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Limited arbitrage in mergers and acquisitions ☆

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Abstract

A diversified portfolio of risk arbitrage positions produces an abnormal return of 0.6–0.9% per month over the period from 1981 to 1996. We trace these profits to practical limits on risk arbitrage. In our model of risk arbitrage, arbitrageurs' risk-bearing capacity is constrained by deal completion risk and the size of the position they hold. Consistent with this model, we document that the returns to risk arbitrage increase in an ex ante measure of completion risk and target size. We also examine the influence of the general supply of arbitrage capital, measured by the total equity holdings of arbitrageurs, on arbitrage profits.

JEL classification: G14; G23; G34

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1. Introduction

This paper examines the market pricing of merger and acquisition offers. Professional risk arbitrageurs claim to profit by providing insurance to selling

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shareholders in the following way.[1] After a merger or acquisition is announced, investors in the target firm face completion risk. Some shareholders may wish to insure this risk by selling their shares. In an efficient capital market, the price of the target and acquirer will fully and immediately reflect the terms of the merger. In reality, shareholders sell to a limited number of capital-constrained investors and financial institutions specializing in risk arbitrage. As a result of this selling pressure, the price of the target firm can fall below its efficient market price. This market inefficiency—what Shleifer and Vishny (1997) call the limits of arbitrage—leaves abnormal profits.

We construct risk arbitrage positions for 1,901 cash and stock merger and acquisition offers over the period from 1981 to 1996. Each is designed to provide a fixed payoff if the deal is successfully completed according to its original terms. We develop a simple model of limited arbitrage where selling pressure, imperfect substitutes, and a small number of arbitrageurs combine to create an abnormal return to risk arbitrage positions. The model predicts that the expected return is increasing in completion risk and selling pressure and decreasing in risk arbitrage capital.

Our analysis of the cross section of returns points to limited arbitrage. First, excess returns are increasing in completion risk, which rises when the probability of success moves toward 0.5 and when the difference in payoffs between success and failure increases. To estimate the probability of success, we use predictions from a regression of merger outcome on acquirer attitude. As in Walkling (1985) and Schwert (2000), for example, we find that acquirer attitude is the best single predictor of merger success. As a proxy for the difference in payoffs, we use the takeover premium scaled by the value of the target firm after announcement. Second, excess returns are increasing in target size following the merger announcement, which can proxy for the dollar value of selling pressure by target shareholders.

Third, we examine the influence of the general supply of arbitrage capital, measured by the total equity holdings of arbitrageurs, on arbitrage profits. We identify risk arbitrageurs with data on institutional holdings. Risk arbitrage involves taking a long position in a target following a merger announcement. By our classification, arbitrageurs are institutions that frequently move from zero to positive holdings in the target firms. We define risk arbitrage capital as the aggregate quarterly equity holdings of these arbitrageurs. Consistent with limited arbitrage, when this measure of capital falls, subsequent returns rise. However, this third cross-sectional result is not as strong statistically as the first two.

[1] For example, Boesky (1985) claims that the arbitrageur "provides liquidity to the marketplace. He is typically buying from those who do not want to bear the risk of waiting to see if the deal will go through." In addition to providing insurance, arbitrageurs play an active role in the takeover process as large shareholders (Singh, 1998; Cornelli and Li, 2001; Gomes, 1999) and play an information gathering role (Larcker and Lys, 1987). Our focus is on the returns available for a marginal arbitrageur, not an active or privately informed investor. Howard and Perold (1998) and Perold (1999) provide case studies and additional detail on risk arbitrage.

Before undertaking the cross section analysis, we analyze the returns to risk arbitrage. The existing literature suggests that target firm shares earn very high returns. Lakonishok and Vermaelen (1990) evaluate repurchase offers, and Larcker and Lys (1987), Dukes et al. (1992), and Karolyi and Shannon (1999) analyze cash tender offers. All find abnormal profits. We corroborate these past studies with the new approach of measuring the abnormal return to a risk arbitrage portfolio. This helps us evaluate the systematic risk and the economic and statistical significance of the returns in a way that previous research has not.[2] A merger or acquisition is included in the portfolio beginning two days after announcement and ending with the withdrawal or successful completion of the deal. While we use a different approach and a much larger sample of cash and stock offers, our results are broadly consistent with the existing literature. Risk arbitrage beats its capital asset pricing model and Fama-French three-factor benchmarks. However, the economic significance of the abnormal returns, while high at 0.6–0.9% per month, are not as dramatic as those reported in earlier studies of event returns. In one specification, the intercept is not statistically significant at the 10% level.

The rest of the paper is organized as follows. Section 2 reviews the theory of limited arbitrage and develops a price pressure model in the context of mergers and acquisitions. Section 3 describes the data from Securities Data Company. Section 4 shows that a risk arbitrage portfolio earns abnormal profits. Section 5 evaluates the cross section implications of limited arbitrage. Section 6 concludes.

2. Limited arbitrage in the context of mergers and acquisitions

A textbook arbitrage opportunity arises when two identical assets sell for different prices. By selling the expensive asset and buying the cheap asset, an arbitrageur earns positive profits with no capital and no risk. Real-world risk arbitrage differs in two respects. First, instead of identical assets, a merger offer creates two similar assets. For example, after a stock merger offer, there are two ways to buy the acquiring firm's shares: with a direct purchase and with an indirect purchase. The indirect purchase involves buying the target firm's shares and waiting for the deal to go through, at which point the target shares are exchanged for acquirer shares. These two approaches have identical payoffs if the merger offer is completed according to its original terms. A risk arbitrageur faces fundamental risk because the deal can fail or be revised. Second, real-world risk arbitrage requires capital. The proceeds of selling the expensive asset cannot be used to buy the cheap asset. The lender typically

[2] Mitchell and Pulvino (2001), in a contemporaneous and independently written paper, use the same portfolio approach in measuring the abnormal returns to risk arbitrage. Their data produce a slightly higher gross return of about 1% per month over the period from 1963 to 1999. Mitchell and Pulvino also evaluate a practical risk arbitrage portfolio, which limits the dollar level and percentage investment in any single deal and, as a result, contains a substantial amount of cash. This cash reduces the magnitude of the abnormal return by about two-thirds without materially changing its statistical significance. We consider risk aversion implicitly in our cross-sectional analysis, rather than explicitly reducing the exposure of the portfolio to idiosyncratic risks.

requires 102% of the short position as collateral (for example, see Perold and Singh, 1995).

Textbook arbitrage prevents identical assets from selling at different prices. Real-world risk arbitrage will also eliminate the possibility that two similar assets can have systematically and dramatically different average returns under two scenarios. First, in the classic analysis of Friedman (1953) and Fama (1965), a very large number of small arbitrageurs are effectively risk neutral when they take only a small position in an idiosyncratic gamble. In the mergers and acquisitions context, however, this sort of arbitrage is not likely to be feasible. The idea of an individual investing a very small part of her wealth—without financial intermediation—into a diversified portfolio of target firms seems implausible. Even small fixed transaction costs related to implementing a dynamic risk arbitrage strategy convert to large percentage costs when divided by a marginal component of an individual investor's wealth.

Second, when the mispriced security has a perfect and correctly priced substitute, even a small number of arbitrageurs will force price to fundamental value.[3] Only stocks with perfect substitutes, because they can be arbitraged without risk, are not affected by selling pressure. A stock without perfect substitutes can have a downward sloping demand curve (Scholes, 1972; Shleifer, 1986). Wurgler and Zhuravskaya (2001) show that the impact of demand by index funds on a stock included in the S&P 500 depends on its substitutes. In mergers and acquisitions, the idiosyncratic risk of deal completion cannot typically be hedged. This gives the first empirical prediction:

Prediction 1. The returns to risk arbitrage depend on selling pressure and completion risk.

The second empirical prediction relates to financial intermediation, which can improve the effectiveness of arbitrage. If a relatively small number of hedge funds and proprietary trading groups could raise capital from a large number of small investors, we are back to the convincing arguments of Friedman and Fama. However, Shleifer and Vishny (1997) and Shleifer (2000) argue that agency and information costs limit the amount of capital that arbitrageurs can raise. Furthermore, Merton and Perold (1993) and Froot and Stein (1998) show that

[3] Even when there are perfect substitutes, arbitrage may fail if arbitrageurs have short horizons or if transaction costs and institutional constraints limit short selling. In De Long et al. (1990), noise trader risk can lead price to diverge from fundamental value within the arbitrageur's horizon. For example, the shares of Royal Dutch and Shell, although perfect substitutes, often diverge significantly in part because there is no identifiable date at which the two prices will converge (Froot and Dabora, 1999). In mergers and acquisitions, the horizon is comparatively short. Nonetheless, the effect of pure noise trader risk may play some role. For example, in stock deals, a short position in the acquirer could be liquidated beyond the arbitrageur's control at a time when prices diverge from fundamental value. In addition, Lamont and Thaler (2001) document that costly short selling causes persistent violations of the law of one price in tech stock carve-outs. D'Avolio (2001) and Geczy et al. (2001) examine short selling costs in larger samples.

capital-constrained financial institutions can have a limited appetite for taking idiosyncratic and unhedgeable risks.[4] As Stein (1999) argues, capital constraints depend on two conditions. The first is that there are "flow" costs to adding new capital, which can arise from adverse selection. The second is that there are "stock" costs to holding excess cash balances, which can arise from taxes and agency problems. Flow and stock costs are particularly problematic in risk arbitrage, because the volume of mergers and acquisitions varies dramatically across time. The end result is that a finite number of arbitrageurs with limited capital are prepared to provide liquidity to selling shareholders. This gives the second empirical prediction:

Prediction 2. The returns to risk arbitrage depend on arbitrageurs' capital.

Some risk arbitrageurs are also active investors, directly influencing the takeover process and outcome. First, some purchase shares prior to announcement, speculating on the possibility of a merger offer. Singh (1998) examines toeholds in takeover bidding, but the focus is on bidders rather than arbitrageurs. Bidders with a toehold bid more aggressively than those without. Gomes (2000) examines freezeouts, where the bidder can by force acquire residual shares not tendered. In this case, by accumulating shares prior to announcement, arbitrageurs can force the bidder into paying a high takeover premium. In contrast to these papers, we examine arbitrage profits after the announcement of the merger. Second, the existence of arbitrageurs can help with the Grossman and Hart (1980) free-rider problem. In Cornelli and Li (2001), risk arbitrageurs make abnormal profits because they have an informational advantage: They know the size of their own position. The size of their position affects the probability that the merger will go through. This theoretical work does not predict abnormal profits on the average deal or systematic relations between deal characteristics and subsequent returns. By contrast, the focus of this paper is on the returns of a marginal arbitrageur. The model and the empirical analysis below are not an attempt to shed light on the active role that arbitrageurs play in the takeover process as large shareholders in the target firm.

2.1. A model of limited arbitrage in mergers and acquisitions

In reality, the possibility of revisions and competing bidders means that a merger offer has an infinite number of outcomes. However, in our stylized model, there are only two outcomes. A merger offer succeeds with probability π, and the target shareholders receive $1 + p$. The offer fails with probability $(1 - \pi)$, and the target is worth 1. We calculate the price of the target shares in three scenarios. In each case, we assume that a set of target shareholders does not want to bear completion risk and instead sells a total of X shares, where X is exogenous.[5]

[4] In a particularly clean test of the hypothesis that idiosyncratic risk can command a risk premium, Green and Rydqvist (1997) show that Swedish lottery bonds command a higher return.

[5] A model that endogenizes the amount sold X is available from the authors upon request. For a more general model of the effects of arbitrageurs' wealth, see Kyle and Xiong (2000).

In the first case, there are a large number of small investors with no transaction costs who are willing to absorb these shares. Because they each must take only a small position in the idiosyncratic gamble, they require no compensation for risk, and the price following a takeover offer is equal to the expected payoff of a target share:

$$P_T = 1 + \pi p. \tag{1}$$

In the second case, these investors face transaction costs. These costs include fixed and proportional costs of implementing a risk arbitrage strategy. Fixed costs cannot be divided across a large number of small investors, but must be separately incurred by each trader. For this reason, the total transaction cost c can be large relative to the small investor's position:

$$P_T = 1 + \pi p - c. \tag{2}$$

In the third and final case that we evaluate, a limited number A of arbitrageurs with no transaction costs compete with small investors to provide insurance. We assume that the arbitrageurs are mean–variance utility maximizers with a coefficient of absolute risk aversion γ. Because there are only a small number of arbitrageurs, they must bear completion risk. To sell X shares of the target, the selling shareholders must offer the arbitrageurs a risk premium, even for idiosyncratic risk:

$$P_T = 1 + \pi p - \frac{X}{A}\gamma\pi(1-\pi)p^2. \tag{3}$$

The second term represents the reduction in price required to compensate the limited number of arbitrageurs A for the idiosyncratic risk that they bear. The expected excess return is r/P_T where $r \equiv (X/A)\gamma\pi(1-\pi)p^2$. If r is smaller than the individual investor's transaction costs c, price will be determined by Eq. (3). If not, the nonarbitrageur is the marginal investor, and price will be determined by transaction costs alone as in Eq. (2). Whether Eq. (2) or Eq. (3) holds is an empirical question. If Eq. (2) holds, variation in transaction costs can explain the cross section of returns. If Eq. (3) holds, risk arbitrage returns are increasing in selling pressure X, the takeover premium p, and the arbitrageurs' risk aversion γ. Returns are decreasing in the number of arbitrageurs A, and related to the ex ante probability of successful completion π in a nonlinear way. In sum, Eq. (3) provides a somewhat more formal motivation for Predictions 1 and 2 and a precise notion of completion risk based on the takeover premium and the probability of success.

Unlike Jindra and Walkling (2001), we focus on explaining the cross section of returns, rather than the cross section of initial spreads—the difference between the offer price and the post-announcement trading price. This allows us to separate out the impact of the probability of success and the takeover premium that arises because of limited arbitrage in Eq. (3) from the direct impact in Eq. (1).

Our model leaves out many risks faced by real-world arbitrageurs. These include the possibility that the original deal terms will be revised, that a new offer will emerge, that the deal will take longer to complete than anticipated, and, in the case of stock deals, the costs of short selling. First, in the empirical analysis, we measure the frequency of revisions and try to gauge their economic importance. Second, competing offers lower risk for the arbitrageur. If one deal fails, the other might succeed. To examine this possibility, we consider a portfolio of only initial offers and a portfolio that contains all offers. Third, we capture holding costs by deducting the risk-free rate from the arbitrage portfolio in the time series and deducting the risk-free rate and a measure of systematic risk from the dependent variable in the cross section. The possibilities of delayed completion and a short position that is involuntarily liquidated are largely idiosyncratic risks that, like completion risk, would be priced in a more general version of Eq. (3), but not in Eq. (2). Without a good empirical proxy for the ex ante probability of delay, we are forced to omit this risk from the empirical model.

3. Data

We start with all merger and acquisition offers recorded by Securities Data Company (SDC) between 1981 and 1996. 1978 is the first year in the SDC mergers database. But, prior to 1981, SDC does not provide full coverage of mergers and acquisitions. From this large sample, we restrict our attention to the 4,135 announced merger and tender offers where both the target firm and the acquirer firm are public companies and the target firm is listed by the Center for Research on Security Prices (CRSP).[6] Fig. 1 and the first column of Table 1 show the number of mergers in each year between 1981 and 1996.

3.1. Coding the data

For each deal, SDC provides us with a brief summary of the offer, the announcement date, and the effective or withdrawal date. We classify these offers as pure cash deals, pure stock deals, or as a mixture of cash and stock. In a pure cash deal, the consideration does not depend on the level of the acquirer's share price. For example, Union Pacific's bid of \$25 for each share of Southern Pacific Rail on August 2, 1995, is a cash deal. A cash deal, by our classification, need not be paid for in cash. For example, Johnson & Johnson's bid of \$109 in common stock for each share of Cordis on October 19, 1995, is also a cash deal. In a pure stock deal, the consideration varies one for one with the level of the acquirer's share price. For example, Frontier offered to buy each share of ALC Communications for two of its

[6] The sample excludes deals in the SDC mergers database classified as leveraged buyouts, spin-offs, recapitalizations, self-tenders, exchange offers, repurchases, minority stake purchases, acquisitions of remaining interests, and privatizations. It also excludes rumors and acquirers seeking an unspecified target or targets seeking an unspecified buyer. Despite these exclusions, the sample includes a small number of offers for less than 100% of the shares outstanding. For successful deals, SDC records the percentage of the shares outstanding acquired in the transaction. For unsuccessful deals, SDC often reports the percentage sought. In the final sample, we have data on the percentage acquired or sought for 1,552 firms. Where we have data, the average percent acquired (we use percentage sought when the percentage acquired is missing) is 94%. For 89% of the deals, the percentage acquired or sought was for 90% or more of the shares outstanding.

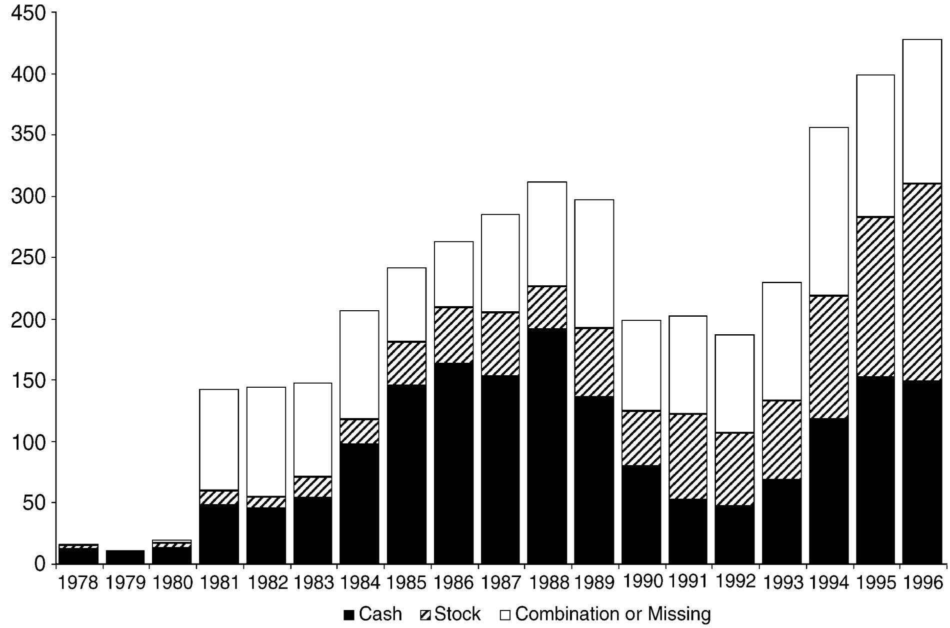

Fig. 1. Mergers and acquisitions, 1981–1996. Annual mergers and acquisitions announced between 1981 and 1996 and recorded by *Securities Data Company* (SDC). The sample contains only deals where the target firm was listed by the *Center for Research on Security Prices* (CRSP) and the acquirer firm was a public company. We use the SDC description of the consideration to identify deals that are pure cash offers or pure stock offers.

own shares on April 10, 1995. We exclude deals where the consideration is part cash and part stock or has option-like features. Many recent deals include ''collars'' where the offer is fixed in terms of the acquiring firms' shares over some pre-specified range. The collar ensures that the takeover price is above some minimum level but does not exceed some maximum level in dollar terms. In the initial sample, SDC reports that 167 offers, or 4% of the sample, included a collar. These deals are excluded from our final sample.

In many cases, we make additional assumptions to calculate risk arbitrage returns. First, in the early 1980s, SDC describes the type of deal, cash or stock, but not the amount. For these deals, we use the SDC offer price to infer the amount of cash or the number of shares offered. Second, we use Lexis-Nexis to find missing completion and withdrawal dates. Third, when either the target or the acquirer (in the case of a stock deal) underwent a stock split, we adjusted the offer accordingly. We use the CRSP event database to identify stock splits.

3.2. Sample selection

Our final sample consists of 1,901 merger offers. The second three columns of Table 1 show the 1,335 pure cash offers and 566 pure stock offers used in the

Table 1
Mergers and acquisitions, 1981–1996
Provided here is a comparison of the number of mergers and acquisitions in the SDC database and in the final sample. The first three columns show annual mergers and acquisitions announced between 1981 and 1996 and recorded by SDC. The sample contains only deals where the target firm was listed in the CRSP database and the acquirer firm was a public company. We use the SDC description of the consideration to identify deals that are pure cash offers or pure stock offers. Of the total sample of 4,135 mergers and acquisitions, 1,485 deals combined stock and cash or had insufficient information. The second three columns show the subset of pure stock offers and pure cash offers used in the analysis. The remaining sample is reduced from 2,650 to 1,901 for several reasons. In 681 cases, there was insufficient CRSP data. In some of these cases, the target firm was delisted prior to the announcement date, typically because of bankruptcy. Frequently, there was insufficient data on the acquiring firm in a stock deal. And, in some cases, the SDC target name or acquirer name in the case of stock deals did not match the CRSP company name. In 36 cases, we performed additional research using Lexis-Nexis that lead to the exclusion of the deal, because the announcement was not a merger or acquisition offer. Finally, in 32 cases, the SDC consideration was more than double the post-announcement value of the target.

	Complete SDC data			Sample		
Announcement year	All	Pure cash	Pure stock	All	Pure cash	Pure stock
1981	134	50	12	36	29	7
1982	141	44	10	34	30	4
1983	145	53	16	52	39	13
1984	208	96	22	88	75	13
1985	245	145	37	128	108	20
1986	267	162	45	152	128	24
1987	287	153	51	159	125	34
1988	327	198	38	187	162	25
1989	303	136	57	147	111	36
1990	207	78	45	85	58	27
1991	209	52	70	76	37	39
1992	194	48	60	71	37	34
1993	240	69	67	88	50	38
1994	375	122	105	163	101	62
1995	410	156	134	207	123	84
1996	443	155	164	228	122	106
Total	4,135	1,717	933	1,901	1,335	566

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Fig. 1 and Table 1 show our sample of pure cash and pure stock deals. There are two identifiable periods of relatively higher merger activity in the late 1980s and the middle 1990s. Also apparent is the increasing prevalence of stock deals. Before 1990, 19% of the deals were stock deals. After 1990, over 44% were stock deals.

The 1,901 offers in our final sample were for 1,556 target firms. The remaining 345 offers represent competing bids. As a result, we perform the analysis in two ways. In the first, we treat all offers identically, whether or not there is another outstanding. As a result, the risk arbitrage portfolio contains multiple bets on completion for a particular firm when there are multiple offers. In the second, we discard follow-on offers, where a follow-on offer is defined using the full sample of 4,135 deals recorded by SDC. As a result, this second risk arbitrage portfolio never contains more than one bet on completion for a particular firm.

4. The returns to risk arbitrage

In this section we evaluate the performance of a risk arbitrage portfolio. As a benchmark we use both the CAPM and the Fama-French three-factor model (Fama and French, 1996). The portfolio of 1,901 risk arbitrage positions earned abnormal returns of 0.6–0.9% per month over the period from 1981 through 1996. This result is robust for value and equal-weighted returns, though the statistical significance is stronger for equal-weighted returns.

4.1. Calculating portfolio returns

A merger or acquisition is included in the portfolio beginning two days after announcement. This is to exclude explicitly the large abnormal returns that are associated with takeover announcements (see, for example, Jensen and Ruback, 1983). The merger or acquisition is removed from the portfolio when completed or withdrawn.

Each day we calculate the return for all active deals. The arbitrage position for each active deal is designed to provide a fixed-dollar payoff if the deal is a success and an uncertain payoff if the deal fails. For a cash deal, constructing this position is simple. The offer itself is fixed, so an investment in the target firm provides a fixed payoff conditional on completion. The return for a cash deal i on day t is the return on the target firm T from CRSP:

$$r_{it} = r_{Tit}. \tag{4}$$

Constructing the arbitrage position for stock deals is more complicated. The offer is a fixed amount δ of the acquirer's shares. To provide a fixed payoff conditional success, each share of the target firm must be balanced by a short position in δ of the acquirer's shares. The daily return for stock deals then has three pieces: the return on the target, the return from a short position in acquirer shares, and the risk-free return on the short sale proceeds. Our assumption is that arbitrageurs do not have access to the short sale proceeds. In practice, they often receive less than the risk-free rate and face the additional risk that the lender recalls the short position prior to the completion of the merger. Each target share requires an initial investment equal to the target price P_T. The arbitrageur receives the dollar return on the target stock $r_T P_T$ and pays out the return in excess of the risk-free rate $(r_A - r_f)$ times the acquirer price P_A for δ shares.[7] Dividing the sum of these two amounts by the initial investment gives the return for stock deal i on day t:

$$r_{it} = r_{Tit} - (r_{Ait} - r_{ft})\,\delta\,\frac{P_{Ait-1}}{P_{Tit-1}}. \tag{5}$$

It is important to note that both deals require the same up front investment of P_T. In the case of a cash deal, this is straightforward. In the case of a stock deal, an investment is required because arbitrageurs do not have access to the short sale proceeds.

We then average the returns across all active deals to get a daily portfolio return. To check for robustness, we evaluate six portfolios: both value-weighted and equal-weighted combinations of all deals, of cash deals only, and of stock deals only. Compounding the daily average returns across each month gives us 192 monthly portfolio returns beginning in January 1981 and ending with December 1996:[8]

$$R = \prod\left[1 + \sum_{i=active} w_{it} r_{it}\right] - 1. \tag{6}$$

Table 2 reports the mean, standard deviation and Sharpe ratio for the monthly arbitrage portfolio returns. The first three columns in Panel A show returns where the weight w is the CRSP target firm market value scaled by the total target firm market value for all deals in the portfolio. The mean value-weighted return is 1.5% per month. The second three columns in Panel A show returns where the weight w is the inverse of the number of deals in the portfolio. The mean equal-weighted return is 1.6% per month. Panel B shows the returns for only first offers. This eliminates the possibility that the arbitrage portfolio contains more than one position in a single target company. Also, a follow-on offer has a different risk profile for an arbitrageur. If one deal fails, the other still can succeed, limiting downside risk. However, the returns are broadly similar, with some higher and some lower than the full sample returns. Panel C shows that the average monthly market return is 1.2% on the CRSP value-weighted market portfolio and 1.4% on the CRSP equal-weighted market portfolio. In a simple comparison, the merger arbitrage portfolio beats these market returns. In Panels A and B, we also report returns on portfolios of pure cash and pure stock deals. The merger arbitrage portfolios beat the market in all cases but one.

[7] The risk-free rate is from Ibbotson (1999).

[8] There are five months where there are no deals in the stock portfolio.

Table 2
Monthly portfolio returns, 1981–1996
Provided here are monthly compound arbitrage portfolio returns. Value-weighted VW and equal-weighted EW portfolio returns for pure cash offers c and pure stock offers s are calculated as follows:

$$r_{cit} = r_{Tit}, \ r_{sit} = r_{Tit} - (r_{Ait} - r_f)\delta\frac{P_{Ait-1}}{P_{Tit-1}}, \text{ and}$$

$$R = \prod\left[1 + \sum_{i=active} w_{it}r_{it}\right] - 1.$$

Active deals i and the number of acquirer shares offered δ are from SDC. The daily acquirer firm returns r_A, acquirer firm stock prices P_A, target firm returns r_T, and target firm stock prices P_T are from CRSP. The daily Treasury bill return r_f is calculated from Ibbotson (1999). Panel A shows arbitrage portfolio returns. Panel B shows market returns for comparison. In the first three columns, daily returns are weighted by the target firm market value from CRSP and compounded to monthly returns. In the second three columns, the daily returns are weighted equally across deals. Each set of three columns shows the mean, standard deviation, and Sharpe ratio for the monthly portfolio returns.

	Value-weighted			Equal-weighted		
Portfolio	Mean (%)	SD (%)	Sharpe ratio	Mean (%)	SD (%)	Sharpe ratio
Panel A: Arbitrage portfolios, all offers						
All deals	1.54	4.25	0.23	1.55	2.54	0.39
Cash deals	1.62	4.84	0.22	1.48	3.13	0.29
Stock deals	1.67	4.42	0.25	1.97	4.81	0.29
Panel B: Arbitrage portfolios, first offers						
All deals	1.63	3.49	0.30	1.51	2.72	0.35
Cash deals	1.76	4.32	0.28	1.40	3.30	0.25
Stock deals	1.40	4.62	0.18	1.95	5.03	0.27
Panel C: Market returns						
Market	1.21	4.16	0.15	1.41	5.08	0.17
T-bills	0.57	0.24		0.57	0.24	

We also compare Sharpe ratios, the excess return over Treasury bills per unit of standard deviation. The Sharpe ratio for the value-weighted arbitrage portfolio is 0.23 (annualized 0.80), or the mean return of 1.5% less the return on Treasury bills of 0.6% divided by the standard deviation of 4.3%. The Sharpe ratio for the equal-weighted arbitrage portfolio is 0.39 (annualized 1.35). Both exceed their market benchmarks of 0.15 (annualized 0.52) and 0.17 (annualized 0.59).

None of the analysis thus far has considered systematic risk. If the arbitrage portfolios had more systematic risk than the market as a whole, the high returns would not be surprising. However, even before benchmarking the returns, we would expect merger arbitrage to have *less* not more systematic risk than the market: The 1,901 merger offers failed less than 22.7% of the time. When we take into account competing offers, the target firm remained independent a year later for only 16.3% of the offers. So, with rational expectations, about 83.7% of the portfolio had only the risk associated with possibility of revisions and competing offers.

4.2. Benchmarking portfolio returns

Abnormal returns must be defined relative to some benchmark model. In Table 3, we test the portfolio returns against the CAPM by regressing the monthly excess arbitrage portfolio return against the excess market return. We also use the Fama-French three-factor model, adding the size (*SMB*) and book-to-market (*HML*) factors to the regression. In each case, we check whether the intercept is positive and statistically significant.

Panel A of Table 3 shows results for the full sample, and Panel B shows results for first offers only. When all deals are included in the portfolio, the point estimate is 0.8% per month for both value-weighted returns and equal-weighted returns. When only first offers are included, the value-weighted results are slightly higher at 0.9%. The Fama-French factors explain some of this abnormal return. The loadings on the size and value factors are positive and reduce the intercept by 0.1%, to 0.6% for the full sample, and 0.7% for first offers. The intercepts are all statistically significant at the 10% level, with one exception. The value-weighted Fama-French three-factor intercept has a p-value of 0.11. The equal-weighted results are all significant at least at the 2% level.

Table 3
Market model and Fama-French three-factor portfolio regressions, 1981–1996
This table provides OLS regressions of the monthly excess arbitrage portfolio returns on the monthly excess market return and the Fama-French size and book-to-market factors, where

$$R_t - R_f = a + b(R_{Mt} - R_f) + sSMB_t + hHML_t + \varepsilon_t.$$

In the first two rows of each panel, the daily returns are weighted by the target firm market value from CRSP and compounded to monthly returns. In the second two rows of each panel, the daily returns are weighted equally across deals. Panel B limits the sample to first offers for a target firm. Fama and French provided the monthly risk-free rate, the excess market return, SMB, and HML. Heteroskedasticity robust p-values are shown in parentheses.

			Intercept		$R_{Mt} - R_f$		*SMB*		*HML*	
	N	R^2	a	p-value	b	p-value	s	p-value	h	p-value
Panel A: All offers										
Value-weighted										
Market model	192	0.09	0.78	(0.02)	0.30	(0.03)				
Fama-French three-factor	192	0.12	0.59	(0.11)	0.37	(0.01)	0.26	(0.05)	0.32	(0.01)
Equal-weighted										
Market model	192	0.13	0.84	(0.00)	0.22	(0.00)				
Fama-French three-factor	192	0.18	0.74	(0.00)	0.25	(0.00)	0.22	(0.01)	0.18	(0.03)
Panel B: First offers										
Value-weighted										
Market model	192	0.15	0.86	(0.00)	0.32	(0.04)				
Fama-French three-factor	192	0.20	0.72	(0.02)	0.37	(0.02)	0.31	(0.04)	0.25	(0.07)
Equal-weighted										
Market model	192	0.12	0.80	(0.00)	0.22	(0.00)				
Fama-French three-factor	192	0.16	0.73	(0.00)	0.24	(0.00)	0.23	(0.01)	0.15	(0.11)

We do not separate out the returns for cash and stock deals in Table 3. The portfolio of only stock deals has no deals at all for five months between 1981 and 1996, and in the first half of the sample often contains fewer than five deals. When we do separate out the two sets of returns, we do not find a statistically significant difference between the intercept for all deals and the intercept for cash deals alone.

To put these returns in perspective, we compare our results to another pricing anomaly. Ritter (1991) and Loughran and Ritter (1995) focus on the abnormal returns of firms issuing new equity, either through initial public offerings (IPOs) or seasoned equity offerings (SEOs). Brav and Gompers (1997) employ an identical portfolio approach to IPO firms over a similar time period, beginning in 1972 and ending in 1992. The IPO portfolio underperforms its benchmarks by approximately 0.5% per month. The abnormal returns in merger arbitrage are at least as large.

Direct transaction costs reduce these abnormal returns. However, the impact is small for this time period. When we follow Mitchell and Pulvino (2001) and include a transaction cost of \$0.05 per share for the period between 1981 and 1990 and \$0.04 for the period after 1990, the intercepts fall by less than 0.1%.

4.3. Revisions and portfolio returns

We try to gauge the economic importance of revisions in two ways. First, we tabulate revisions from SDC. SDC mentions revisions in the description of the consideration. The descriptions offer more detail in recent years. So, we focus on the last five years of our sample. Of the 624 deals recorded by SDC between 1992 and 1996 that end up in our final sample, only 82, or 13%, are listed as revised or amended one or more times. Of the total number of revisions, 16 are downward revisions. Second, we recalculate the monthly portfolio returns. This recalculation restricts the price of the target below the original consideration to either a fixed dollar ceiling or, in the case of stock deals, a ceiling in terms of the acquirer's stock price. Put another way, we replace the price of the target with the consideration, whenever the price of the target is higher. Of course, using this price series reduces the raw and abnormal returns. The raw return for the full sample is 1.0% per month for value-weighted returns, and 1.1% per month for equal-weighted returns.

Our aim in analyzing revisions is to gauge the accuracy of the stylized model of limited arbitrage, which has only two outcomes, success and failure. Real-world arbitrageurs face a number of other risks, including the possibility that the deal will be revised or a competing offer will emerge. While we do not precisely quantify the relative importance of these additional risks, these two analyses provide some guidance. 2.6% of the deals are revised downward, 10.6% are revised upward, and the remaining 86.8% fit the model in an ex post sense. Downward revisions represent risk. However, a downward revision, even a substantial outcome, is a better outcome for an arbitrageur than outright withdrawal. The second analysis shows that upward revisions and competing offers explain about a third of the abnormal return. Capping the target stock price reduces the abnormal return by 0.5% per month for value-weighted returns. To sum up, revisions are not a trivial risk, but the majority of merger and acquisitions are not revised. So, the primary concern for risk arbitrageurs is typically whether or not the deal will be completed according to its original terms or withdrawn.

5. The cross section of merger arbitrage returns: testing for limited arbitrage

In this section, we use event returns to test the cross section predictions of limited arbitrage. First, we describe a measure of systematic risk for cash and stock deals that is a function of the ex ante probability of success. Second, we describe the calculation of event returns. And third, we describe the empirical proxies and the cross-section results.

5.1. Benchmarking event returns

An event return r has three components: the probability of success π, the return conditional on success r_s, and the return conditional on withdrawal r_w. This model of returns,

$$r = \pi r_s + (1 - \pi) r_w, \tag{7}$$

which matches our stylized model of limited arbitrage, does not directly take into account the possibility of renegotiated terms, competing bids, and delays. In this simplified decomposition, outcomes other than the completion of the original deal are implicitly lumped into the return conditional on withdrawal r_w. In other words, withdrawal can be a favorable outcome. Conditional on success, there is no risk, systematic or otherwise. In the case of a cash deal, r_s is known in advance. In a stock deal, when the acquirer offers δ shares for each target share, the arbitrage position is long a single target share and short δ of the acquirer. If the deal goes through, the two positions exactly cancel, and again r_s is risk free.

The chance of failure gives rise to risk. When a cash deal fails, the arbitrageur is left with a share of target stock, which has uncertain value. For the average target, this component has market risk. When a stock deal fails, the arbitrageur has an unhedged position long the target and short the acquirer. For the average deal, this is approximately market neutral.

As a benchmark for event returns, we use a probability weighted average of the required return conditional on success and the required return conditional on failure.[9] For stock deals, the benchmark is simply the risk-free rate r_f. If the deal succeeds, the arbitrageur receives a fixed profit, if the deal fails, the position is market neutral. For cash deals, the chance of failure leads to systematic risk:

$$r_f + (1 - \pi)(r_M - r_f). \tag{8}$$

[9] The formula is more complicated if the probability of failure itself has systematic risk. But, we find that the number of failed deals in each month both as a fraction of active deals and completed deals does not have a statistically significant correlation with contemporaneous and lagged market returns. In other words, deals typically fail for idiosyncratic reasons, such as regulatory hurdles and takeover defenses.

This benchmark requires a risk-free return r_f and a market return r_M, each over the event window, and a measure of the ex ante probability of success π. The event window begins two days after the announcement of the merger and ends with completion or withdrawal. We use the risk-free rate from Ibbotson (1999), and the value-weighted market return from CRSP.

To estimate π, we use predictions from an in sample regression of the merger outcome on the acquirer attitude. Whether the acquirer attitude is classified as hostile by SDC is the best single predictor of merger success in our sample of mergers. Target and acquirer firm size also have some explanatory power in a probit regression of merger outcome on deal characteristics. However, the impact is smaller than the attitude indicator variable. Walkling (1985) concludes that managerial resistance is a "decisive deterrent to offer success". This is also consistent with Schwert (2000), who finds that moving from a hostility index of zero to one reduces the success rate by 45%. The probit regression predictions of merger outcome on acquirer attitude are simply the sample averages. Only 38% of the 201 hostile deals succeed. Some of these target firms are ultimately taken over by other acquirers within one year of the hostile offer, raising the probability that a hostile offer leads to an eventual acquisition up to 65%. Of the remaining non-hostile deals, 82% succeed and 86% are ultimately acquired in the broader definition of success. The merger outcome regressions are described in the appendix.

5.2. Event returns

We calculate event returns from a buy and hold strategy in each deal. A cash deal event return,

$$r_c = \prod_{t=2}^{T}[1 + r_{Tt}] - 1, \tag{9}$$

is the return on a single target share from two days after announcement through completion or withdrawal $T - 2$ days later.

An example illustrates the excess return calculation for cash deals. On September 9, 1993, Viacom Inc. made a friendly cash bid for Paramount Communications. The deal closed successfully on July 7, 1994. During the period two days after announcement until completion, Paramount shares had a return of 23.4%. The Treasury bill and market returns were 2.6% and −1.6%, respectively. The benchmark return of 1.9% is the sum of the risk-free return and an ex ante probability of failure of 0.16 times the excess return of the market. The excess event return is 21.5% (23.4% minus 1.9%).

As before, the event return for a stock deal has three pieces: the return on a single target share, the return from a short position in δ acquirer shares, and the risk-free return on the short sale proceeds. The buy and hold return, computed from the announcement date to completion or withdrawal $T - 2$ days later on this portfolio, is

$$r_s = \prod_{t=2}^{T}\left[1 + r_{Tt} - (r_{At} - r_f)\,\delta\,\frac{P_{At-1}}{P_{Tt-1}}\right] - 1. \tag{10}$$

Another example illustrates the excess return calculation for stock deals. On July 19, 1995, Banc One Corporation made a friendly bid for Premier Corporation by offering 0.6 shares of its own for each Premier share. The deal closed successfully on January 2, 1996. During the time period beginning two trading days after announcement and ending approximately six months later, an arbitrage position long one Premier share and short 0.6 Banc One shares returned 8.7%. Returns for Treasury bills and the market were 2.5% and 12.7%, respectively. The excess return is 6.2% (8.7% minus the Treasury bill return of 2.5%) since the arbitrage position is market neutral.

5.3. Determinants of the cross section of returns

If arbitrageurs are the marginal investors and the assumptions of our stylized model of limited arbitrage hold, their risk aversion leads to a discount on the target of $(X/A)\gamma\pi(1-\pi)p^2$. By contrast, in a transaction cost theory, the discount compensates arbitrageurs for their transaction costs c. We use the cross section of returns in an attempt to identify the characteristics of the marginal investor. In particular, we consider three predictions of limited arbitrage. The first prediction is that returns are increasing in idiosyncratic risk. Idiosyncratic risk increases as the ex ante probability of successful completion falls toward 0.5 and $\pi(1-\pi)$ rises. It also increases with the takeover premium p. The empirical test of this prediction does not distinguish between the limited arbitrage and transaction cost theories, but positive coefficients are consistent with the limited arbitrage explanation. The second prediction is that returns are increasing in the number of shares sold X after announcement. Unlike limited arbitrage, transaction costs predict that mergers involving larger target firms have lower required returns. Finally, we consider the prediction that arbitrage capital A reduces returns.

To measure the probability of success π, we take the same approach as in the benchmarking section, using fitted values from the regression of merger outcome on acquirer attitude described in the appendix.

To measure the takeover premium p, we subtract the target share price 20 days prior to the takeover announcement from the offer price. We also rerun the regressions subtracting the target price 30 and 60 days prior to the announcement of the merger. The coefficient on the takeover premium is unaffected. We censor this premium at zero and scale it by the target share price two days after announcement, which is the required investment in a risk arbitrage position. This is meant to capture the difference between the return if the takeover offer is withdrawn (the price following withdrawal divided by the post-announcement price) and the return if the takeover offer succeeds according to the original terms (the offer price divided by the post- announcement price). All that is required is that a larger takeover premium increases proportionally with the difference between success and expected failure payoffs. It is not necessary that the target fall all the way back to its pre-offer share price.

To measure the number of shares sold X after the announcement of a merger, we use target firm size. Ideally, we would like to measure the total dollar value of seller-initiated trades. Unfortunately, this information is not available. So, we use target firm size as a proxy. If the propensity to sell shares following a merger announcement is independent of firm size, then firm size will increase the dollar value of seller-initiated volume. We measure firm size as the log of target market value, the number of shares outstanding times price two days after announcement, converted into 1996 dollars using the consumer price index from Ibbotson Associates (1999).

To measure arbitrage capital, our approach is to identify arbitrageurs using 13F filings of institutional ownership recorded by Spectrum.[10] These data are available back to 1981, covering our full sample period. For each merger where data are available, we measure institutional ownership for the target company for the quarter end immediately before and immediately after announcement. These data are summarized in Table 4. The institutions are divided into five categories: banks, insurance companies, investment companies including mutual funds, independent investment advisors, and all others. The first panel shows ownership as a percentage of shares outstanding, and the second panel shows ownership as a percentage of total institutional shares. Institutional ownership falls following the announcement of a merger or acquisition. However, some of the reduction in Table 4 can occur prior to announcement if, for example, the acquirer accumulates shares to gain a toehold. The fall in ownership is most pronounced for banks, insurance companies, and investment companies. The share of institutional ownership for independent investment advisors rises by about 5%. This group includes some known arbitrageurs, such as Farallon Capital Management (Howard and Perold, 1998) and Long Term Capital Management (Perold, 1999).

We define an institution as an arbitrageur if its holdings go from zero to positive in at least 20 mergers in the 1981 through 1996 sample period.[11] The screen picks up known arbitrageurs and other institutions that are evidently willing to provide some form of deal completion insurance. We aggregate the nonmerger-related equity holdings of this set of institutions for each quarter from 1981 through 1996 and label

[10] Larcker and Lys (1987) use an alternative definition of arbitrageurs. They collect data on 13D filings where the stated purpose was described as "arbitrage or other business activities" or "to participate in a potential merger or tender offer". A large majority of these filings either preceded or followed an initial announcement of a corporate reorganization. Our approach can be distinguished in two ways. First, we identify a broader range of arbitrageurs and investors providing liquidity to target shareholders. A 13-D filing is required only when an investor exceeds an ownership limit of 5% of the outstanding shares. Second, we are able to use the same data source on institutional ownership to produce a time series of capital available for arbitrage.

[11] The top ten independent investment advisors by our measure are: Schroder & Co. (349 deals), Beacon Capital Management (312), Furman Selz (227), Fleming Capital (169), Sheer Asset Management (168), Soros Fund Management (163), Morgan Stanley Dean Witter (152), Arnhold & A Bleichroeder (148), Kellner Dileo (144), and Farallon Capital Management (143). Of the 1,901 deals, we have Spectrum data for 1,874.

Table 4
Institutional ownership
This table shows institutional ownership before and after a takeover announcement. The first column shows ownership for the quarter ending prior to announcement, the second column shows ownership for the quarter ending after announcement, and the third column reports the difference between the first two. Panel A shows ownership as a fraction of shares outstanding for five types of asset managers. Panel B shows ownership as a fraction of total institutional ownership.

Group	Quarter before announcement	Quarter after announcement	Change as a percent of initial holdings
Panel A: Percent of shares outstanding			
Banks	5.52	4.25	−23.01
Insurance companies	2.07	1.52	−26.57
Investment companies	3.04	2.29	−24.67
Independent investment advisors	13.15	11.07	−15.82
All others	1.74	1.40	−19.54
All institutions	25.52	20.53	−19.55
Panel B: Percent of institutional ownership			
Banks	25.28	24.14	−4.50
Insurance companies	6.82	6.15	−9.83
Investment companies	9.90	8.81	−11.02
Independent investment advisors	52.99	55.88	5.46
All others	5.01	5.01	0.14
All institutions	100.00	100.00	0.00

this arbitrage capital. Spectrum does not provide information on nonequity sources of capital. As a result, the measure is a noisy proxy for arbitrage capital.

We scale each independent variable by its standard deviation. As a result, each coefficient is comparable in the sense that it measures the change in average return per standard deviation move in the independent variable.

5.4. Regression results

We present the regression results in Table 5. Because the deal lengths vary, we focus on the first 30-day excess return.[12] The first column of Table 5 shows the

[12] We use a relatively short horizon for the cross-sectional analysis for two reasons. First, many deals take considerably longer to be completed. The median time to completion or withdrawal for our sample is 120 days. Yet, some deals are withdrawn in less than 30 days. Ideally, we would like our dependent variable to be measured over the same horizon for all deals. Only 6% of the sample offers are completed or withdrawn within 30 days. Meanwhile, over 20% of the sample offers are completed or withdrawn within 60 days. Second, benchmarking returns over a longer horizon is challenging (Barber and Lyon, 1997; Lyon et al., 1999). We also rerun the cross section results for two-month returns. The coefficients and statistical significance of the probability of success term, firm size, and arbitrage capital rise in the two-month regressions. The coefficient on the takeover premium falls slightly. A table is available from the authors upon request.

Table 5

Estimating the model of returns

This tables shows OLS regressions of one-month excess event returns on measures of idiosyncratic risk, target firm size, and arbitrage capital. Idiosyncratic risk is a function of the probability of success π and the takeover premium p. As an estimate of π, we use fitted values from a regression of merger outcome on acquirer attitude. The takeover premium, p, is equal to the offer price minus the price 20 days before the takeover announcement date. P is the target price two days after. All prices are from CRSP. Log market equity is the log target equity measured in 1996 dollars. Arbitrage capital is described in the text. All independent variables are standardized to have zero mean and unit variance. The residuals are clustered by month. Heteroskedasticity robust p-values are shown in parentheses.

	Prediction	All offers				First offers			
		(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Probability of success $\pi(1-\pi)$	+	1.13	0.96	0.96	0.85	1.13	0.98	0.97	0.83
		(0.00)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)	(0.05)
Takeover premium $[p/P]$	+	1.64	1.72	1.77	1.81	1.72	1.79	1.84	1.90
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Log market equity ($1996)	+		0.77	0.79	0.82		0.67	0.70	0.75
			(0.00)	(0.00)	(0.00)		(0.01)	(0.01)	(0.01)
Past arbitrage return (%)	−			−0.48				−0.61	
				(0.19)				(0.15)	
Change in capital (%)	−				−0.52				−0.45
					(0.08)				(0.20)
Stock deal	?	−0.64	−0.77	−0.88	−0.77	−0.75	−0.92	−1.05	−0.95
		(0.21)	(0.13)	(0.08)	(0.12)	(0.16)	(0.09)	(0.05)	(0.07)
R^2		0.04	0.05	0.06	0.06	0.05	0.05	0.06	0.06
N		1,901	1,901	1,889	1,874	1,556	1,556	1,544	1,534

predicted sign for the limited arbitrage variables. Our theoretical predictions pertain to expected returns. The realized one-month excess return is equal to the expected return plus an error. This noise lowers the model fit and increases the standard errors of our estimates. Also, returns are overlapping in time and thus are not independent. To address this problem, we cluster the residuals by announcement month. Rogers (1993) describes the estimation of robust standard errors that relaxes the assumption of independence across groups.

In the first column, the takeover premium p/P and the transformed probability of success $\pi(1-\pi)$ enter with the expected positive sign. The probability term and the takeover premium term are significant at the 5% level. Importantly, the standard errors are corrected for heteroskedasticity. The uncorrected errors are sometimes less than half as large. The coefficients suggest that a one standard deviation change in the transformed probability of success leads to a 1.1% increase in average returns and a one standard deviation change in the takeover premium leads to a 1.6% increase in average returns. We conclude that excess returns are increasing in completion risk.

In all the regressions, we include an indicator variable for stock deals. The coefficient is negative and sometimes significant at the 10% level. This provides some evidence against transaction costs as the primary determinant of returns. On the one hand, stock deals are taxed differently from cash deals. In a stock transaction, target shareholders need not realize a capital gain and can have less incentive to sell following the announcement of a merger or acquisition, leading to lower arbitrage returns. On the other hand, transaction costs predict higher returns for stock deals because entering into a risk arbitrage position for a stock deal requires two transactions instead of one. The arbitrageur incurs direct costs for both the long and short positions and often does not receive full interest on the short sale proceeds.

In next column, we add a proxy for seller-initiated volume. Firm size has two possible effects. First, holding risk and arbitrage capital constant, a larger firm and a larger dollar amount sold leads to higher returns. However, arbitrageurs also focus on larger companies where more information is available and transaction costs are lower. This could reduce returns. The first column shows that target firm size enters with a positive coefficient, and is significant at the 1% level. A one standard deviation change in firm size leads to a 0.8% increase in average returns. This result suggests that limited arbitrage effects dominate transaction costs.

Another test of the limited arbitrage model is to examine the influence of arbitrage capital on returns. Froot and O'Connell (1999) find evidence of capital constraints in catastrophe reinsurance. Following a catastrophe that depletes the capital of reinsurers, prices for insurance rise. More interestingly, the effect works across markets. For example, a hurricane increases the price of earthquake insurance. This supports limited capital, rather than a higher probability of a subsequent earthquake, as the cause of higher insurance prices. In this spirit, we would like to measure changes in capital available for risk arbitrage across time.

In the third column, we add the arbitrage portfolio return in the two calendar quarters prior to the merger announcement to the basic model. This first measure of capital enters negatively and has a p-value of 0.19. A one standard deviation reduction in past returns leads to an increase in average one-month returns of 0.5%. The second column shows the change in arbitrage capital based on the Spectrum data. Again, the coefficient is negative and is now significant at the 10% level. A one standard deviation reduction in this measure of capital also leads to an increase in average one-month returns of 0.5%.

We also run but do not report regressions using past returns on distressed securities hedge funds from the MAR Hedge Fund database. The same money managers often focus on both risk arbitrage and distressed securities. Although there is no obvious direct economic link between the returns on target firms and the returns on bankrupt firms, there can be an indirect connection through limited arbitrage. Unfortunately, these data are only available from 1990. As a result, we lose a little over half of the sample. The coefficient on the distressed securities return is negative, but it has a p-value greater than 0.3.

The second set of four columns in Table 5 repeat the analysis using only first offers. The results are broadly similar, though the measure of arbitrage capital derived from institutional holdings is no longer statistically significant.

To sum up, we find evidence in favor of a model of limited arbitrage as an explanation for the abnormal returns to risk arbitrage. Excess returns are increasing in target firm size, two measures of idiosyncratic risk, the takeover premium and the transformed probability of success, and decreasing in a measure of arbitrage capital.

6. Conclusions

Past research suggests that merger arbitrage produces very high returns. This paper addresses *why* these returns are not arbitraged away. Unlike in previous empirical studies of limited arbitrage (for example, Pontiff, 1996), we focus on the merger and acquisition market, a large and economically important component of the stock market. And, unlike earlier studies of merger arbitrage, we develop a model and test the cross section implications of a limited number of arbitrageurs. We find evidence that supports a model where undiversified investors sell to avoid completion risk. Arbitrageurs, limited in capital and number, require a premium for bearing this risk. Consistent with limited arbitrage, a cross section analysis reveals that idiosyncratic risk and firm size are determinants of expected returns. Our results on arbitrage capital are also consistent with limited arbitrage. A proxy for changes in arbitrage capital is negatively related to future risk arbitrage returns. When capital falls, subsequent returns rise.

This paper also provides quantitative evidence about the limits of arbitrage. The average risk-adjusted return on a risk arbitrage portfolio about 0.6%–0.9% per month. This portfolio beat the market outright by 0.3% per month. If fairly precise information on merger terms is not fully absorbed in prices, arbitrage may fail to guarantee market efficiency elsewhere. Put in terms of Scholes (1972), the target firm has an almost perfect substitute in merger arbitrage, that is, perfect conditional on the completion of the original offer and a completion rate of over 83%. When stocks do not have good substitutes, mispricing could be more severe.

Appendix. Predicting merger success

Table 6 shows the determinants of merger outcome. The dependent variable is defined in two ways. In the first two columns, success is equal to one if the merger offer succeeds. In the second two columns, success is equal to one if the merger offer succeeds or the firm is taken over by any acquirer within one year of the offer. In the first column, the only independent variable is a categorical variable equal to one if the deal is classified as hostile by SDC. This measure of acquirer attitude explains 8% of the variation in outcomes and is significant at the 1% level.

The second column adds other deal characteristics. First, target and acquirer firm size are the log of target and acquirer equity market value after the announcement of the merger, converted to 1996 dollars using the consumer price index from Ibbotson Associates (1999). Larger firms may have an easier time acquiring smaller firms. Second, we include a categorical variable equal to one if the target and acquirer are in the same two-digit SIC code. Horizontal mergers may face regulatory hurdles.

Table 6
Predicting merger outcome
This table shows probit regressions of merger outcome on acquirer attitude and other deal characteristics. Offer completed is equal to one if the particular merger or acquisition offer is completed successfully. Target acquired is equal to one if any merger or acquisition offer for the target is completed successfully. Hostile is equal to one if SDC characterizes the deal as such. The other deal characteristics are the log target equity measured in 1996 dollars, the log acquirer equity measured in 1996 dollars, whether the target and acquirer are in the same industry, and the takeover premium. The takeover premium is equal to the offer price minus the price 20 days before the takeover announcement date scaled by the target price two days after. All prices are from CRSP. Stock deal is equal to one if the consideration is in acquirer stock. Heteroskedasticity robust p-values are shown in parentheses.

	Offer completed (success = 1)		Target acquired (success = 1)	
	(1)	(2)	(3)	(4)
Acquirer attitude				
Hostile	−0.44	−0.38	−0.21	−0.20
	(0.00)	(0.00)	(0.00)	(0.00)
Other deal characteristics				
Target log market equity ($1996)		−0.04		−0.02
		(0.00)		(0.17)
Acquirer log market equity ($1996)		0.10		0.08
		(0.00)		(0.00)
Target and acquirer in same industry		−0.01		−0.02
		(0.60)		(0.35)
Takeover premium [p/P]		0.00		0.01
		(0.80)		(0.47)
Stock deal		0.03		0.00
		(0.12)		(0.97)
R^2	0.08	0.11	0.03	0.07
N	1,901	1,670	1,901	1,670

Third, the takeover premium is the difference between the target share price 20 days prior to the takeover announcement and the offer price scaled by the target share price two days after announcement. A higher premium may increase the odds of target shareholder approval. Fourth, stock is equal to one if the consideration is in acquirer shares. The means of payment may also influence the attractiveness of the deal. For example, Travlos (1987), Huang and Walkling (1987), and Eckbo and Langhor (1989) find the means of payment affect bidder and target announcement returns.[13] Target and acquirer firm size are statistically significant, but the four variables together increase the R^2 by less than 3%.

[13] Managerial ownership is another influence on takeover completion. For example, Mikkelson and Partch (1989) and Song and Walkling (1993) find that managerial ownership influences the probability of completion. Unfortunately, we do not have ownership data for our sample of target firms.

The second set of two columns uses a broader measure of success. The results are similar, though the explanatory power falls and only the acquirer attitude and acquirer size are statistically significant. Because acquirer firm size is not universally available, we use fitted values from the regression in the third column to measure the ex ante probability of a successful outcome in the main analyses.

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