes a value of one when the hedge fund's prime broker is an advisor to the acquirer and zero otherwise. Top Investment Bank takes a value of one when at least one advisor to the merger is also a prime broker to a hedge fund in the sample. Premium is equal to the offer price minus the price 20 days prior to the takeover announcement divided by the target price two days after announcement. Probability of Completion is the fitted value from a probit regression in Appendix B for the ex ante probability that a deal will be completed. Idiosyncratic risk is $\pi(1-\pi)$, where π is the ex ante probability of merger success. Fund Equity Assets ($100 M) is the total value of all hedge fund long equity positions in the quarter prior to deal announcement. Attitude is the percentage of deals that are considered hostile as measured by SDC; Block Holder is the percentage of deals that have a single institutional share holder that owns greater than 5% of the firm in the quarter previous to announcement; Stock Deal is the percentage of announced deals that are 100% stock based; Control variables not included in the table include: Market-to-book which is the ratio of market-to-book value of assets; Leverage is the book debt to asset ratio; ROA is the return on assets ratio; Target Size is the target firm's market capitalization ($millions) and Acquirer Size is the acquirer firm's market capitalization ($millions). All accounting variables are measured at the end of the accounting year immediately preceding the deal announcement. Heteroskedastic robust standard errors are listed below marginal effects. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)
Prime Broker / Advisor	0.014***	0.013***		0.007	
	(0.005)	(0.005)		(0.005)	
Target Advisor					0.010
					(0.007)
Acquirer Advisor					0.003
					(0.006)
Top Investment Bank			0.021***	0.019***	0.019***
			(0.004)	(0.005)	(0.005)
Premium		0.004**	0.004**	0.004**	0.004**
		(0.002)	(0.002)	(0.002)	(0.002)
Probability of Completion		1.102**	1.200**	1.190**	1.194**
		(0.479)	(0.479)	(0.478)	(0.479)
Idiosyncratic Risk		-0.032***	-0.032***	-0.032***	-0.032***
		(0.011)	(0.011)	(0.011)	(0.011)
Fund Equity Assets ($100M)		-0.06	-0.061	-0.061	-0.061
		(0.039)	(0.039)	(0.039)	(0.039)
Attitude		0.975***	1.026***	1.021***	1.025***
		(0.283)	(0.282)	(0.282)	(0.282)
Large Block Holder		0.02***	0.017***	0.017***	0.017***
		(0.004)	(0.004)	(0.004)	(0.004)
Stock Deal		-0.021***	-0.020***	-0.020***	-0.020***
		(0.003)	(0.003)	(0.004)	(0.004)
Controls	No	Yes	Yes	Yes	Yes
Fund Fixed Effects	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.062	0.065	0.065	0.065	0.065
N	42,933	42,933	42,933	42,933	42,933

Table 2.6: Increase in the Frequency of Hedge Fund Investment in Risk Arbitrage

This table shows a regression of the change in hedge fund frequency of investment when their prime brokers are merger advisors on a number of fund characteristics. The change is measured as: *Non Advisor Investment* is their base investment rate when their prime brokers are not advisors; it Fund Age; *Top 3 Investment Bank* is a dummy variable for the three largest investment banks as measured by the number of hedge fund clients they have in the sample; *Fund Size* is measured as the average total 13F equity assets inflation adjusted using the CPI; and *prime broker count* is the number of prime brokers identified for each hedge fund firm.

Dep't Var	Inc Inv Prob
Non Advisor Investment %	0.248***
	(0.074)
Fund Age (2008)	0.003
	(0.002)
Top 3 Investment Bank	0.018
	(0.018)
Log Fund Size	0.004
	(0.007)
Prime Broker Count	-0.001
	(0.004)
Adj. R^2	0.140
N	57

Table 2.7: Idiosyncratic Risk and Prime Broker Relationships

This table shows tests of the level of expected merger related idiosyncratic risk $\pi(1-\pi)$ in hedge fund risk arbitrage investment and prime broker relationships. Panel A presents *t*-test results for idiosyncratic risk when hedge fund prime brokers are and are not advisors in merger deals and a test of idiosyncratic risk when any sample investment bank is an advisor in the deal. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Differences in Expected Merger Variance			
	PB Advisor	Non Advisor	Difference
$\hat{\pi}(1-\hat{\pi})$	9.483	9.089	0.394^{***}
	(0.063)	(0.103)	(0.116)
	Top Inv Bank	Other Inv Bank	Difference
$\hat{\pi}(1-\hat{\pi})$	9.241	8.985	0.256
	(0.057)	(0.164)	(0.185)

Table 2.8: Prime Brokers and the Returns to Investing in Targets

This table shows results from a time-series regression of risk arbitrage excess returns on targets from two days post announcement until either deal completion or withdraw on common risk factors from the Fama-French 4-factor model. Equal and Value-weighted target returns are computed for a portfolio of all active targets. Hedge Fund Arbitrageur Returns replicates the target portfolio held by hedge funds as measured by their holdings on 13F filings when either their prime broker is or is not an advisor to merger deals. Estimated coefficients for each variable are presented in the table with Newey-West standard errors recorded in parentheses. Seven lags are used to determine reported standard errors. Alpha is in percentage per month. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	α	β_{Mkt}	β_{SMB}	β_{HML}	β_{MOM}	$Adj.R^2$
Panel A: Target Returns						
Value Weighted	0.70***	0.86***	0.03	0.10	-0.11	0.62
	(0.20)	(0.06)	(0.07)	(0.10)	(0.08)	
Equal Weighted	1.03***	0.80***	0.42***	0.02	-0.11	0.76
	(0.24)	(0.08)	(0.06)	(0.10)	(0.07)	
PB/Advisor Investment	1.4***	0.65***	0.28***	-0.28***	0.03	0.48
	(0.30)	(0.13)	(0.08)	(0.11)	(0.05)	
Non Advisor Investment	0.86**	0.57***	0.10	-0.27	0.12	0.31
	(0.39)	(0.08)	(0.08)	(0.19)	(0.12)	
Panel B: Spread Returns						
Advisor - VW	0.72*	-0.21	0.25**	-0.38**	0.14	0.14
	(0.39)	(0.15)	(0.11)	(0.18)	(0.11)	
Non Advisor - VW	0.16	-0.28***	0.07	-0.37	0.23*	0.14
	(0.45)	(0.10)	(0.11)	(0.24)	(0.13)	
Advisor - EW	0.39*	-0.15	-0.14	-0.31***	0.14*	0.10
	(0.23)	(0.10)	(0.11)	(0.09)	(0.07)	
Non Advisor - EW	-0.17	-0.23**	-0.32***	-0.30*	0.27*	0.14
	(0.39)	(0.09)	(0.07)	(0.17)	(0.12)	

Appendix A

Measuring Risk Arbitrage Returns

Risk arbitrage entails a long position in target stock and can involve a short position in the stock of the acquirer. This position provides a fixed payoff when deals are completed and exposes shareholders to downside in the event the deals are withdrawn. For cash deals risk arbitrage returns are equal to target returns for deal i on day t:

$$R_{it} = R_{TARit} \tag{A.1}$$

where R_{it} is the risk arbitrage return for deal i on day t and R_{TARit} is the return on target firm i on day t.

Long positions in target stock are also held for stock deals but are typically accompanied by a short position in acquirer stock to hedge against market risk and other risks unrelated to deal completion. Mitchell, Pulvino and Stafford (2004) find downward price pressure on acquirer stock for stock swap deals, but not for cash deals. A long-short portfolio for stock deals provides a similar payoff structure to a long-only position for cash deals, namely, a fixed payoff when deals are completed and exposure to downside in the event of withdrawn deals. The risk arbitrage returns for stock deals are determined as

$$R_{it} = R_{TARit} - (R_{ACQit} - R_f)\delta P_{ACQit-1}/P_{TARit-1} \tag{A.2}$$

where R_{it} is the risk arbitrage return for deal i on day t and R_{TARit} is the return on

target firm i on day t; R_{ACQit} is the return on the acquiring firm i on day t; and R_f is the cost of borrowing for the short position and the risk-free rate. The exchange ratio of target stock for acquirer stock is represented by δ. The ratio of the lagged acquirer stock price, $P_{ACQit-1}$, to the lagged target stock price, $P_{TARit-1}$, times δ yields the number of shares of acquirer stock to be shorted for the ownership of one share of target stock.

Arbitrageurs' exact short positions in target stocks are not observed because institutions report only long positions on 13F filings. Therefore, we measure risk arbitrage returns using the observed long holdings of target stock. Our measure captures the returns on the entire risk arbitrage portfolio for cash deals, but it is only an approximation for stock deals and hybrid cash and stock deals. In omitting the short component of risk arbitrage portfolios, we assume that the short positions primarily act as a hedge and have little impact on the actual returns from risk arbitrage. We verify the validity of this assumption by calculating the size of the theoretical short positions for 318 stock deals with sufficient data. SDC does not report the exchange ratio of acquirer to target stock for many stock and hybrid deals. We use stock deals with information on the exchange ratios to compare the long-only and long-short returns.

We find that the impact of omitting short positions on measured risk arbitrage returns is negligible. Returns to risk arbitrage are primarily a function of the target stock price, even for pure stock exchange deals. For example, the raw target returns and long-short risk arbitrage returns are 9.92% and 9.19%, respectively, and the difference is insignificant. The target excess returns and long-short risk arbitrage excess returns are also close (4.06% versus 3.33%) and the difference is small. The impact of short positions on risk arbitrage returns is likely even smaller for hybrid deals that combine cash and stock considerations.

Appendix B

Prime Broker Turnover

Hedge fund's prime brokers can change over time. The databases used to identify prime broker relationships are header files that provide a snapshot of the currently listed prime broker for each fund. The live fund databases provide information about active funds and their current prime brokers. Dead fund databases provide a listing of the last prime broker listed for each fund as of the last reporting date for that fund. Holdings data in 13(F) filings are company level, not fund level, so I use any when identifying company prime brokers, I include any broker that is identified for any fund within the management company. If companies have live and dead funds in the hedge fund databases, I am able to compare currently listed prime brokers to those listed for past funds.

To examine how prevalent changes are in prime brokers, I used a larger sample of hedge funds from the Barclay Hedge database. I used snapshots of the Barclay Hedge database each year from 2006-2010 to determine how much turnover there is in prime broker listings. Comparisons of the active header files for each year show any changes in reported prime brokers. Table B.1 shows the annual turnover for the entire sample of hedge fund companies in the Barclay Hedge database. Approximately 10% of hedge fund companies had some changes to their prime broker listing annually. Over the five year span 73.2% of hedge fund companies had no reported changes to their prime brokers. This number over states the actual changes in prime broker's listings because they are company level numbers. Many of

the changes in prime brokers were hedge fund companies opening a new fund that listed a different prime broker than other funds in the management company.

While turnover in prime broker listings does exist, the snapshot data does provide confidence that hedge fund's prime brokers are somewhat stable over time. The main cause of change in prime broker listings is when new funds are listed that have different prime brokers than their parent management companies, this means that using the current active and dead databases will yield most of the prime brokers used by hedge fund companies. While there is some noise in the identification of prime brokers, I don't believe that it would yield any bias towards or against the results found in this paper. Also survivorship is not an issue regarding prime broker relationships because I only use data as of 1994, which is when most hedge fund databases began listing dead funds in their data. As a result the number of funds in my sample is not static over time. There are new hedge fund companies being listed over the sample period, and companies that are removed from the sample once they become defunct. This allows for both successful and unsuccessful funds to be included in the sample including their prime broker relationships.

Table B.1: Prime Broker Turnover

This table shows the rate of change of the identified prime brokers for a large sample of hedge fund firms using snapshots of the Barclay Hedge database each year from 2006-2010.

	No Prime Broker Change	Prime Broker Change
2006-2007	89.5%	10.5%
2007-2008	86.5%	13.5%
2008-2009	83.4%	16.6%
2009-2010	94.8%	5.2%
2006-2010	73.2%	26.8%

Appendix C

The Probability of Completion

I estimate the probability of merger success on the sample of 1,952 merger deals using a probit regression. The dependent variable is defined to take a value of one if the announced deal is subsequently completed or if any overlapping announced deal for the same target firm is subsequently completed, and zero otherwise. Table C.1 shows the results of a probit regression on merger outcome. The first column shows a model of deal completion that only uses target attitude as an independent variable. The attitude variable takes a value of one if the deal is classified as hostile by SDC, and zero otherwise. Consistent with previous literature such as Baker and Savasoglu (2002) I find that target managerial attitude measured by SDC as either hostile or friendly is the best predictor of deal completion probability.

Columns two and three include target and deal characteristics in the regression. *Cash* is the cash-to-assets ratio for target firms and is the only other independent variable that is a significant determinant of merger outcome in the sample. Other variables include: *Large Block Holder* which is an indicator for target firms with a single institutional share holder that owns greater than 5% of target equity in the quarter previous to announcement; *Stock Deal* takes a value of one for deals that are 100% stock based and zero otherwise; *Target Size* is the target firm's market capitalization ($100 M); *Acquirer Size* is the acquiring firm's market capitalization ($100 M);*Market-to-book* is the ratio of market-to-book value of assets; *Leverage* is the book debt-to-asset ratio; *Return-on-Assets* is the return on assets ratio for

the target firm; and *Premium* is equal to the offer price minus the price 20 days prior to the takeover announcement divided by the target price two days after announcement. All accounting variables are measured at the end of the accounting year immediately preceding the deal announcement.

The deal and target characteristic variables add little to the pseudo r^2 value. Using only managerial attitude as an indpenedent variable generates a pseudo r^2 of 6.2% which only increases slightly to 6.4% with the inclusion of the target cash-to-assets ratio, and is unchanged by including other independent variables. As a result, fitted values for the probability of deal completion used throughout the paper come from the second column in Table C.1 which uses the significant determinants, managerial attitude and cash-to-assets ratio.

Table C.1: Probability of Completion

This table presents estimation results of probit regressions of the merger outcome. The dependent variable is equal to 1 if the announced deal is completed and 0 otherwise. Attitude is a dummy variable with a value of 1 for deals that are considered hostile as measured by SDC; Cash is the cash-to-assets ratio for each target firm; Large Block Holder is a dummy variable that takes a value of 1 for deals that have a single institutional share holder that owns greater than 5% of the firm in the quarter previous to announcement; Stock Deal is the percentage of announced deals that are 100% stock based; Target Size is the target firm's market capitalization ($millions) and Acquirer Size is the acquirer firm's market capitalization ($millions); Market-to-book which is the ratio of market-to-book value of assets; Leverage is the book debt to asset ratio; ROA is the return on assets ratio; Premium is equal to the offer price minus the price 20 days prior to the takeover announcement divided by the target price two days after announcement. All accounting variables are measured at the end of the accounting year immediately preceding the deal announcement. The estimated marginal effects for each variable are presented in the table with heteroskedasticity robust standard errors recorded in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)
Attitude	-0.436***	-0.418***	-0.420***
	(0.065)	(0.081)	(0.066)
Cash		0.101***	0.088**
		(0.032)	(0.040)
Large Block Holder			0.001
			(0.016)
Stock Deal			-0.012
			(0.015)
Acquirer Size ($100M)			0.003
			(0.003)
Target Size ($100M)			-0.005
			(0.012)
Market-to-Book			0.006
			(0.005)
Leverage			0.007
			(0.031)
Return-on-Assets			0.015
			(0.021)
Premium			0.011
			(0.011)
Pseudo R^2	0.062	0.064	0.064

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