Behavioral Factors in Risk Arbitrage*

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Abstract

In the context of takeovers, this paper examines the trading behavior of investors around a salient reference point, the 52-week high, and its effect on asset prices. Using a large sample of institutional trade-level data the paper documents a 50% increase in institutional investor exit at the announcement date for offer prices exceeding the 52-week high. The increased selling pressure leads to significant stock price underreaction and explains a large part of the returns in risk arbitrage. A risk arbitrage strategy exploiting the underreaction generates annual alphas of up to 11.9% with a sharpe ratio of 1.63 in the US and in a large sample of over 7000 international takeover transactions. Consistent with limits to arbitrage, the trading strategy's profits vary negatively with the available capital in the arbitrage sector. I rule out several alternative explanations for my results and finally, using trading costs estimated from institutional trade-level data and a parametric portfolio policy approach, the paper demonstrates the economic significance of the effect controlling for other behavioral and rational return predictors in risk arbitrage.

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Merger arbitrage strategies are investments in stocks of companies involved in a merger or acquisition (M&A). After the announcement of a takeover, the target stock usually trades at a discount to the price offered by the acquirer. A merger arbitrage strategy takes a long position in the target stock to eventually capture the spread between the current market price and the offer price in the event of deal completion. While the success probability of announced takeovers is very high, deals can and regularly do fail. Due to this deal completion risk, merger arbitrage is also known as risk arbitrage.[1]

Risk arbitrage is profitable. Mitchell and Pulvino (2001) as well as Baker and Savasoglu (2002) document significant risk-adjusted returns in risk arbitrage and postulate that the abnormal returns are compensation for providing liquidity to exiting shareholders. Assuming demand curves for stocks are not perfectly elastic, i.e. there are limits to arbitrage, selling pressure by target shareholders pushes prices below their fundamental value and generates a profitable trading opportunity for investors willing and able to provide liquidity. So far, the literature however lacks a full and satisfactory explanation for the liquidity demand of target shareholders after the takeover announcement.[2] Therefore, our understanding of the profitability of merger arbitrage is incomplete.

Drawing on the literature of psychological anchors (Tversky and Kahneman (1974)) and prospect theory (Kahneman and Tversky (1979)), Baker, Pan, and Wurgler (2012) provide significant empirical evidence for the importance of behavioral biases in the takeover market. In particular, they document a clustering of offer prices in takeovers around recent peak prices and they find a jump in the success probability of a takeover for offer prices only slightly

[1] In the rest of the paper the terms risk arbitrage and merger arbitrage are used interchangeably.

[2] Direct empirical evidence exploring the determinants of investor exit around takeover announcements is scarce. Using institutional trade-level data, Jegadeesh and Tang (2010) suggest that one important motive to trade, portfolio rebalancing, cannot explain the investor exit after takeover announcements.

exceeding the target stock's 52-week high.[3] Besides the aforementioned results, the work of Baker, Pan, and Wurgler (2012) also shows a promising direction to look for an explanation of merger arbitrage profitability.

The idea is the following: Investors prone to behavioral biases sell the target stock when the offer price is above the 52-week and their liquidity demand is absorbed by risk arbitrageurs. This, by the way, leads to a higher fraction of risk arbitrageurs in the shareholder base. As risk arbitrageurs are more likely to accept a takeover offer, their presence increases the success probability of a takeover (Cornelli and Li (2002), Hsieh and Walkling (2005)). Risk arbitrageurs are however also risk averse and have a limited amount of capital. Thus, to provide liquidity to the selling shareholders, they require a compensation even for idiosyncratic risk (Baker and Savasoglu (2002)). Drawing on this idea, a large portion of the abnormal returns in merger arbitrage should be concentrated in takeover deals with offer prices above the target stock's 52-week high.

Note that the results of Baker, Pan, and Wurgler (2012) do not imply this explanation for merger arbitrage profits. On the one hand, they do not examine the trading behavior of investors. This means that it is unclear whether offer prices above the 52-week high trigger any selling pressure. The higher deal success probability for offer prices above the target stock's 52-week high can also be consistent with channels different from the aforementioned one. On the other hand, their results could even predict the opposite. A higher success probability decreases the risk of a takeover deal and therefore, risk arbitrageurs require a lower compensation to absorb the shares of selling shareholders. Hence, it is an open empirical question whether the behavioral bias identified by Baker, Pan, and Wurgler (2012) also offers

[3]Although the authors stress that the 52-week is not the *magic* number and there are other peak prices with incremental importance in merger negotiations, they provide significant empirical evidence highlighting the role of this *specific* price level.

an explanation for the profitability of merger arbitrage.

This paper empirically tests this explanation. First, I ask whether offer prices above the 52-week high trigger selling pressure by investors. To do so, I use institutional trading data provided by Ancerno. Most behavioral effects are empirically examined using data on individual investor trading (for example Odean (1998)).[4] The rising amount of equity held by institutional investors makes an understanding of this group's trading behavior however increasingly important.

I find that institutional investors are selling on average 50% more of the target stock at the announcement date if the offer price exceeds the target stock's 52-week high. While slightly lower in magnitude, this effect also prevails in the days after the announcement day. The economic magnitude of the effect is even stronger when I use the more robust median. Using the median, institutional investor exit from the target for offer prices above the 52-week high exceeds institutional investor exit for offer prices below the 52-week high by more than 100% at the announcement date. The effect statistically and economically survives after controlling for the offer premium, the size of the target, acquirer characteristics, other deal characteristics and time fixed effects.

Second, I test whether offer prices exceeding the 52-week high predict higher returns in a sample of over 7000 takeover deals in the US and across 23 developed countries in the period from 1985 to 2012. At the beginning of each month I sort all takeover deals into three portfolio depending on the distance between the offer price and the target stock's 52 week high (**Δ52**). A trading strategy investing in takeover deals in the highest tercile generates annual abnormal returns of 7.4% in the period between 1985 and 2012. To the contrary, a trading strategy investing in takeover deals in the lowest tercile does not generate any

[4] One of the exceptions is Frazzini (2006)

abnormal returns. Thus, consistent with the proposed explanation, risk arbitrage profits are fully concentrated in takeovers with offer prices above the 52-week high.

I rule out several other explanations of my results. I find that my results survive when I use different asset pricing models to compute risk-adjusted returns. Furthermore, I show that other variables, correlated with $\Delta 52$, are not driving out the results. Specifically, neither the offer premium, an important predictor of risk arbitrage returns proposed by Baker and Savasoglu (2002), nor the disposition effect can explain my results.

Having established a robust unconditional relation between risk arbitrage returns and offer prices above the 52-week high, I study their conditional relation. In particular, I analyze whether the return predictive power of $\Delta 52$ varies systematically with the supply of arbitrage capital.

To proxy for the amount of available arbitrage capital, I build on the following idea: It is a well-known fact that mergers and acquisitions occur in cycles (see e.g. Shleifer and Vishny (2003)). If capital is slowly moving into and out of merger arbitrage funds, there will be an oversupply of arbitrage capital at times of low deal activity growth and an undersupply of arbitrage capital at times of high deal activity growth.[5] Using the growth in takeover activity as a proxy for the supply of arbitrage capital, I find the predictive power of $\Delta 52$ to be significantly higher at times when arbitrage capital is scarce.

I provide several additional results in the paper. First, I investigate the role of transaction costs. I compute risk arbitrage returns adjusted for costs arising through the bid-ask spread using the estimator of Corwin and Schultz (2012) and I estimate trading cost functions from trade level data following Keim and Madhavan (1997) and Moskowitz, Frazzini, and Israel

[5] Such a mechanism can be motivated for example with the work of Pastor and Stambaugh (2012). In their model investors slowly learn and update their beliefs about the returns from active management. Due to this slow updating of beliefs investor capital does not react sufficiently as a response to a changing investment opportunity set.

(2014). I find that trading costs for takeover targets are low and risk-arbitrage strategies based on $\Delta 52$ exhibit significant scalability.[6]

Second, I study the investment value of the variable $\Delta 52$ in a portfolio setting using the parametric portfolio policy approach proposed by Brandt, Santa-Clara, and Valkanov (2009). Brandt, Santa-Clara, and Valkanov (2009) estimate optimal portfolio weights as functions of asset characteristics. The approach of Brandt, Santa-Clara, and Valkanov (2009) allows me to evaluate the economic importance of the 52-week high from the perspective of a risk arbitrageur after controlling for several other return predictors in takeovers. Assuming an investor with constant relative risk aversion $\gamma = 4$ and imposing a no-short sale constraint, I estimate significant utility gains in- and out-of sample when the investor incorporates the difference between the offer price and the target stock 's 52-week high in his portfolio decision. Furthermore, other variables and transaction costs are not driving out the effect.

This paper contributes to the literature in several ways. First, it complements the results of Baker, Pan, and Wurgler (2012). One can argue the effect of the 52-week high on merger pricing and merger outcomes are mainly due to its impact on small investors where behavioral biases are more present. Indeed, Baker, Pan, and Wurgler (2012) provide evidence suggesting that in the more recent half of their sample, where the amount of equity held by institutional investors already increased significantly, offer prices seem to be somewhat less influenced by the 52-week high. My evidence however suggests that the 52-week high also affects institutional investors. Thus, the results of Baker, Pan, and Wurgler (2012) may not only be important in their sample period, but also going forward. Additionally, the paper provides results concerning the impact of offer prices exceeding the 52-week high on another

[6] They decrease by around 50% in the post-announcement period compared to the pre-announcement period

aspect of the takeover market, risk arbitrage profits. As pointed out earlier, the impact on risk arbitrage profits is ex ante not clear.

Second, the paper contributes to the growing literature documenting significant shifts in asset supply or demand around a stock's 52-week high. George and Hwang (2004) find that a stock's nearness to its 52-week high explains most of the returns to momentum investing and Heath, Huddart, and Lang (1999) find a doubling of employee option exercise when a stock exceeds its 52-week high. Two contemporaneous papers by Birru (2014) and George, Hwang, and Li (2014) study the relation between a stock's 52-week high and the earnings announcement drift. Both studies find a significant earnings announcement drift only for stocks trading near their 52-week highs and interpret this result as evidence for psychological anchoring.

Third, to the best of my knowledge this is the first paper to study returns in risk arbitrage using an international sample of takeovers. Most studies on risk arbitrage returns focus on the US market (e.g. Mitchell and Pulvino (2001), Baker and Savasoglu (2002)) or study another market in isolation. Most risk arbitrage funds however invest globally. Studying risk arbitrage using a global sample therefore provides better insights into the performance of this alternative investment strategy.

Fourth, the paper provides transaction cost estimates for trading takeover targets and analyzes the scalability of risk arbitrage strategies. In their seminal paper Mitchell and Pulvino (2001) use transaction cost estimates provided by Breen, Hodrick, and Korajczyk (2002). They note however, that trading costs can be different during merger situations. This paper empirically shows that the trading costs of merger stocks are indeed very different.

Fifth, the paper investigates the usefulness of the Brandt, Santa-Clara, and Valkanov

(2009) parametric portfolio policy approach for event-driven investment strategies.[7]

The remainder of this paper is structured as follows. Section 1 reviews theory which motivates the relation between a stock's 52-week high, trading decisions and asset prices. Section 2 describes the data sources, section 3 studies investors' trading behavior around takeover announcements, section 4 studies the impact of recent peak prices on risk arbitrage returns, section 5 provides additional results and section 6 concludes.

1 Background and Motivation

The 52-week high is a salient price level. It is mostly irrelevant, but highly visible as it is usually reported in the finance section of every major newspaper (for example the Wall Street Journal). Experimental evidence of Tversky and Kahneman (1974) suggests that such salient and often irrelevant information can have a major influence when individuals have to perform complex tasks like estimating a quantity. Specifically, according to Tversky and Kahneman (1974) individuals often anchor on salient information. In the case of stocks, investors may use as an initial estimate for the fair price the 52-week high and afterwards they incorporate other information into their estimate. The final estimate usually does not deviate too much from the initial value however. Hence, individuals seem to anchor on the initial value.

How does this impact the trading decisions of investors around a takeover announcement? Takeover announcements are good news for target shareholders and the stock price increase due to the takeover announcements usually grabs investor attention. According to Ben-David

[7]The Brandt, Santa-Clara, and Valkanov (2009) approach has already been applied in Plazzi, Torous, and Valkanov (2011) for real estate portfolios, in Ghysels, Plazzi, and Valkanov (2013) for international asset allocation and in Barroso and Santa-Clara (2013) for currency investments. The results of all these studies suggest that the Brandt, Santa-Clara, and Valkanov (2009) approach is robust, delivers good out of sample results and is often superior to traditional portfolio optimization methods despite potential model mis-specifications.

and Hirshleifer (2012) this can lead many investors to re-examine their positions and trade depending on their beliefs concerning the stock. An offer price significantly exceeding the 52-week high pushes the market price of the stock above the 52-week high and when investors anchor on the 52-week high, they may sell their positions in the target stock as (1) they believe the investment has run its course, (2) they do not expect high returns going forward as the offered price is already above the estimated fair value and hence, higher offers are unlikely.

A different explanation for observing increased liquidity demand around the 52-week high is based not on beliefs, but on values. Prospect theory proposed by Kahneman and Tversky (1979) provides an alternative theory of decision making under risk to the standard expected utility theory. Importantly, prospect theory assumes individuals evaluate outcomes relative to a reference point, they have a greater aversion to losses than they appreciate gains and their sensitivity to changes in an outcome decreases the further away the outcome moves away from the reference point. These assumptions imply a utility function which is concave in the region of gains and convex in the region of losses. The reference point in prospect theory is not well defined and can be the status quo, an expectation or an aspirational level. In finance, empirical evidence (Heath, Huddart, and Lang (1999)) as well as experimental evidence (Gneezy (2005)) however suggests a stock's 52-week high is one important reference point. Thus, when the stock price moves above the 52-week high investors are pushed into the concave region of their utility function, which increases their risk aversion and their propensity to sell.

Finally, recent work by Barberis and Xiong (2012) provide a third motivation for observing an increased liquidity demand for offer prices exceeding the 52-week high. Barberis and Xiong (2009) examine theoretically the ability of prospect theory to predict the disposition effect (see Shefrin and Statman (1985)) and raise doubts. Empirically, individual stock returns are positively skewed whereas market returns are negatively skewed (see e.g. Hong and Stein (2001)). In particular with a positively skewed return distribution, prospect theory, according to Barberis and Xiong (2009), often predicts the opposite of a disposition effect. In Barberis and Xiong (2012) the authors therefore propose a new theory based on the realization utility hypothesis. According to this hypothesis made by Shefrin and Statman (1985) investors experience a direct utility (disutility) from realizing gains (losses). Assuming a sufficiently high discount rate, investors with realization utility preferences exhibit a disposition effect. Furthermore, the model of Barberis and Xiong (2012) predicts increased selling intensity around a stock's 52-week high.

2 Data

2.1 Data on Mergers and Acquisitions

I use data on mergers and acquisitions from the Thomson SDC database between 1985 and 2012. The SDC database covers mergers and acquisitions around the world. In this paper I restrict the sample to a set of 23 developed countries. Specifically, I use data from the US, Canada, Australia, New Zealand, Hong Kong, Singapore, Japan, Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.

For my final sample I apply the following filters to the dataset:

- In the US I only keep deals where I am able match the cusip of the target provided by SDC with the CRSP daily tapes. For all other countries I require a valid match between a target's cusip (Canada), sedol (rest of the world) or name with the Compustat Global Security Daily files. For equity financed deals I furthermore require a valid match between the acquirer's cusip, sedol or name and CRSP or Compustat.

- A deal has to be pure cash or pure stock financed. For stock financed deals I require a valid exchange ratio from SDC. In case of missing exchange ratios I checked manually whether the exchange ratio is stated in the SDC deal synopsis.

- Although I checked the match between SDC and the different databases manually, there are some unreasonable matches. Several deals report negative bid premia, initial arbitrage spreads of more than 100% or smaller than -20%. I delete these observations from the sample.

- Merger Arbitrage is a mid to small cap strategy. I delete however deals with a value of less than USD 10 million to guarantee that my results are not contaminated by extremely illiquid securities.

After applying the aforementioned filters I have a sample of 7740 takeover transactions. With 4888 transactions most of the deals in my sample take place in the US. This is however mainly due to the overrepresentation of US deals in the early part of the sample. Takeover transactions outside of the United States became increasingly important in the more recent period. The top graph of Figure 1 shows the number of deals and the bottom graph of Figure 1 the volume of deals for the US sample and the international sample excluding the US. Until 2005 over 50% of all deals as well as 50% of all deal volume occurred inside the United States. Afterwards the number and volume of takeover transactions outside the US outpaced deal volume inside the US.

The impact of the financial crisis on the takeover market is clearly visible in Figure 1. The total value of announced takeover deals was around USD 700 billion in 2007 and dropped to USD 100 billion in 2009. The deterioration in credit market conditions increased the financing costs of acquisitions and the macroeconomic uncertainty led many companies to postpone larger investments like acquisitions. The minimum of takeover volume in my whole sample occurred in 1991 with a volume of just USD 11 billion when the takeover market had to recover from the junk bond financed merger wave of the late 1980s. The maximum of takeover volume is in 2007 with USD 710 billion. In terms of number of deals the minimum is in 1991 and the maximum in 1999.

Table 1 shows summary statistics for the total sample of takeover deals as well as for takeover deals inside and outside of the United States. The first row of Table 1 shows the offer premium computed as $(OP-P)/P$, where OP is the offer price and P the stock price 20 days prior to the announcement date. The average takeover premium is 39.5% and a comparison between Panel B and Panel C suggests a slightly higher premium paid for US companies compared to companies outside of the US. The second row of Table 1 presents the difference between the offer price and the 52-week high of the target company's stock scaled by the 52-week high. The 52-week high is thereby computed as the highest stock price of the target from 385 days before the announcement until 20 days before the announcement. On average acquirers pay a premium 2.5% above the 52-week high of the stock. This result is in line with the work of Baker, Pan, and Wurgler (2012) showing a clustering of offer prices slightly above the 52-week high. Also when the 52-week high is used as a reference point to determine the offer premium, prices paid to US target shareholders seem to be more favorable compared to other countries. Shareholder protection in the US is in general better compared to other countries, which can be an explanation for the differences in premiums paid to target shareholders.

Most of the other deal characteristics do not show interesting differences between the US and other countries. Around 13% of deals are leveraged buy-outs, 6% of the deals are hostile, 20% of the deals are financed with stock and for 40% of the deals the acquirer is private. The only deal characteristic being significantly different between the US and international markets is the number of tender offers. In the US only 32% of takeover deals are classified as tender offer whereas 66.7% of the deals outside of the US are tender offers. Compared to a merger or acquisition agreement target shareholders are approached directly by the acquirer in a tender offer. A tender offer has the advantage of a higher speed of execution and a higher chance of shareholder approval. Therefore it should be the preferred form for an acquisition bid. A reason for the lower share of tender offers in the US compared to other countries can be the "Best Price Rule". In order to curb the practice of greemailing during the hostile takeover wave of the 1980s the Securities and Exchange Commision (SEC) introduced the "Best Price Rule". This rule forces an acquirer to pay the same price per share for every shareholder including the management of the company. Crucially, this also included employment compensation, severance or other employee benefit arrangements of security holders of the target. Due to these strict requirements tender offers became less attractive for bidders beginning in 1986. In 2006 the "Best Price Rule" was amended to exempt the aforementioned items which led to a significant increase in the number of tender offers afterwards.

2.2 Institutional Trading Data

I obtain institutional trading data from Ancerno, a trading cost consultant. The sample period of the Ancerno data spans the period from January 1999 to December 2010 and the analysis focuses on data for the U.S. equity market. As a stock identifier Ancerno provides a cusip which allows me to match the institutional trading data to my sample of takeovers from SDC. I am able to match 1601 takeover transactions and Table 2 provides summary statistics for this subsample of transactions.

A visual inspection suggests that the distribution of deal characteristics is very similar to the broader sample reported in Table 1 Panel 3. With an average market capitalization of USD 990 million targets in the sample matched with Ancerno are however larger than targets in the broader sample (average market capitalizaion USD 723 million). As the average target size grows over time the larger target size is due to the shorter time period of the matched sample. Another explanation is the preference of institutional investors for larger stocks reported by for example Gompers and Metrick (2001).

The Ancerno database is used by several recent academic studies including Puckett and Yan (2010), Franzoni and Plazzi (2012) and Jegadeesh and Tang (2010). Ancerno receives data either from pension funds or directly from money managers. The institution sending the data is identified with the clientcode, but Ancerno also provides a managercode identifying the institution managing the assets. Following prior literature this paper focuses on the institution managing the assets and I define a daily trade as the aggregation of all executions in the same stock, at the same side and at the same date by one manager. For every trade Ancerno provides several variables besides the already mentioned ones including the execution price and the commisions paid.

Panels B to D provide summary statistics for the trading of institutional investors in takeover targets during the period from -200 days before the announcement until the completion or the withdrawal of the takeover. Takeover deals are kept in the sample until a maximum of 200 days after the announcement. The different panels present statistics separately for the full sample, the pre-announcement and post-announcement period. My full sample includes a total of 728 different managers. For a single deal, on average 16 to 25 of them are trading the target stock and the average trade size is between USD 1 million and USD 1.4 million. The distribution of the dollar trade volume is however highly skewed with the median dollar trade being between USD 68000 and USD 93000.

Besides the amount of institutional trading another interest of this paper are also the trading costs of institutional investors before and during the takeover deal. Trading costs can be split into two parts. The first part are the commisions paid for the execution of the trade. Panels B to D suggest that average commisions are equal to 10 basis points of the stock price and median commisions are around 5 basis points. The second part are price impact costs. Similar to Anand, Irvine, Puckett, and Venkataraman (2013), I use the execution shortfall to measure price impact costs. Execution shortfall is defined as

$$ES(t) = \frac{P_l(t) - P_0(t)}{P_0(t)} D(t),$$

where $P_l(t)$ is the volume-weighted execution price, $P_0(t)$ is last day's closing price of the stock and $D(t)$ is a categorical variable equal to 1 for buy trades and equal to -1 for sell trades. Anand, Irvine, Puckett, and Venkataraman (2013) use the opening price of the stock as a pre-trade benchmark. The difference between using the last day's closing price and the opening price are however negligible. Panels B to D of Table 2 suggest institutional investors' price impact costs are around 4 basis point before the announcement, 2 basis points after the announcement and around 3 basis points for the full sample.

3 Institutional Exit and the 52-Week High

This section examines the trading behavior of institutional investors around takeover announcements and tests whether offer prices exceeding the 52-week high lead to an excessive liquidity demand from institutional investors. Following Jegadeesh and Tang (2010) I study the net trading volume of institutional investors defined as the dollar volume bought minus dollar volume sold divided by the market capitalization of the stock.

Figure 2 plots the net trading volume of institutional investors from -10 days to +10 days around the takeover announcement for offer price below and above the 52 week high. In order to ensure that the results are not driven by outliers the top graph of Figure 2 shows the average net trading volume and the bottom graph shows the more robust median. Figure 2 does not exhibit a particular trading pattern in the pre-announcement period. The mean net trading volume seems to be slightly negative and the median is close to zero for both sub-groups. After the announcement institutional investors sell large amounts of their holdings in the target stock in particular when the offer price is above the 52-week high. At the announcement date institutional investors sell around 0.6% of the target company for offer prices above the 52-week and 0.4% for offer prices below the 52-week high. Thus, offer prices exceeding the target stock's 52-week high increase the trade imbalance by 50%. The median shown in the bottom graph draws an even clearer picture with institutional investors selling 2.4 times more when the offer price exceeds the 52-week high. The difference in the trade imbalance among these two sub-groups does not vanish after the announcement date. Indeed, institutional investors sell more given the offer price is above the chosen reference point on every day after the announcement date.

The univariate results are in line with the hypothesis that offer prices above the target stock's 52-week high lead to an excessive liquidity demand. To test whether the effect is significant after controlling for other drivers of the trading behavior of institutional investors after and at the announcement I use multivariate regressions in Table 3. The dependent variable in the regressions is the cumulated net trading volume between the announcement date and the 10th day after the announcement. In column 1 a dummy equal to one for offer prices above the 52-week high is used as an independent variable. For offer prices above the 52-week high institutional investors sell 0.8% more of the target company at the announcement date and in the first 10 trading days after the announcement. In column 3 I use the difference between the offer price and the 52-week high. The results suggest an increase of institutional selling of 0.1% for an increase of the offer price of 10% compared to the 52 week high. Columns 5 and 7 of Table 3 repeat the results including time fixed effects without a significant change in the results.

Jegadeesh and Tang (2010) find a number of other deal characteristics correlated with the magnitude of institutional selling after the announcement date. First, I include the offer premium measured as the difference between the offer price and the stock price 20 days before the takeover announcement. Baker and Savasoglu (2002) use the offer premium as a measure of the downside risk of a takeover deal.[8] If investors care about downside risk and measure the downside relative to the stock price 20 days before the announcement date, they will sell more target stocks depending on the size of the offer premium. Column 2 of Table 3 however does not show a significant effect of the offer premium on net trading volume of institutional investors.

A positive and significant effect has the stockdeal dummy. Jegadeesh and Tang (2010)

[8]Baker and Savasoglu (2002)ăactually compute the offer premium as the difference between the target stock price 2 days after the announcement and 20 days before the announcement. Merger arbitrage spreads are usually very small however. Therefore, using the difference between the price offered by the acquirer and the target stock price 20 days before the announcement, does not make any difference.

suggest that some funds are considering the acquirers as attractive investment. Therefore, the funds hold on to their target stocks which are eventually converted into acquirer stocks. Another interpretation of this result are tax considerations. If an institutional investor invested in the target stock less than 12 month before the announcement, he would decrease his capital gains taxes by staying invested in the target stock until his investment is only taxed with the lower long-term capital gains tax. This can even imply an eventual exchange of target stock into acquirer stock. Of course, this argument applies mainly to institutional investors having bought the target stock in the recent past, i.e. between 1 and 6 months before the announcement. The average takeover deals closes after 100 days or around 5 month. Hence, for an investor having bought the target stock 10 month before the announcement it is advantageous from a tax view not to sell immediately even in a cash deal.

In line with Jegadeesh and Tang (2010) the size of the takeover deal negatively impacts institutional trading around the takeover announcement. Column 2 of Table 3 does not include time fixed effects. Column 4 of Table 3 however does and after controlling for time fixed effects the tender offer dummy has a negative and significant impact on the amount of institutional trading. As already mentioned earlier due to less regulatory burdens tender offers are executed at a faster speed compared to other deal structures. Furthermore, as a consequence of the faster execution, competing offers are less likely. Institutional investors may therefore expect low expected returns going forward and exit their investments in the target stocks.

The final three deal characteristics included in the regressions of table 3 are a dummy for hostile bids, a dummy for private acquirers and a dummy for leveraged buyouts. The leveraged buyout dummy and the hostile dummy are insignificant. The private acquirer dummy however is highly significant. Thus, institutional investors appear to be reluctant to exit the target stock conditional on the acquirer being private. Bargeron, Schlingemann, Stulz, and Zutter (2008) find that private acquirers pay significantly lower premiums compared to public acquirers. If target shareholders expect a competing offer due to the low premium offered by a private acquirer, they may hold on to their investment in the target stock.

4 The 52-Week High and Risk Arbitrage Returns

4.1 Baseline Results

Using portfolio sorts this section examines whether the increased price pressure for offer prices above the 52-week high predicts high future abnormal returns due to a limited number of risk averse arbitrageurs. Every month I sort takeover deals according to the distance between the offer price and the 52-week high into three portfolios and track the portfolios' performance over time.

For the return computation of each individual deal I follow Mitchell and Pulvino (2001). The daily return in USD on cash deal i at time t is the target return reported in CRSP or Compustat Global $r_{it} = r_{Tit}$. For a stock deal the return computation is more complicated as it includes a short position in the acquirer stock. The merger arbitrage return in a stock transaction is given by $r_{it} = r_{Tit} - \delta(r_{Ait} - r_{ft})\frac{P_{Ait-1}}{P_{Tit-1}}$, where δ is the exchange ratio, r_{Tit} the target stock return, r_{Ait} the acquirer stock return, r_{ft} is the risk free rate, P_{Ait-1} and P_{Tit-1} are the acquirer stock price and the target stock price. I assume that the risk arbitrageur is earning the risk free rate as a short rebate. Afterwards monthly returns are computed by compounding daily returns for every transaction. In the portfolio analysis I define a deal as investable if it was announced before the beginning of the month. In case a deal is not active for the whole month, i.e. the deal closes before the end of the month, I use the risk-free rate for the non-active days of the month. [9]

Finally, I have to compute the performance of the portfolio of all transactions. Mitchell and Pulvino (2001) and Baker and Savasoglu (2002) report portfolio returns for a value-weighted or equal weighted portfolio of risk arbitrage situations.[10] Equal-weighting the returns leads to well-diversified portfolios with high-weights on small and less liquid deals. Value-weighting the returns leads to a tilt towards larger and more liquid deals. The resulting portfolios are however not well diversified. In my sample the largest transaction often has a weight of more than 40%. In order to have well-diversified portfolios tilted towards larger deals I construct rank-weighted portfolios. For the rank-weighted portfolios the weight of deal i at time t is

$$w_{i,t} = \frac{rank(size_{i,t})}{\sum_{i=1}^{N} rank(size_{i,t})}.$$

Using these weights I compute every month the rank weighted return of all active takeover deals.

Panel A of Table 4 shows risk-adjusted returns (alpha) for rank-weighted portfolios using the US sample of risk arbitrage situations. For the risk-adjustment I use the three Fama and French (1993) factors and the Carhart (1997) momentum factor. Using the four factor model the portfolio in the lowest tercile and the middle tercile have insignificant alphas of 0.05% and 0.14% monthly. The highest tercile to the contrary generates an alpha of 0.58% monthly. With a monthly alpha of 0.53%, a long-short portfolio going long the highest tercile and short

[9] Mitchell and Pulvino (2001) assume a zero return for non-active days. Following this rule does not change the results of my analysis

[10] Mitchell and Pulvino (2001) also report results imposing a diversification constraint where the maximum weight of a deal is restricted to 10%.

the lowest tercile provides economically significant risk-adjusted returns. With a t-statistic of 2.85 the long-short portfolio is also statistically significant. I interpret these results as evidence for stock price underreaction as a consequence of the selling pressure documented in the previous section.

Panel B of Table 4 shows portfolio returns for the international sample and Panel C for an international sample excluding the United States. Enlarging the sample decreases idiosyncratic noise in the portfolios and increases the statistical power of the tests. Thus, while the economic magnitude of the return spread between the high and low portfolio stays nearly the same in Panel B, the statistical significance increases. Panel C of Table 4 suggests that the results also hold outside of the United States. The small number of deals before 1999 does not allow the construction of diversified portfolios. Panel C therefore focuses on the period after 1998. Despite differences in the time period the results inside and outside of the United States look very similar.

The results in Table 4 are conservative estimates. First, there is only an investment in a takeover transaction when the transaction was announced before the beginning of the month. Price pressure is particularly strong in the first days following the announcement. An extended lag between the announcement of the deal and the investment into the deal can therefore mean that returns due to a decreasing spread are missed out. Second, the hypothetical portfolios have often large cash holdings. I assume deals becoming inactive during the month earn the risk-free rate for the rest of the month, i.e. the proceeds of for example a closing of a deal are invested in a cash-like asset. Around 20% of all deals become inactive each month. The large cash holdings can understate the returns for an investor rebalancing his portfolio in a more timely manner. Column 1 to 4 of Table 5 therefore show results using a different methodology to aggregate returns. Specifically, I follow Baker and Savasoglu (2002) and aggregate first the returns across all deals at the daily level level and then aggregate the resulting portfolio return on the monthly level. The results are qualitatively similar to the results reported in Table 4 Panel B, but economically and statistically stronger. Additionally columns 5 to 8 also reports portfolio returns using value-weights instead of the rank weights. The results remain economically the same, but the statistical significance decreases which I attribute to the aforementioned decreased diversification of the portfolios.

4.2 The Role of Risk

In the previous section I assume the Carhart (1997) four factor model to be the correct asset pricing model. While the Carhart (1997) four factor model is one of the most used asset pricing models in the academic literature, the more recent literature finds a host of other factors explaining the time-series and cross-sectional behavior of asset returns. In particular since the most recent financial crisis beginning in 2008 asset pricing models taking into account systematic exposure to market liquidity risk, funding liquidity risk, tail risk and downside risk gained popularity.

On theoretical grounds systematic market liquidity risk seems to be a well motivated factor to explain the returns of risk-arbitrage investments. Investors require a risk premium for assets whose liquidity comoves positively with market wide liquidity. In the model of Brunnermeier and Pedersen (2009) exposure to liquidity risk can in particular occur in the presence of many leveraged investors. In their model funding liquidity shocks due to sudden investor redemptions or changes in margin constraints can lead to a sudden decrease in market liquidity when leveraged investors have to liquidate their positions in a very short period time. The main investors in the risk arbitrage market are proprietary desks of investment banks and hedge funds. Hence, according to the theory of Brunnermeier and Pedersen (2009) there should be a strong link between market and funding liquidity in the risk arbitrage market and the systematic liquidity risk should explain parts of the returns in this market.

In column 1 of Table 6 I add the funding liquidity risk factor of Adrian, Etula, and Muir (2012). Adrian, Etula, and Muir (2012) propose an asset pricing model where expected returns depend on an asset's covariance with shocks to the leverage of financial intermediaries. The authors argue that as leveraged financial intermediaries are most of the time the marginal investors in financial markets asset prices are closely tied to their marginal value of wealth. The marginal value of wealth of a financial intermediary on the other hand depends on its funding capacity. Hence, the authors propose a stochastic discount factor, which is linear in the leverage of financial intermediaries and demonstrate empirically its strong pricing ability in the cross-section of asset return. Furthermore, to allow time-series tests the authors construct a leverage mimicking portfolio (LMP). I add the LMP as an additional factor to test its explanatory power for the spread portfolio. The results reported in column 1 of Table 6 suggest that the LMP factor is not able to explain the return spread. The same holds when I use a market liquidity risk factor instead of a funding liquidity risk factor. In columns 2 I add the traded liquidity risk factor of Pastor and Stambaugh (2003) to the Fama and French (1993) three factors and the Carhart (1997) momentum factor. The results in Table 6 suggest that there is only a weak link between market liquidity risk and the spread portfolio.

I use a global sample of risk arbitrage situations, but use a local asset pricing model. In column 3 of Table 6 I use global versions of the Fama and French (1993) and the Carhart (1997) factors. [11] The results using the global factors span a shorter time period as they are only available from 1990. At least for this shorter time period using the global factor model

[11] The global factors are provided on Kenneth French's homepage `http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html`.

does not influence the results significantly.

A key insight of the seminal work by Mitchell and Pulvino (2001) is the non linear risk exposure of risk arbitrage returns. Specifically, Mitchell and Pulvino (2001) find risk arbitrage returns to have high systematic risk exposure in down markets and a low systematic risk exposure in up markets. To account for the non linear risk exposure I follow Mitchell and Pulvino (2001) and run CAPM regressions separately for months with market returns below -4% and above -4%. The results reported in columns 4 and 5 of Table 6 suggest the return spread is stronger during down markets. This is economically intuitive. During down markets there is price pressure due to the de-leveraging of market participants (see e.g. Mitchell and Pulvino (2012)). In deals with offer prices above the 52-week high, this price pressure will be stronger as more (leveraged) arbitrageurs are invested in these deals. Although the alphas in down markets are economically larger, they are statistically insignificant. One explanation for the low statistical significance could be the small sample size.

4.3 Alternative Explanations

In this section I explore whether other variables, correlated with $\Delta 52$, can explain the predictive power of $\Delta 52$ in the cross-section of risk arbitrage returns.

First, I study whether my results survive after controlling for the offer premium. The offer premium and $\Delta 52$ have a correlation of 0.33, i.e. takeovers with a high value of $\Delta 52$ also have a high offer premium.[12] In the model of Baker and Savasoglu (2002) the offer premium is a key determinant of the excess returns in risk arbitrage. A higher offer premium implies a higher loss given default for an arbitrageur and hence, a higher required risk compensation

[12] The 52-week high is computed as the highest stock price of the target from 385 days before the announcement until 20 days before the announcement. Hence, the offer premium is always higher or equal to $\Delta 52$

due to an increase in idiosyncratic risk.[13]

Second, I study whether my results survive when I control for the disposition effect. The disposition effect describes the tendency of investors to sell winners and hold on to losers (Shefrin and Statman (1985)). In the model of Grinblatt and Han (2005), the disposition effect leads to stock price underreaction for winner stocks and stock price overreaction for loser stocks. A takeover announcement is usually good news for investors due to the control premium paid by the acquirer. This holds in particular when the offer price is above the 52-week high as at least all shareholders having acquired the stock in the previous 52-weeks made a positive profit on their investment. Hence, some target shareholder may have a higher propensity to sell their target stocks due to the disposition effect, which could explain my results.

I use cross-sectional regressions of event time returns on $\Delta 52$, the offer premium and a proxy for the disposition effect to test whether the effect of $\Delta 52$ survives. The event time return is defined as the cumulative return in excess of the risk free rate from two days after the announcement until 32 days after the announcement. The 30-day event window ensures that most takeover deals have returns over the full event window (see Baker and Savasoglu (2002)).

Table 7 presents the results. In column 1 I only include $\Delta 52$ and consistent with the results from the portfolio sorts, the coefficient is positive and statistically significant. In the regressions I use standardized variables. Hence, the coefficient suggests that a one standard deviation increase in $\Delta 52$ leads to 1% higher event time returns.

I column 2 of Table 7 I run the regression using only the offer premium. In line with

[13] As pointed out earlier, Baker and Savasoglu (2002) compute the offer premium as the difference between the target stock price 2 days after the announcement and 20 days before the announcement. Merger arbitrage spreads are usually very small however. Therefore, using the difference between the price offered by the acquirer and the target stock price 20 days before the announcement, does not make any difference.

Baker and Savasoglu (2002), the offer premium positively predicts risk arbitrage returns. A one standard deviation increase in the offer premium leads to 1.23% higher event time returns. In unreported results I also repeated the portfolio sorts from the previous section replacing $\Delta 52$ with the offer premium. Interestingly, after controlling for systematic risk exposures takeovers with a higher offer premium do not have higher expected returns than takeovers with a low offer premium.

To study the role of the disposition effect, I use the capital gains overhang measure CG of Grinblatt and Han (2005). The capital gains overhang (CG) is computed as $CG = (P_t - R_t)/R_t$. P_t is the closing price at the announcement day and R_t is the market's cost basis defined as

$$R_t = \sum_{n=1}^{\infty} \left(V_{t-n} \prod_{\tau=1}^{n-1} [1 - V_{t-n+\tau}] \right) P_{t-n},$$

where V_t is the weekly turnover in a stock at date t and P_t is the stock price. To compute this quantity Grinblatt and Han (2005) use weekly data. As it is not feasible to use an infinite sum in the estimation, the authors use as an estimation window a maximum of five years. Column 3 of Table 7 finds that the capital gains overhang does not have any explanatory power for risk arbitrage returns.

Finally, in columns 4 and 5 I study all the three variables together and include other control variables. Columns 4 and 5 find that the effect of $\Delta 52$ stays economically as well as statistically significant after controlling for other variables. Besides the offer premium and the capital gains overhang, I also include the deal attitude (hostile) and the target's market capitalization in the regressions. I include the deal attitude and the target's market capitalization to control for the findings of Baker and Savasoglu (2002) that risk arbitrage returns are increasing in completion risk and the target's size.[14]

Overall, the findings from this section suggest that other explanations are not able to explain my results.

4.4 The Role of Arbitrage Capital

Having established a robust unconditional relation between risk arbitrage returns and offer prices above the 52-week high, I study their conditional relation. In particular, I analyze whether the return predictive power of $\Delta 52$ varies systematically with the risk-bearing capacity of the arbitrage sector.

To proxy for the amount of available arbitrage capital, I build on the following idea. It is a well-known fact that mergers and acquisitions occur in cycles (see e.g. Shleifer and Vishny (2003)). Figure 1 suggests that in the sample used in this paper there were three waves of M&A activity. There was a merger wave in the 1980s peaking around 1988. The second merger wave occurred at the end of the 1990s and the third merger wave peaked in 2007. If capital is slowly moving into and out of merger arbitrage funds, there will be an oversupply of arbitrage capital in times of low deal activity growth and an undersupply of arbitrage capital in times of high deal activity growth. Such a mechanism can be motivated for example with the work of Pastor and Stambaugh (2012). In their model investors slowly learn and update their beliefs about the returns from active management. Due to this slow updating of beliefs investor capital potentially does not react sufficiently as a response to a changing investment opportunity set.

Drawing on this idea, I hypothesize that at periods when deal activity significantly grows,

[14]Baker and Savasoglu (2002) use as a control for completion risk a transformation of the estimated deal success probability. The deal attitude is the most important predictor of deal success however. Hence, I use for simplicity only this variable as a proxy for completion risk. Using more complicated proxies for completion risk does not change my results.

there is insufficient arbitrage capital to absorb the liquidity demand in takeover deals with offer prices near the target stock's 52-week high. The insufficient amount of arbitrage capital during such times may drive the aforementioned return difference between takeover deals sorted according to $\Delta 52$.

To test this explanation I divide the sample period into states of high deal activity growth, medium deal activity growth and low deal activity growth. The different states are thereby defined in the following way: I compute the percentage deviation of deal volume in USD at the beginning of the month from the average deal volume in the preceding 12 month. I then divide the sample into the three states according to the values of this variable. Table 8 presents the results of the portfolio sorts from section 4.1. separately for states of high deal activity growth and states of low deal activity growth. The lowest tercile portfolio neither generates abnormal returns at times of high deal activity growth nor at times of low deal activity growth. For the highest tercile the results are however significantly different in the two different states. At times of high deal activity growth the portfolio in the highest tercile generate an annual alpha of 10.4% whereas its annual alpha is only 4% at times of low deal activity growth. Hence, slow movement of arbitrage capital across the M&A cycle offers a potential explanation for the persistence of the results documented in the previous sections.

5 Additional Results

5.1 Transaction costs

This section asks whether the abnormal returns in risk arbitrage documented in the previous section are robust to trading costs. As a first measure I use the Corwin and Schultz (2012) spread estimator based on daily high and low prices.[15] This estimator is particularly useful in my sample as in the earlier years bid-ask spreads are often missing especially for stocks outside of the U.S..

As a second measure of transaction costs and I estimate transaction costs using Ancerno trade-level data. Besides paying a spread, investors face price impact costs and direct transaction costs like commissions. Price impact costs have a significant effect on the scalability of investment strategies and are one of the main explanations for the negative relationship between fund size and fund performance in the active management industry.

Keim and Madhavan (1997) argue implicit costs like price impact and explicit costs like commissions are not independent from each other. Using the total costs, i.e. the sum of implicit and explicit costs, therefore provides a better estimate of the costs incurred by an investor. As a measure of explicit trading costs I use the trading commissions reported in Ancerno. For the implicit costs I use execution shortfall described in section 2. To get a first impression for the trading costs in takeover deals Figure 4 plots the median transaction costs for different trade complexity groups. I define trade complexity as the size of the trade compared to the average daily trading volume during the last 20 days. Mitchell and Pulvino (2001) conjecture that the trading costs during the takeover deal can be different. Therefore, figure 4 plots the trading costs for the takeover targets before and after the announcement. [16] Figure 4 suggests that indeed the trading costs are different. Specifically, trading for example 10% of average daily trading volume costs 20 basis points in the pre-announcement period and only 10 basis points in the post announcement period which suggests a significant decrease in trading costs during the post-announcement period.

[15] The estimator is described in more detail in the Appendix.

[16] The post-announcement period is defined as the period from 2 days after the announcement until deal completion. The pre-announcement period is defined as the period from 200 days before the announcement until 2 days before the announcement

To examine trading costs in more depth, I study trading costs using pooled regressions following Keim and Madhavan (1997). I estimate trading cost functions in three different specifications. The first specification only uses the trade complexity as an independent variable defined as the dollar value of the trade divided by the average daily trading volume during the last 20 days. In the second specification I allow the trade complexity to have a different price impact for buy and sell trades. Finally, in the third specification I use the second specification and add a company's market capitalization as well as a trend variable to control for the declining transaction costs over time. Compared to my analysis in section 3 I use in this section disaggregated data which is significantly more noisy. In order to prevent outliers from driving my results I winsorize the data at the 5% level.

Table 9 shows results separately for targets and acquirers, before and after the acquisition announcement. The after announcement period begins at the second day after announcement to estimate the trading costs.[17] The first column suggests trading 1% of average daily trading volume of a target stock has a price impact of 0.472 basis points and additional costs of 5.542 basis points in the form of spread costs and direct costs. This is a decrease of more than 50% compared to the trading costs in the pre-announcement period shown in Panel A column 4 of Table 9. Panel A column 2 of table 9 suggests there is a small asymmetry in the price impact of buy trades and sell trades, with buy trades being less expensive than sell trades. Finally, in line with Keim and Madhavan (1997) trading costs are decreasing in the size of the stock and trading costs are decreasing over time.

Overall, takeover stocks seem to be very liquid. In the model of Kyle (1985) the price impact of a trade depends on the uncertainty concerning the value of an asset as well as on the order flow by uninformed investors. On the one hand, I documented significant amounts

[17]The announcement day and the first day after the announcement are excluded from all the estimations

of uninformed selling due to behavioral effects in section 3. On the other hand, the results of Barber and Odean (2008) suggest uninformed buying by investors is increasing when a stock receives a lot of attention in the news or have extreme one day returns. Both of these effects are potential explanations for the significant decrease in trading costs after the takeover announcement.

While it is cheaper to trade takeover stocks in the post-announcement period compared to the pre-announcement period, it becomes more expensive to trade the shares of stock acquirers. Increasing uncertainty concerning the value of the acquirer stock is one explanation for this rise in the trading costs with negative performance consequences for a risk arbitrage strategy as the acquirer stock has to be shorted in a stock deal.

Using the two measures of transaction costs I adjust portfolio returns in order to understand whether the reference price effect is a valuable signal for an arbitrageur after accounting for transaction costs. In practice, except for the short positions in stock acquirers to hedge market risk, risk-arbitrage is a long-only strategy. Thus, to present results from the viewpoint of a risk-arbitrageur I compare after-cost returns for a strategy investing only in takeover deals in the highest tercile of $\Delta 52$ and a strategy investing in a rank-weighted portfolio of all takeover transactions. As a benchmark Panel A of Table 10 presents again results assuming no transaction costs. Panel B of Table 8 shows results using the Corwin and Schultz (2012) spread estimator. Accounting for the bid-ask spread decreases average returns as well as alphas by around 1.5% annually for both strategies. Hence, focusing only on the top tercile transactions does not lead to a significant increase in transaction costs which suggests that deals with offer prices near or above the target stock's 52-week high are not less liquid.

In Panels C to G of Table 10 I use the trading cost functions reported in column 3 of Table 9 to simulate the performance of the risk arbitrage portfolios accounting for the price impact of trades. I make three assumptions when simulating the portfolios. First, I assume a cost conscious investor not willing to pay trading costs exceeding 100 basis points. Second, I assume the investor does not want to become a major blockholder. Therefore, I restrict the position size to a maximum of 5% of the outstanding shares of the target company. In times of low deal activity or times with a large number of small transactions these assumptions lead to an increasing fraction of capital invested in cash. I assume the cash account is earning the risk-free rate. Third, I assume the trading cost function estimated for the U.S. is representative for the other countries in my sample. The difference between Panels C to G of Table 10 are the initial portfolio sizes. All the portfolios are simulated for the period from 1985 to 2012, but the initial portfolio size varies from USD 1 million to USD 500 million.

With an initial portfolio size of USD 1 million the transaction costs using the trading costs from Ancerno are lower than the bid-ask spread. According to column 4 of Table 10 the average monthly trading costs are between 11.13 and 12.31 basis point using Corwin and Schultz (2012) estimate whereas they are only between 4.56 and 7.29 basis point using the estimates from Ancerno. This is surprising as the second measure of transaction costs even includes commissions whereas we ignore them in the first measure. Apparently, institutional investors are mostly trading inside the bid-ask spread and thus face significantly lower transaction costs.

With an increasing initial portfolio size monthly transaction costs rise to more than 10 basis points and the average fraction of capital invested in takeover deals decreases significantly. For an initial portfolio size of USD 500 million the average fraction of capital invested is only 48% for the strategy investing only in top tercile transactions and 65% for the strategy investing all announced deals. Despite the larger cash position the top tercile strategy however still outperforms. Over the 28 year period it generated an annual excess return (alpha) of 1.75% (0.99%) compared to an annual excess return (alpha) of 1.33% (-0.34%) for the strategy investing in all takeover deals.

5.2 An Investment Perspective

This section studies the economic importance of the documented reference price effect from the perspective of a risk-arbitrage arbitrageur taking into account other return predictors in risk arbitrage as well as transaction costs. I therefore employ the parametric portfolio policy approach by Brandt, Santa-Clara, and Valkanov (2009). The Brandt, Santa-Clara, and Valkanov (2009) approach is particularly useful in the context of event-driven strategies as it estimates optimal portfolio weights as linear functions of asset characteristics. Hence, it does not require an estimation of returns, variances and covariances, but assumes the joint distribution of returns is fully characterized by the asset characteristics.

In order to account for transaction costs I simulate risk-arbitrage portfolios using either the proportional transaction cost estimate of Corwin and Schultz (2012) or non-proportional transaction costs estimated from Ancerno trade-level data.

5.2.1 Parametric Portfolio Policies

I assume an investor with power utility and risk aversion $\gamma = 4$.[18] The investor chooses portfolio weights to maximize the conditional expected utility of his portfolio return $r_{p,t}$

$$max_{(w_{i,t})_{i=1}^{N}} E_t[u(r_{p,t})], \tag{1}$$

[18]The power utility function is defined as $U(W) = \frac{W^{(1-\gamma)}}{\gamma}$, where W is the level of wealth

where the portfolio return $r_{p,t}$ is defined as $\sum_{i=1}^{N} w_{i,t} r_{i,t}$. I estimate the weights of the optimal portfolio policy as linear functions of deal characteristics following Brandt, Santa-Clara, and Valkanov (2009). Let x_t be the k-dimensional vector of standardized deal characteristics with mean zero and a standard deviation of one, $\bar{w}_t$ is the weight on all the deals under a benchmark policy. The benchmark policy can be for example an equally weighted portfolio of deals. The linear portfolio policy is then parameterized as

$$w_{i,t} = \bar{w}_{i,t} + \frac{1}{N_t}\theta' x_{i,t} \tag{2}$$

where θ is a k-dimensional vector of parameters to be estimated. The vector θ specifies how an investor should deviate from the benchmark portfolio policy given that a deal characteristic deviates from the cross-sectional mean by one standard deviation. Risk arbitrageurs usually take long positions in takeover situations. Therefore, I impose the short-sale constraint

$$w_{i,t}^{+} = \frac{max[0; w_{i,t}]}{\sum_{i=1}^{N} max[0; w_{i,t}]}. \tag{3}$$

In equation (3) the weights are truncated at zero and scaled by the sum of the new weights. The second step ensures that the weights sum up to 1.

To obtain estimates for θ the sample analogue of equations (2) and (3) is maximized,

$$max_{\theta} \frac{1}{T} \sum_{t=1}^{T} u \left(\sum_{i=1}^{N} \frac{max(0; \bar{w}_{i,t} + \frac{1}{N_t}\theta' x_{i,t})}{\sum_{i=1}^{N} (max(0; \bar{w}_{i,t} + \frac{1}{N_t}\theta' x_{i,t})} r_{i,t} \right). \tag{4}$$

While equation (4) can be relatively easy maximized it is more difficult to obtain standard errors for the estimated coefficients due to the non-differentiability of w_{it} at zero. The non-differentiability does not allow us to compute the first order derivatives of equation (4) necessary to compute standard errors. This paper therefore uses bootstrapped standard errors instead.

Trading is not costless. When I incorporate transaction costs I change the portfolio return from $w_t' r_t$ to $w_t' r_t - c_t' |w_t - w_{t-1}|$. The vector c_t contains the one-way transaction costs for the different takeover deals.

5.2.2 Optimized Portfolios

The approach of Brandt, Santa-Clara, and Valkanov (2009) allows to condition the portfolio weights on several variables. Thus, the approach also offers an alternative to test whether other characteristics drive out the cross-sectional importance of the difference between the 52-week high and the offer price. As the benchmark policy I use the rank weights as described in the previous section.[19] Column 1 of Table 11 shows the performance of the rank weighted portfolio. Over the period from 1985 to 2012 portfolio's gross return was 9.7% annually with a standard deviation of 6.4%. Even this portfolio has a sharpe ratio of 0.9 which is significantly higher than the sharpe ratio of the market portfolio or the sharpe ratio of other popular investment style like value or momentum. The certainty equivalent return is 8.8% annually. The certainty equivalent is a performance statistics particular useful to assess investment strategies with skewed pay-off profiles like merger arbitrage and for investors caring about moments beyond mean and variance. It is the risk-less pay-off which gives the same utility as the risky profit from the risk arbitrage strategy to a risk-averse investor.

In column 2 of Table 11 I estimate an optimized risk arbitrage portfolio using only the Δ 52 Week High as a conditioning variable. Conditioning on this single variable has a significant effect on the utility of a risk averse investor and also on other commonly used performance

[19]Using equal weights yields the same results.

statistics. The certainty equivalent increases to 12.2% annually, the sharpe ratio to 1.326 and the CAPM alpha to 7.5% annually. Although the portfolio is more concentrated it is still well diversified. The maximum portfolio weight in a single deal is 8% and on average there is a positive investment in over 50% of the deals. The results from column 2 corroborate the results from the naive portfolio sorts that an investor should tilts its portfolio optimally towards deals where the offer prices exceeds the 52-week high significantly.

In column 3 I add several other conditioning variables. First, I add the size of the deal. As already mentioned,Baker and Savasoglu (2002) use size as a proxy for the post-announcement price pressure arbitrageurs have to absorb. Next, I include a stock deal dummy, a tender dummy and a LBO dummy. Mitchell and Pulvino (2001) find a higher downside risk exposure of cash deals versus stock deals and attribute this to the financing risk of cash deals. I conjecture that among cash deals the financing risk should be even higher among tender offers and leveraged buyouts. Tender offers are sensitive to adverse movements in the market as they fall under Regulation T. Hence, when the collateral value of the shares is decreasing due to systematic shocks, acquirers can face margin calls with a negative impact on a deal's success probability. Due to the extensive use of leverage, LBOs are in general very sensitive to adverse developments in the equity and credit markets. Thus, if an investor cares about downside risk, he will tilt away from cash financed deals and in particular from tender offers and LBOs. Finally, I include the offer premium measured as the offer price minus the target price before the announcement, the sign of the arbitrage spread at the beginning of the month, a dummy equal to one for hostile deals and a dummy for private acquirers. The economic intuition to include the offer premium and the hostile dummy was already discussed. A negative arbitrage spread suggests that the market expects a positive improvement of the bid. The private acquirer dummy is included due to its high correlation with institutional selling reported in Table 3.

Most of the variables seem to be unimportant from the perspective of a risk averse risk arbitrageur according to the results reported in Table 11 column 3. The only conditioning variables significantly affecting the utility of the investor are Δ 52 Week High, Tender and Arbitrage Spread< 0. The addition of the other conditioning variables improves the performance of the risk arbitrage strategy in the range of 25% to 45% percent. Contrary to the initial conjecture a risk averse investor however optimally tilts his portfolio towards tender offers and not away.

In columns 4 to 6 I incorporate transaction costs into the portfolio decision. As an estimate for the one-way transaction costs I use the Corwin and Schultz (2012) spread estimator based on daily high and low prices.[20]This estimator is particularly useful in my sample as in the earlier years bid-ask spreads are often missing especially for stocks outside of the U.S.. Column 5 and 6 suggest transaction costs do not have a strong impact on the parameter estimates of the optimal portfolio policy. The impact on average annual return is similar to Mitchell and Pulvino (2001) around 1.5%.[21] Sharpe ratios and alphas decrease by around 30%. Thus, while transaction costs have a significant impact on the performance of the optimized risk arbitrage strategy, it is still a highly profitable strategy.

The results reported in Table 11 are in-sample. Although the risk of over-fitting using the Brandt, Santa-Clara, and Valkanov (2009) is significantly smaller compared to other approaches, I estimate the portfolio policy also out-of sample. The 10 year period from 1985 to 1994 is used as the initial estimation period. The coefficients of the initial portfolio policy are then used for the next 12 month, i.e. for 1995. Afterwards, the portfolio policy is

[20]The estimator is described in more detail in the Appendix.

[21]Mitchell and Pulvino (2001) report in their Table 7 the impact of indirect transaction costs on a hypothetical fund with assets under management of USD 1 million

re-estimated every year using an expanding window.

In order to see the importance of my key variable $\Delta 52$ for the portfolio policy I plot in figure 3 the estimated parameter for this variable together with the bootstrapped 95% confidence interval. The parameter is slightly increasing over time and the confidence intervals suggest it is always significantly different from zero. Conditioning the portfolio decision on $\Delta 52$ is however not only statistically significant, but also economically. Column 2 of Table 12 suggests an increase of 3.3% in the annual certainty equivalent when an investor conditions his portfolio decision on $\Delta 52$.

Transaction costs have again a significant impact on the performance of the optimized portfolios as well as on the rank-weighted portfolio. On average transaction costs reduce the returns by around 1.5% annually.

5.2.3 Are the Profits scalable

I use the trading cost functions reported in column 3 of Table 9 to simulate the performance of optimized risk arbitrage portfolios accounting for the price impact of trades and direct costs like commissions . Again, I make the three assumptions stated in section 4.3.3 when simulating the portfolios. My simulated portfolios are out-of-sample and therefore the trading period is from 1995 to 2012. As a starting value I assume a portfolio of USD 10 million, which is close to the median assets under management (AUM) of a hedge fund at the end of 1994. [22] I compare the optimized risk arbitrage portfolio with price impact to the optimized portfolios without price impact and proportional transaction costs as well as to the non-optimized risk-arbitrage portfolio with price impact.

Figure 5 indicates a substantial influence of the price impact costs on portfolio perfor-

[22] An analysis of the Lipper Tass hedge fund database suggests an average AUM of USD 57 million and a median AUM of USD 12 million in December 1994

mance. The optimized portfolio without transaction costs generated an average annual alpha of 8.4% during the sample period and had a sharpe ratio of 1.8. Proportional transaction costs decrease the alpha by 2.2% to 6.2% and the sharpe ratio decreases to 1.3. Finally, incorporating price impact costs leads to an annual alpha of 4.2% and a sharpe ratio of 1.22. While this is a significant performance decrease compared to the no transaction cost case, the optimized portfolio still performs better than the rank-weighted portfolio. Interestingly, using raw returns the performance difference between the optimized and the rank-weighted portfolio is not very large judging from the graph in figure 5. There are however large differences in the alphas and sharpe ratios of the strategies. The optimized strategy has an alpha which is 2.2% per year higher than the alpha of the rank-weighted strategy and the sharpe ratios is also significantly higher (1.22 versus 0.79). In unreported results I find the optimized strategy has a market exposure of only 0.05 compared to a market exposure of 0.2 for the rank-weighted strategy.

Finally, I study how the portfolio performance of the optimized portfolio changes when I vary the initial portfolio size. I start with USD 10 million and increase the initial portfolio size in steps of USD 10 million up to an initial portfolio value of USD 500 million. Figure 6 plots the evolution of annual alphas. The annual alpha decreases in a convex fashion and starting from an initial portfolio size of around USD 200 million the alphas drop below 2. Hence, assuming a hypothetical management fee of 2% the strategy wouldn't have delivered any alpha to investors for an initial portfolio exceeding USD 200 million.

6 Conclusion

Prior research suggests that the abnormal returns in risk arbitrage are a compensation for liquidity provision to exiting shareholders. The literature however lacks explanations why this liquidity demand arises in the first place. Our understanding of the abnormal profits in merger arbitrage is therefore incomplete.

This paper provides evidence consistent with a behavioral explanation for the post-announcement liquidity demand and merger arbitrage profits. Importantly, I show that behavioral biases are not only present among retail investor, but also among institutional investors. This implies that the abnormal returns in merger arbitrage may persist despite an increasing institutionalization of equity markets.

A market inefficiency can only persist if there is not enough rational arbitrage capital to correct it. The results of this paper suggest that arbitrage capital reacts too slowly to the strong cyclicality of the M&A market, which lets market inefficiencies persist at least in certain states of the world.

The M&A market is highly discussed in the media and merger arbitrage is a well-known and simple alternative trading strategy. Therefore, to study the causes and the persistence of pricing inefficiencies in this market provides a good starting point to understand inefficiencies in other markets.

References

Adrian, Tobias, Erkko Etula, and Tyler Muir, 2012, Financial intermediary leverage and the cross section of asset returns, *Journal of Finance* forthcoming.

Anand, Amber, Paul Irvine, Andy Puckett, and Kumar Venkataraman, 2013, Institutional trading and stock resiliency: Evidence from the 2007-2009 financial crisis, *Journal of Financial Economics* 108, 773 – 797.

Baker, Malcolm, Xin Pan, and Jeffrey Wurgler, 2012, The effect of reference point prices on mergers and acquisitions, *Journal of Financial Economics* 106, 49–71.

Baker, Malcolm, and Serkan Savasoglu, 2002, Limited abitrage in mergers and acquisitions, *Journal of Financial Economics* 64, 91–115.

Barber, Brad M., and Terrence Odean, 2008, All that glitters: The effect of attention and news on the buying behavior of individual and institutional investors, *Review of Financial Studies* 21, 785–818.

Barberis, Nicholas, and Wei Xiong, 2009, What drives the disposition effect? an analysis of a long-standing preference-based explanation, *Journal of Finance* 64, 751–784.

——— , 2012, Realization utility, *Journal of Financial Economics* 104, 251–271.

Bargeron, Leonce L., Frederik P. Schlingemann, Rene M. Stulz, and Chad J. Zutter, 2008, Why do private acquirers pay so little compared to public acquirers?, *Journal of Financial Economics* 89, 375 – 390.

Barroso, Pedro, and Pedro Santa-Clara, 2013, Beyond the carry trade: Optimal currency portfolios, *Journal of Financial and Quantitative Analysis* forthcoming.

Ben-David, Itzhak, and David Hirshleifer, 2012, Are investors really reluctant to realize their losses? trading responses to past returns and the disposition effect, *Review of Financial Studies* 25, 2485–2532.

Birru, Justin, 2014, Psychological barriers, expectational errors, and underreaction to news, *Working Paper*.

Brandt, Michael W., Pedro Santa-Clara, and Rossen Valkanov, 2009, Parametric portfolio policies: Exploiting characteristics in the cross-section of equity returns, *Review of Financial Studies* 22, 3411–3447.

Breen, William, Laurie Hodrick, and Robert Korajczyk, 2002, Predicting equity liquidity, *Management Science* 48, 470–483.

Brunnermeier, Markus, and Lasse Heje Pedersen, 2009, Market and funding liquidity, *Review of Financial Studies* 22, 2201–2040.

Carhart, Mark, 1997, Persistence in mutual fund performance, *Journal of Finance* 57, 28–57.

Cornelli, Francesca, and David D. Li, 2002, Risk arbitrage in takeovers, *Review of Financial Studies* 15, 837–868.

Corwin, Shane, and Paul Schultz, 2012, A simple way to estimate bid-ask spreads from daily high and low prices, *Journal of Finance* 67, 719–760.

Fama, Eugene, and Kenneth R. French, 1993, Common risk factors in the returns on stocks and bonds, *Journal of Financial Economics* 33, 3–56.

Franzoni, Francesco, and Alberto Plazzi, 2012, Hedge funds' liquidity provision and trading activity, *Working Paper*.

Frazzini, Andrea, 2006, The disposition effect and underreaction to news, *Journal of Finance* 61, 2017–2046.

George, Thomas J., and Chuan-Yang Hwang, 2004, The 52-week high and momentum investing, *Journal of Finance* 59, 2145–2176.

———, and Yuan Li, 2014, Anchoring, the 52-week high and post earnings announcement drift, *Working Paper*.

Ghysels, Eric, Alberto Plazzi, and Rossen Valkanov, 2013, Conditional skewness of stock market returns in developed and emerging markets and its economic fundamentals, *Working Paper*.

Gneezy, Uri, 2005, Updating the reference level: experimental evidence, *Experimental Business Research* 3, 263–284.

Gompers, Paul A., and Andrew Metrick, 2001, Institutional investors and equity prices, *The Quarterly Journal of Economics* 116, 229–259.

Grinblatt, Mark, and Bing Han, 2005, Prospect theory,mental accounting,and momentum, *Journal of Financial Economics* 78, 311–338.

Heath, Chip, Steven Huddart, and Mark Lang, 1999, Psychological factor and stock option exercise, *Quarterly Journal of Economics* 114, 601–627.

Hong, Harrison, and Jeremy Stein, 2001, Forecasting crashes: trading volume, past returns, and conditional skewness in stock prices, *Journal of Financial Economics* 61, 345–381.

Hsieh, Jim, and Ralph Walkling, 2005, Determinants and implications of arbitrage holdings in acquisitions, *Journal of Financial Economics* 77, 605–648.

Jegadeesh, Narasimhan, and Yue Tang, 2010, Institutional trades around takeover announcements: Skill vs. inside information, *Working Paper*.

Kahneman, Daniel, and Amos Tversky, 1979, Prospect theory: An analysis of decision under risk, *Econometrica* 47, 263–292.

Keim, Donald, and Ananth Madhavan, 1997, Transaction costs and investment style: An inter exchange analysis of institutional equity trades, *Journal of Financial Economics* 46, 265–292.

Kyle, Albert, 1985, Continous auctions and insider trading, *Econometrica* 53, 1315–1335.

Mitchell, Mark, and Todd Pulvino, 2001, Characteristics of risk and return in risk arbitrage, *Journal of Finance* 56, 2135–2175.

———, 2012, Arbitrage crashes and the speed of capital, *Journal of Financial Economics* 104, 469–490.

Moskowitz, Tobias, Andrea Frazzini, and Ronen Israel, 2014, The trading costs of asset pricing anomalies, *Working Paper*.

Odean, Terrence, 1998, Are investors reluctant to realize their losses, *Journal of Finance* 54, 1775–1797.

Pastor, Lubos, and Robert Stambaugh, 2003, Liquidity risk and expected stock returns, *Journal of Political Economy* 111, 642–685.

——— , 2012, On the size of the active management industry, *Journal of Political Economy* 120, 740–781.

Plazzi, Alberto, Walter Torous, and Rossen Valkanov, 2011, Exploiting property characteristics in commercial real estate portfolio allocation, *Journal of Portfolio Management* 35, 39–50.

Puckett, Andy, and Xuemin (Sterling) Yan, 2010, The interim trading skills of institutional investors, *Journal of Finance* 66, 601–633.

Shefrin, Hersh, and Meir Statman, 1985, The disposition to sell winners to early and ride losers too long, *Journal of Finance* 40, 777–790.

Shleifer, Andrei, and Robert W. Vishny, 2003, Stock market driven acquisitions, *Journal of Financial Economics* 70, 295–311.

Tversky, Amos, and Daniel Kahneman, 1974, Judgement under uncertainty: heuristics and biases, *Science* 185, 1124–1131.

Appendix

A.1 Proportional Trading Costs

I use the spread estimator (S) of Corwin and Schultz (2012) defined as

$$S = \frac{2(e^{\alpha} - 1)}{1 + e^{\alpha}}. \tag{A.1}$$

For a deeper understanding of the estimator the reader should consult the work of Corwin and Schultz (2012). Here, I only state the equations used to compute the estimator.

$$\alpha = \frac{\sqrt{2\beta} - \sqrt{\beta}}{3 - 2\sqrt{2}} - \sqrt{\frac{\gamma}{3 - 2\sqrt{2}}}, \tag{A.2}$$

where

$$\gamma = \left[ln \left(\frac{H^0_{t,t+1}}{L^0_{t,t+1}} \right) \right]^2 \tag{A.3}$$

and

$$\beta = \sum_{j=0}^{1} \left[ln \left(\frac{H^0_{t+j}}{L^0_{t+j}} \right) \right]^2 . \tag{A.4}$$

H^0_{t+j} and L^0_{t+j} stand for high and low price on day $t+j$ and $H^0_{t,t+1}$ and $L^0_{t,t+1}$ stand for two day high and low prices in the period from t to $t+1$.

Table 1

Summary Statistics Takeover Transactions

This table presents summary statistics for the sample of takeover transactions from Thomson Financial. The sample starts with all change of control transactions of publicly listed targets in the US, Canada, Australia, New Zealand, Hong Kong, Singapore, Japan, Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom. For the final sample following filters are applied (1) In the US I only keep deals where I am able match the cusip of the target provided by SDC with the CRSP daily tapes. For all other countries I require a valid match between a target's cusip (Canada), sedol (rest of the world) or name with the Compustat Global Security Daily files. For equity financed deals I furthermore require a valid match between the acquirer's cusip, sedol or name and CRSP or Compustat, (2) A deal has to be pure cash or pure stock financed. For stock financed deals I require a valid exchange ratio from SDC; (3) deals with negative bid premia, initial arbitrage spreads of more than 100% or smaller than -20% are deleted; (4) deals with a value of less than USD 10 million are deleted. The "Offer Premium" is defined as the difference between the offer price and the target stock price 20 days prior to announcement scaled by the target stock price 20 days prior to announcement. "Δ 52" is defined as the difference between the offer price and the target stock's 52-week high scaled by the target stock 52-week high. "Target Size" is the target's market capitalization in USD billions. All the other variables are dummies

	Obs	**Mean**	**Std. Dev.**	**25th Pct.**	**Median**	**75th Pct.**
	Panel A: International					
Offer Premium	7740	0.395	0.308	0.187	0.333	0.530
Δ 52 Week High	7740	0.025	0.301	-0.130	0.032	0.198
Target size	7740	0.711	2.822	0.0440	0.125	0.418
Tender	7740	0.448	0.497	0	0	1
Stock	7740	0.201	0.401	0	0	0
Hostile	7740	0.0610	0.239	0	0	0
LBO	7740	0.135	0.341	0	0	0
Private	7740	0.43	0.49	0	0	1
Completed	7740	0.750	0.433	0	1	1
	Panel B: US					
Offer Premium	4888	0.424	0.313	0.209	0.360	0.563
Δ 52 Week High	4888	0.063	0.310	-0.111	0.085	0.247
Target size	4888	0.723	2.989	0.0452	0.130	0.431
Tender	4888	0.320	0.467	0	0	1
Stock	4888	0.215	0.411	0	0	0
Hostile	4888	0.0620	0.241	0	0	0
LBO	4888	0.139	0.346	0	0	0
Private	4888	0.38	0.49	0	0	1
Completed	4888	0.796	0.403	1	1	1
	Panel C: International ex US					
Offer Premium	2852	0.346	0.293	0.154	0.284	0.474
Δ 52 Week High	2852	-0.040	0.273	-0.149	0.004	0.103
Target size	2852	0.689	2.499	0.0426	0.117	0.401
Tender	2852	0.667	0.471	0	1	1
Stock	2852	0.176	0.381	0	0	0
Hostile	2852	0.0593	0.236	0	0	0
LBO	2852	0.128	0.334	0	0	0
Private	2852	0.51	0.50	0	1	1
Completed	2852	0.670	0.470	0	1	1

Table 2

Summary Statistics Ancerno

This table shows summary statistics for the matched sample of US takeover transactions and trade level data provided by Ancerno. Panel A shows summary statistics for the takeover targets. Panel A to Panel C provide trading statistics for target stocks for the full sample, before the takeover announcement and after the takeover announcement. "Managers" is the number of managers in the Ancerno database trading the target stock. "Price Impact" is execution shortfall (ES) defined as $ES(t) = \frac{P_l(t)-P_0(t)}{P_0(t)}D(t)$, where $P_l(t)$ is the average execution price, $P_0(t)$ is the prior day's closing price and $D(t)$ is the direction of the trade. Commisions per stock traded are expressed as a fraction of prior day's closing pricing. Total costs are commissions plus price impact and trade size is expressed in thousand dollars.

	Obs	Mean	Stdev.	25th Pct.	Median	75th Pct.
		Panel A: Deal Characteristics - Ancerno Match				
Offer Premium	1601	0.43	0.33	0.21	0.36	0.58
Δ 52 Week High	1601	0.02	0.32	-0.16	0.05	0.20
Target Size	1601	0.99	3.25	0.07	0.21	0.70
Tender	1601	0.27	0.45	0	0	1
Stockdeal	1601	0.19	0.40	0	0	0
Hostile	1601	0.02	0.13	0	0	0
LBO	1601	0.14	0.35	0	0	0
Private	1601	0.28	0.45	0	0	1
Completed	1601	0.86	0.35	1	1	1
		Panel B: Full Sample - Trading Statistics				
Managers	1601	25.25	27.26	4.00	15.00	38.00
Price Impact	1601	0.03	2.19	-0.82	0	0.88
Commisions	1601	0.10	1.76	0.02	0.05	0.12
Total Cost	1601	0.13	2.81	-0.73	0.09	0.98
Trade Size	1601	1214	7120	15.42	77.21	418.20
		Panel C: Before Announcement- Trading Statistics				
Managers	1601	22.43	23.79	4.00	14.00	34.00
Price Impact	1601	0.04	2.28	-0.95	0	1.02
Commisions	1601	0.11	2.16	0.02	0.06	0.13
Total Cost	1601	0.14	3.14	-0.86	0.11	1.12
Trade Size	1601	1038	5887	13.93	68.63	363.50
		Panel D: After Announcment - Trading Statistics				
Managers	1601	16.53	19.19	3.00	9.00	24.00
Price Impact	1601	0.02	2.04	-0.62	0	0.66
Commisions	1601	0.09	0.79	0.01	0.05	0.11
Total Cost	1601	0.11	2.19	-0.54	0.07	0.75
Trade Size	1601	1494	8713	18.22	93.74	519.50

Table 3

Institutional Trading around Takeover Announcements

This table shows regressions of net trading of institutional investors around takeover announcement. The dependent variable is defined as the sum all trades from the announcement today until the 10th day after the announcement as a percentage of total shares outstanding."Offer Premium" is defined as the difference between the offer price and the target stock price 20 days prior to announcement scaled by the target stock price 20 days prior to announcement. In all specifications labeled "continuous" the variable "Δ 52" is defined as the difference between the offer price and the target stock's 52-week high scaled by the target stock 52-week high. In all specifications labeled "dummy" the variable "Δ 52" is equal to 1 if the offer price exceeds the target's 52-week high. "Size" is the log of the target's market capitalization. All the other variables are dummies.*,**,*** denotes statistical significance at the 10%, 5% and 1% significance level respectively.

	Dummy	**Dummy**	**Continuous**	**Continuous**	**Dummy**	**Dummy**	**Continuous**	**Continuous**
Δ52 Week High	-0.80***	-0.44***	-1.07***	-0.70***	-0.63***	-0.32**	-0.92***	-0.55**
	(-5.48)	(-3.12)	(-4.79)	(-3.17)	(-4.35)	(-2.27)	(-4.14)	(-2.48)
Offer Premium		0.10		0.22		-0.27		-0.17
		(0.46)		(1.03)		(-1.31)		(-0.78)
Stockdeal		1.38***		1.37***		0.75***		0.74***
		(7.06)		(7.01)		(3.71)		(3.65)
Size		-0.53***		-0.53***		-0.50***		-0.50***
		(-10.85)		(-10.80)		(-10.31)		(-10.23)
Tender		-0.17		-0.21		-0.60***		-0.64***
		(-1.02)		(-1.25)		(-3.59)		(-3.77)
Private		0.85***		0.85***		0.86***		0.86***
		(3.96)		(3.98)		(4.09)		(4.10)
LBO		-0.20		-0.19		-0.21		-0.20
		(-0.76)		(-0.74)		(-0.82)		(-0.81)
Hostile		-0.09		-0.02		-0.28		-0.24
		(-0.18)		(-0.05)		(-0.59)		(-0.51)
Constant	-1.52***	4.51***	-1.96***	4.20***	-1.62***	4.50***	-1.97***	4.25***
	(-13.58)	(6.91)	(-27.12)	(6.32)	(-14.83)	(6.93)	(-28.30)	(6.44)
Time Fixed Effects	N	N	N	N	Y	Y	Y	Y
Observations	1,322	1,322	1,322	1,322	1,322	1,322	1,322	1,322
R-squared	0.02	0.15	0.02	0.15	0.10	0.21	0.10	0.21

Table 4

The 52 Week High and Risk Arbitrage Returns

At the beginning of each month all announced takeover transactions are sorted into three size rank weighted portfolios according to Δ52, defined as the difference between the offer price and the target stock's 52-week high scaled by the target stock 52-week high. Monthly excess returns of the portfolios are regressed on the market factor (MKTRF), the small minus big factor (SMB) and the high minus low factor (HML) of Fama and French (1993) factors as well as on momentum factor (UMD) of Carhart (1997). High-Low is a long-short portfolio going long the portfolio with takeover stocks in the highest Δ52 tercile and short the takeover stocks in the lowest Δ52 tercile. *,**,*** denotes statistical significance at the 10%, 5% and 1% significance level respectively.

	Low	Medium	High	High - Low
Panel A: US(1985-2012)				
Excess Return (in % per year)	3.67	4.00	8.84	4.98
Sharpe Ratio	0.35	0.51	1.00	0.41
MKTRF	0.33***	0.26***	0.18***	-0.14***
	(9.70)	(10.21)	(6.53)	(-3.37)
SMB	0.14***	0.07*	0.15***	0.01
	(3.00)	(1.90)	(3.89)	(0.19)
HML	0.15***	0.13***	0.11**	-0.04
	(2.89)	(3.29)	(2.51)	(-0.64)
UMD	-0.01	-0.01	-0.04	-0.03
	(-0.17)	(-0.41)	(-1.52)	(-0.86)
Alpha (in % per month)	0.05	0.14	0.58***	0.53***
	(0.34)	(1.29)	(4.76)	(2.85)
Observations	336	336	336	336
R-squared	0.27	0.27	0.19	0.03
Panel B: International (1985-2012)				
Excess Return (in % per year)	3.31	4.32	8.83	5.36
Sharpe Ratio	0.33	0.57	1.23	0.57
Alpha (in % per month)	0.00	0.14	0.60***	0.59***
	(0.03)	(1.32)	(5.67)	(3.99)
Panel C: International excluding the US (1999-2012)				
Excess Return (in % per year)	0.71	4.80	7.39	6.64
Sharpe Ratio	0.06	0.51	0.63	0.45
Alpha (in % per month)	-0.06	0.35*	0.56**	0.62*
	(-0.24)	(1.74)	(2.09)	(1.88)

Table 5

Different Portfolio Return Aggregation Schemes

At the beginning of each month all announced takeover transactions are sorted into three size rank weighted portfolios according to Δ52, defined as the difference between the offer price and the target stock's 52-week high scaled by the target stock 52-week high. Monthly excess returns of the portfolios are regressed on the market factor (MKTRF), the small minus big factor (SMB) and the high minus low factor (HML) of Fama and French (1993) factors as well as on momentum factor (UMD) of Carhart (1997). High-Low is a long-short portfolio going long the portfolio with takeover stocks in the highest Δ52 tercile and short the takeover stocks in the lowest Δ52 tercile. *,**,*** denotes statistical significance at the 10%, 5% and 1% significance level respectively.

	Daily Returns				**Value-weighted Returns**			
	Low	**Medium**	**High**	**High - Low**	**Low**	**Medium**	**High**	**High - Low**
Excess Return (in % per year)	5.17	7.63	13.70	7.90	7.37	5.63	9.48	1.97
Sharpe Ratio	0.47	0.89	1.63	0.74	0.40	0.49	0.84	0.10
MKTRF	0.33***	0.28***	0.18***	-0.16***	0.70***	0.33***	0.17***	-0.52***
	(9.47)	(9.95)	(6.18)	(-4.00)	(12.20)	(8.85)	(4.22)	(-7.48)
SMB	0.19***	0.09**	0.16***	-0.03	-0.10	0.14***	0.08	0.18*
	(3.77)	(2.18)	(3.97)	(-0.50)	(-1.23)	(2.72)	(1.44)	(1.85)
HML	0.18***	0.13***	0.12***	-0.06	0.25***	0.27***	0.11*	-0.14
	(3.27)	(3.02)	(2.65)	(-0.98)	(2.91)	(4.66)	(1.76)	(-1.34)
UMD	-0.04	0.05*	-0.03	0.02	-0.01	-0.02	-0.04	-0.03
	(-1.36)	(1.89)	(-1.15)	(0.44)	(-0.16)	(-0.53)	(-0.98)	(-0.45)
Alpha (in % per month)	0.18	0.38***	0.94***	0.74***	0.12	0.18	0.64***	0.52*
	(1.17)	(3.11)	(7.49)	(4.37)	(0.47)	(1.10)	(3.57)	(1.72)
Observations	336	336	336	336	336	336	336	336
R-squared	0.28	0.26	0.17	0.06	0.32	0.24	0.07	0.15

Table 6

The Role of Risk

At the beginning of each month all announced takeover transactions are sorted into three rank weighted portfolios according to Δ52, defined as the difference between the offer price and the target stock's 52-week high scaled by the target stock 52-week high. The table reports results for regressions of the portfolios' monthly excess returns on different risk-factors. MKTRF, SMB, HML are the Fama and French (1993) factors, UMD is the momentum factor of Carhart (1997), LMP is the leverage mimicking factor of Adrian, Etula, and Muir (2012) and PS is the traded liquidity risk factor of Pastor and Stambaugh (2003). Column 3 uses the global versions of the Fama and French (1993) and Carhart (1997) factors. In column 4 a down market is defined as a contemporaneous market return below -4%. In column 5 an up market is defined as a contemporaneous market return above -4%. *,**,*** denotes statistical significance at the 10%, 5% and 1% significance level respectively.

	LMP	**PS**	**Global Factors**	**Down Market**	**Up Market**
MKTRF	-0.24***	-0.18***	-0.13***	-0.16	-0.14***
	(-3.71)	(-4.77)	(-3.55)	(-1.27)	(-3.05)
SMB	-0.01	-0.01	-0.03		
	(-0.24)	(-0.10)	(-0.41)		
HML	-0.19	-0.07	-0.11		
	(-1.58)	(-1.20)	(-1.57)		
UMD	-0.12*	-0.05	-0.01		
	(-1.75)	(-1.47)	(-0.60)		
LMP	0.15				
	(1.19)				
PS		-0.04			
		(-1.06)			
Alpha	0.58***	0.63***	0.53***	0.73	0.48***
	(3.61)	(3.89)	(3.16)	(0.71)	(2.71)
Observations	306	306	240	46	290
R-squared	0.08	0.07	0.06	0.04	0.03

Table 7

Alternative Explanations

This table shows OLS regressions of 30 day excess even returns on Δ52, defined as the difference between the offer price and the target stock's 52-week high scaled by the target stock 52-week high, and a number of control variables. Offer Premium is defined as the difference between the offer price and the target stock price 20 days prior to announcement scaled by the target stock price 20 days prior to announcement; CG is the capital gains overhang measure of Grinblatt and Han (2005), Size is the log market capitalization of the target, hostile and stockdeal are dummies equal to 1 for an unfriendly takeover offer and payment in stock, respectively. T-statistics are in parentheses and all standard are clustered at the monthly level. *,**,*** denotes statistical significance at the 10%, 5% and 1% significance level respectively.

	(1)	(2)	(3)	(4)	(5)
Δ52	1.01***			0.72***	0.66***
	(5.61)			(3.92)	(3.43)
Offer Premium		1.24***		1.01***	0.98***
		(6.86)		(5.53)	(4.97)
CG			0.03	-0.17	-0.27
			(0.17)	(-1.14)	(-1.62)
Size					-0.21
					(-1.56)
Hostile					3.03***
					(4.40)
Stockdeal					-0.85**
					(-2.49)
Constant	1.18***	1.18***	1.18***	1.18***	1.19***
	(8.29)	(8.24)	(8.22)	(8.33)	(6.77)
Observations	7,831	7,831	7,831	7,831	7,732
R-squared	0.01	0.01	0.00	0.02	0.02

Table 8

Time-varying arbitrage capital

This table presents results for portfolios sorted on Δ52, defined as the difference between the offer price and the target stock's 52-week high scaled by the target stock 52-week high. The High-Low portfolio is a long-short portfolio going long the portfolio with takeover stocks in the highest Δ52 tercile and short the takeover stocks in the lowest Δ52 tercile. Column 1-4 show results for states with high deal activity growth. Column 5-8 show results for states with low deal activity growth.The different states are thereby defined in the following way: I compute the percentage deviation of deal volume in USD at the beginning of the month from the average deal volume in the preceding 12 month. I then divide the sample into three terciles according to the values of this variable. The highest tercile defines the state with high deal activity growth whereas the lowest tercile defines the low activity state. MKTRF, SMB, HML are Fama and French (1993) factors, UMD is the momentum factor of Carhart (1997). *,**,*** denotes statistical significance at the 10%, 5% and 1% significance level respectively.

	High Deal Activity Growth				**Low Deal Activity Growth**			
	Low	**Medium**	**High**	**High - Low**	**Low**	**Medium**	**High**	**High - Low**
Mean Excess Return (in % per year)	4.17	5.89	10.55	6.15	3.53	1.90	6.31	2.69
Sharpe Ratio	0.69	1.15	1.98	0.83	0.29	0.24	0.80	0.22
MKTRF	0.20***	0.14***	0.06	-0.14**	0.32***	0.24***	0.18***	-0.14*
	(4.49)	(3.69)	(1.44)	(-2.37)	(4.61)	(5.21)	(3.88)	(-1.83)
SMB	0.08	0.12**	0.10	0.02	0.21**	0.01	0.11*	-0.10
	(1.18)	(2.11)	(1.53)	(0.20)	(2.12)	(0.20)	(1.68)	(-0.91)
HML	0.12*	0.13**	-0.00	-0.13	0.13	0.12**	0.11*	-0.02
	(1.74)	(2.14)	(-0.07)	(-1.37)	(1.46)	(2.10)	(1.90)	(-0.18)
UMD	0.02	0.05	-0.02	-0.04	0.00	0.01	-0.04	-0.04
	(0.45)	(1.26)	(-0.50)	(-0.70)	(0.01)	(0.23)	(-1.18)	(-0.69)
Alpha	0.21	0.37**	0.83***	0.62***	-0.01	-0.02	0.32	0.33
	(1.29)	(2.62)	(5.29)	(2.82)	(-0.03)	(-0.09)	(1.62)	(0.97)
Observations	108	108	108	108	110	110	110	110
R-squared	0.18	0.17	0.06	0.06	0.27	0.25	0.25	0.05

Table 9

Transaction Costs

This table shows estimates of transaction costs in takeover stocks. The dependent variable is the total transaction cost defined as the sum of execution shortfall and commissions as a fraction of the share price in basis points. Execution shortfall is defined as $ES(t) = \frac{P_I(t)-P_0(t)}{P_0(t)}D(t)$, where $P_I(t)$ is the average execution price, $P_0(t)$ is the prior day's closing price and $D(t)$ is the direction of the trade. Size is the natural logarithm of a stock's market capitalization in thousand. Trend is defined as (Year-1999). Complexity is the dollar volume of a trade divided by the average daily trading volume of the stock during the previous 20 days. Buy is a dummy equal to one for buy trades. Sell is a dummy equal to one for sell trades. In order to prevent outliers to drive the results all the regressions are estimated using robust regression techniques. *,**,*** denotes statistical significance at the 10%, 5% and 1% significance level respectively.

	Trading Costs in Target Stocks					
	After Announcement			**Before Announcement**		
Buy*Complexity		0.483***	0.377***		1.004***	0.937***
		(3.571)	(2.714)		(10.34)	(9.366)
Sell*Complexity		0.468***	0.389***		1.255***	1.195***
		(5.077)	(4.102)		(12.39)	(11.54)
Trend			-0.0402			-0.238*
			(-0.330)			(-1.799)
Size (in logs)			-0.893***			-0.628**
			(-3.764)			(-2.345)
Complexity	0.472***			1.124***		
	(5.957)			(15.14)		
Intercept	5.547***	5.546***	19.22***	7.881***	7.882***	18.59***
	(14.38)	(14.38)	(5.181)	(18.90)	(18.91)	(4.589)
Observations	103,060	103,060	103,060	223,967	223,967	223,967
R-squared	0.000	0.000	0.000	0.001	0.001	0.001
	Trading Costs in Stock Acquirers					
Buy*Complexity		1.273***	1.350***		1.114***	1.130***
		(5.063)	(5.214)		(4.706)	(4.638)
Sell*Complexity		1.811***	1.892***		1.638***	1.653***
		(5.915)	(6.066)		(6.414)	(6.359)
Trend			-0.133			0.157
			(-0.558)			(0.804)
Size (in logs)			0.625			0.0456
			(1.582)			(0.133)
Complexity	1.486***			1.354***		
	(7.386)			(7.526)		
Intercept	8.007***	7.994***	-2.081	6.813***	6.813***	5.358
	(10.31)	(10.30)	(-0.299)	(9.917)	(9.917)	(0.884)
Observations	66,220	66,220	66,220	91,085	91,085	91,085
R-squared	0.001	0.001	0.001	0.001	0.001	0.001

Table 10

Portfolio Returns after Transaction Costs

This table presents the performance of different trading strategies in risk arbitrage after transaction costs in the period from 1985-2012. The strategy "Top Tercile Transactions" invests in a rank-weighted portfolio of takeover transactions in the highest Δ52 tercile. The strategy "All Takeover Transactions" invests in a rank-weighted portfolio of all takeover transactions. Panel A assumes no transaction costs and Panel B uses the bid-ask spread estimator of Corwin and Schultz (2012) to compute net-of-cost returns. Panels C-G use the transaction cost functions estimated from Ancerno trade-level data reported in Column 3 of Table 7 to adjust portfolio returns. When simulating the portfolio returns in Panels C-G the following assumptions are made: First, I assume a cost conscious investor not willing to pay trading costs exceeding 100 basis points. Second, I assume the investor does not want to become a major blockholder. Therefore, I restrict the position size to a maximum of 5% of the outstanding shares of the target company. At times of low deal activity or times with a large number of small transactions these assumptions lead to an increasing fraction of capital invested in cash. I assume the cash account is earning the risk-free rate. Third, I assume the trading cost function estimated for the U.S. is representative for the other countries in my sample.

	Alpha in % per year	**Sharpe Ratio**	**Excess Return in % per year**	**Trading Costs in Bps per month**	**Average Fraction Invested**
	Panel A: No Transaction Costs				
Top Tercile Transactions	6.84	1.20	8.40	0	1.00
All Takeover Transactions	3.09	0.87	5.55	0	1.00
	Panel B: Bid-Ask Spread Estimator				
Top Tercile Transactions	5.16	0.96	6.66	11.13	1.00
All Takeover Transactions	1.42	0.61	3.85	12.31	1.00
	Panel C: Ancerno Transaction Cost Function - initial portfolio size: USD 1 million				
Top Tercile Transactions	5.58	1.04	7.16	7.29	0.99
All Takeover Transactions	2.30	0.76	4.78	4.56	1.00
	Panel D: Ancerno Transaction Cost Function -initial portfolio size: USD 10 million				
Top Tercile Transactions	4.41	0.88	5.90	13.53	0.93
All Takeover Transactions	1.58	0.65	4.07	8.88	0.97
	Panel E: Ancerno Transaction Cost Function - initial portfolio size: USD 50 million				
Top Tercile Transactions	3.03	0.75	4.39	15.83	0.80
All Takeover Transactions	0.57	0.51	2.98	13.36	0.91
	Panel F: Ancerno Transaction Cost Function - initial portfolio size: USD 100 million				
Top Tercile Transactions	2.14	0.63	3.36	15.57	0.73
All Takeover Transactions	0.24	0.45	2.46	14.71	0.85
	Panel G: Ancerno Transaction Cost Function - initial portfolio size: USD 500 million				
Top Tercile Transactions	0.99	0.47	1.75	11.82	0.48
All Takeover Transactions	-0.34	0.31	1.33	14.29	0.65

Table 11

In-Sample Results

Long-only optimal portfolio policy parameters are estimated for all cash and stock deals over the 1985-2012 sample period for different specifications: (I) corresponds to a size ranked merger arbitrage portfolio; (II) uses only Δ52 as a conditioning variable; (III) adds the offer premium, the log target size and dummies for stock deals, tender offers, LBOs, private acquirers and hostile transactions. In the optimization, the risk aversion parameter is set to 4. The first set of rows shows the estimated parameters of the portfolio policy and their associated standard errors. The standard errors are estimated using the bootstrap and statistically significant parameters are in bold. The second set of rows displays the certainty-equivalent return, the average return, standard deviation of return, the sharpe ratio, the CAPM alpha and the four factor alpha.All the statistics are annualized. The third set of rows shows the average absolute portfolio weight, the minimum and maximum portfolio weight, the average sum of negative weights in the portfolio and the average fraction of negative weights in the portfolio. Columns 1 to 3 show results without transactions and columns 4 to 6 show results including proportional transaction costs. Proportional transaction costs are estimated using the Corwin and Schultz (2012) bid-ask spread estimator.

	Excluding Transaction Costs			**Including Transaction Costs**		
	Rank	**Optimized**		**Rank**	**Optimized**	
	I	II	III	I	II	III
$\theta_{\Delta 52}$		**4.50**	**3.42**		**4.40**	**3.87**
		1.34	*1.77*		*1.45*	*1.36*
θ_{SIZE}			-3.12			-2.55
			1.56			*1.29*
$\theta_{STOCKDEAL}$			2.64			1.00
			2.10			*1.22*
θ_{TENDER}			**5.19**			**4.56**
			1.90			*1.56*
θ_{LBO}			-1.00			-1.90
			1.22			*1.12*
$\theta_{OFFERPREMIUM}$			-0.19			0.37
			1.69			*1.37*
$\theta_{SPREAD<0}$			**-5.66**			**-4.92**
			1.36			*1.17*
$\theta_{HOSTILE}$			-1.87			-1.12
			2.34			*1.85*
$\theta_{PRIVATE}$			1.06			0.91
			1.68			*1.31*
CE	0.088	0.122	0.150	0.071	0.104	0.118
Mean Return	0.097	0.133	0.159	0.080	0.115	0.128
Stdev	0.064	0.070	0.064	0.064	0.070	0.065
Sharpe Ratio	0.905	1.326	1.884	0.638	1.074	1.360
α_{CAPM}(per year)	0.037	0.075	0.109	0.021	0.059	0.077
α_{FF4} (per year)	0.031	0.072	0.107	0.015	0.056	0.076
$\lvert w_t \rvert$	0.01	0.01	0.01	0.015	0.015	0.015
min	0.00053	0	0	0.001	0.000	0.000
max	0.03	0.08	0.07	0.029	0.075	0.077
$\sum w\_t I(w\_t < 0)$	0	0	0	0.000	0.000	0.000
$\sum I(w\_t \leq 0)$	0	0.39	0.41	0.000	0.385	0.423

Table 12

Out-of-Sample Results

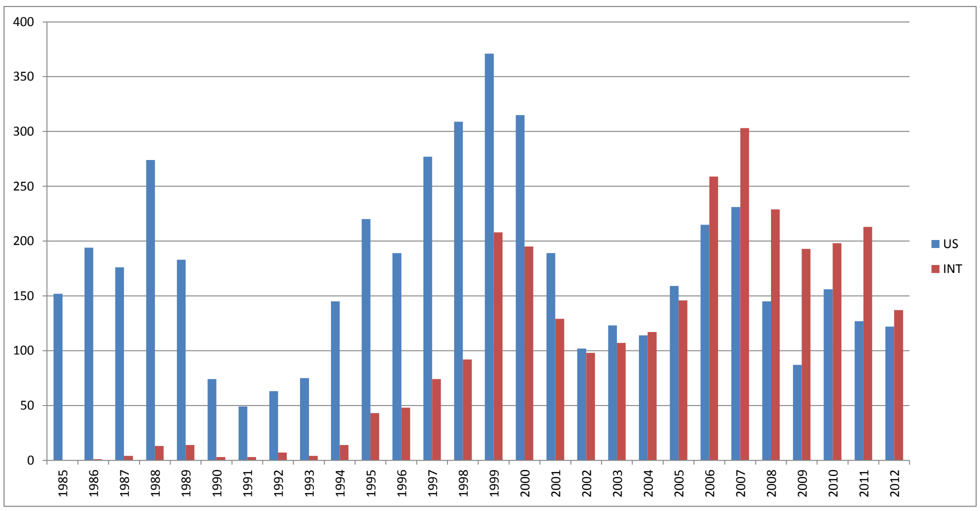
In the out-of-sample results, I use data until December 1994 to estimate the parameters of the long-only portfolio policy and then form out-of-sample portfolios using those parameters in the next year. Every subsequent year, the portfolio policy is reestimated using the enlarged sample. Results for the out-of-sample period from 1995 to 2012 are reported for different specifications: (I) corresponds to a size ranked merger arbitrage portfolio; (II) uses only Δ52 as a conditioning variable; (III) adds the offer premium, the log target size and dummies for stock deals, tender offers, LBOs, private acquirers and hostile transactions. In the optimization, the risk aversion parameter is set to 4. The first set of rows displays the certainty-equivalent return, the average return, standard deviation of return, the sharpe ratio, the CAPM alpha and the four factor alpha.All the statistics are annualized. The third set of rows shows the average absolute portfolio weight, the minimum and maximum portfolio weight, the average sum of negative weights in the portfolio and the average fraction of negative weights in the portfolio. Columns 1 to 3 show results without transactions and columns 4 to 6 show results including proportional transaction costs. Proportional transaction costs are estimated using the Corwin and Schultz (2012) bid-ask spread estimator.

	Excluding Transaction Costs			**Including Transaction Costs**		
	Rank weighted	**Optimized**		**Rank weighted**	**Optimized**	
	I	II	III	I	II	II
CE	0.077	0.110	0.116	0.061	0.095	0.094
Mean Return	0.083	0.116	0.123	0.067	0.101	0.100
Stdev	0.052	0.053	0.055	0.052	0.053	0.055
Sharpe Ratio	1.022	1.645	1.702	0.717	1.360	1.298
α_{CAPM} (per year)	0.037	0.075	0.084	0.022	0.061	0.062
α_{FF4} (per year)	0.033	0.073	0.084	0.018	0.058	0.062
$\lvert w_t \rvert$	0.015	0.012	0.012	0.015	0.012	0.012
min	0.001	0.000	0.000	0.001	0.000	0.000
max	0.029	0.067	0.066	0.029	0.067	0.065
$\sum w_t I(w\_t < 0)$	0.000	0.000	0.000	0.000	0.000	0.000
$\sum I(w_t \leq 0)$	0.000	0.385	0.408	0.000	0.383	0.403

Figure 1

Takeover Activity

The top graph shows the annual number of takeover transactions in the US and in an international sample excluding the US. The bottom graph shows the annual dollar volume in USD billions of takeover transactions in the US and in an international sample excluding the US.



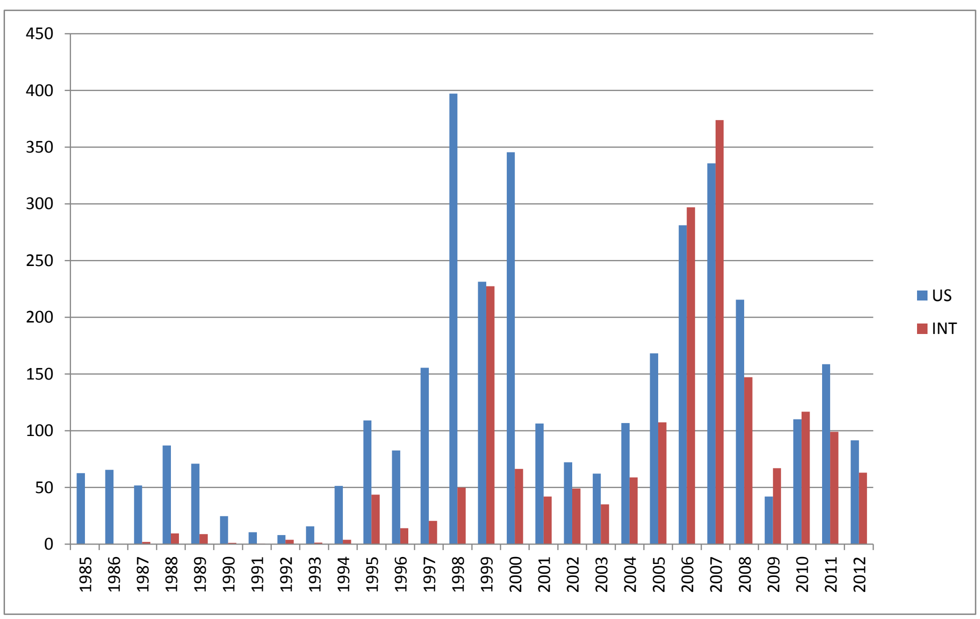
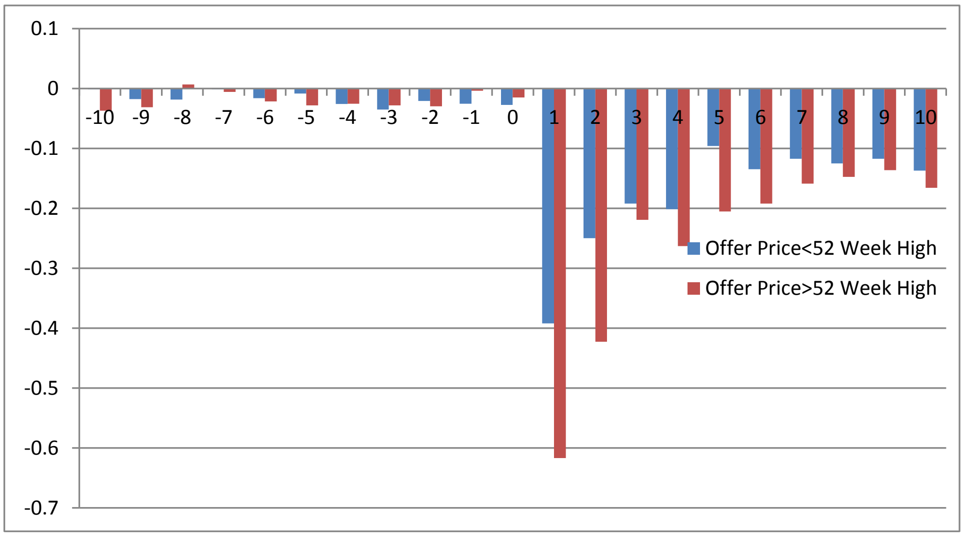


Figure 2

Net trading volume around takeover announcements

The top graph shows the average aggregate net trading volume of institutional investors as a fraction of total shares outstanding around takeover announcements (in %) separately for deals with offer prices above the 52-week high and deals with offer prices below the 52-week high. The bottom graph shows the median aggregate net trading volume of institutional investors as a fraction of total shares outstanding around takeover announcements (in %) separately for deals with offer prices above the 52-week high and deals with offer prices below the 52-week high.



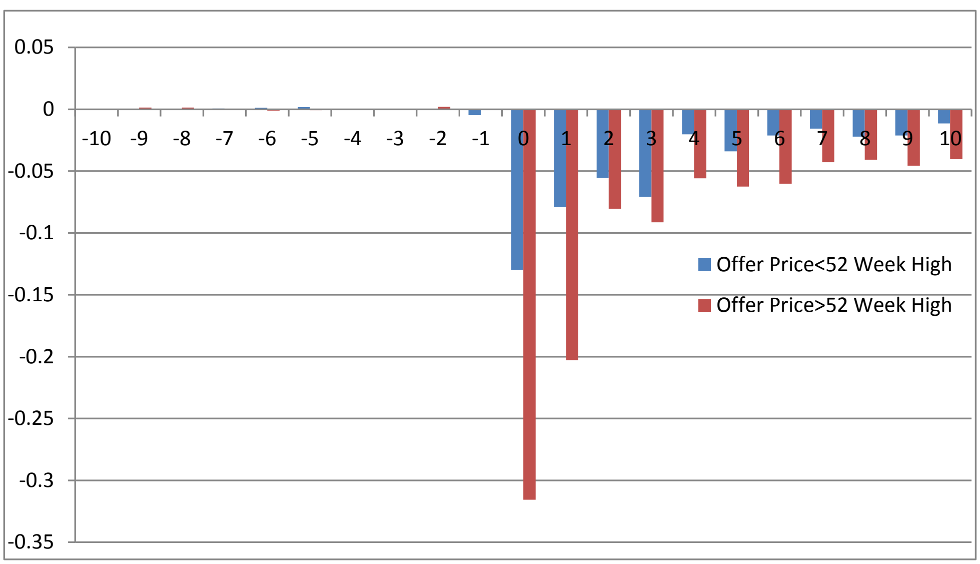


Figure 3

Confidence Interval

The solid line shows the annual parameter $\theta_{\Delta 52}$ for an optimal long-only parametric portfolio policy using only $\Delta 52$ as a conditioning variable. The portfolio policy is estimated using an expanding window beginning in December 1994 and ending in December 2011. The dashed lines show the 95% bootstrapped confidence interval.

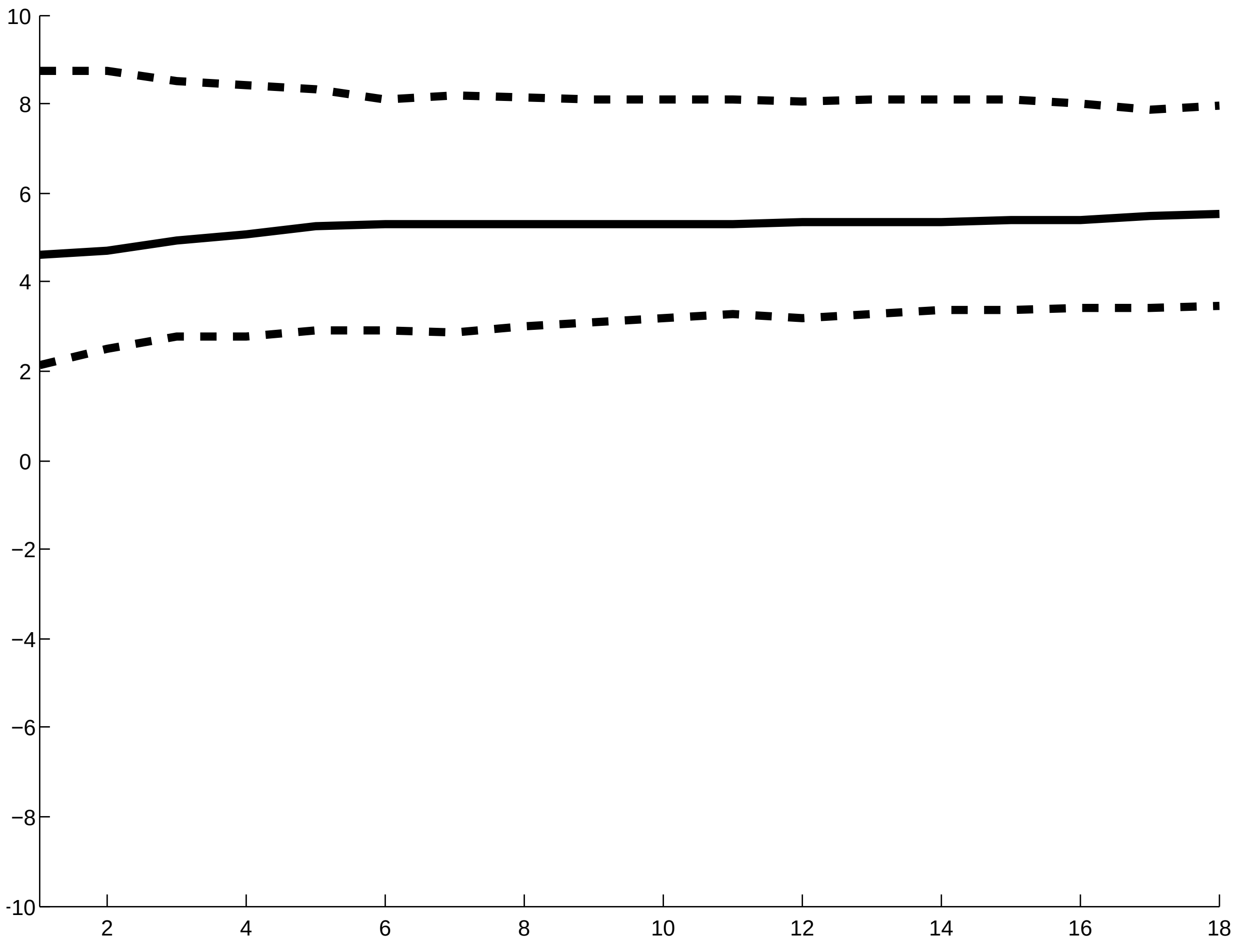


Figure 4

Trading Cost

This graph plots the median trading costs for takeover targets before and after the takeover announcement for different trade sizes. I divide all institutional transaction into 20 bins according their complexity. Complexity is defined as trade size divided by average daily trading volume in the previous 20 days. The y-axis plots median trading costs in basis point. The x-axis shows the median complexity in % of average daily trading volume for each bin.

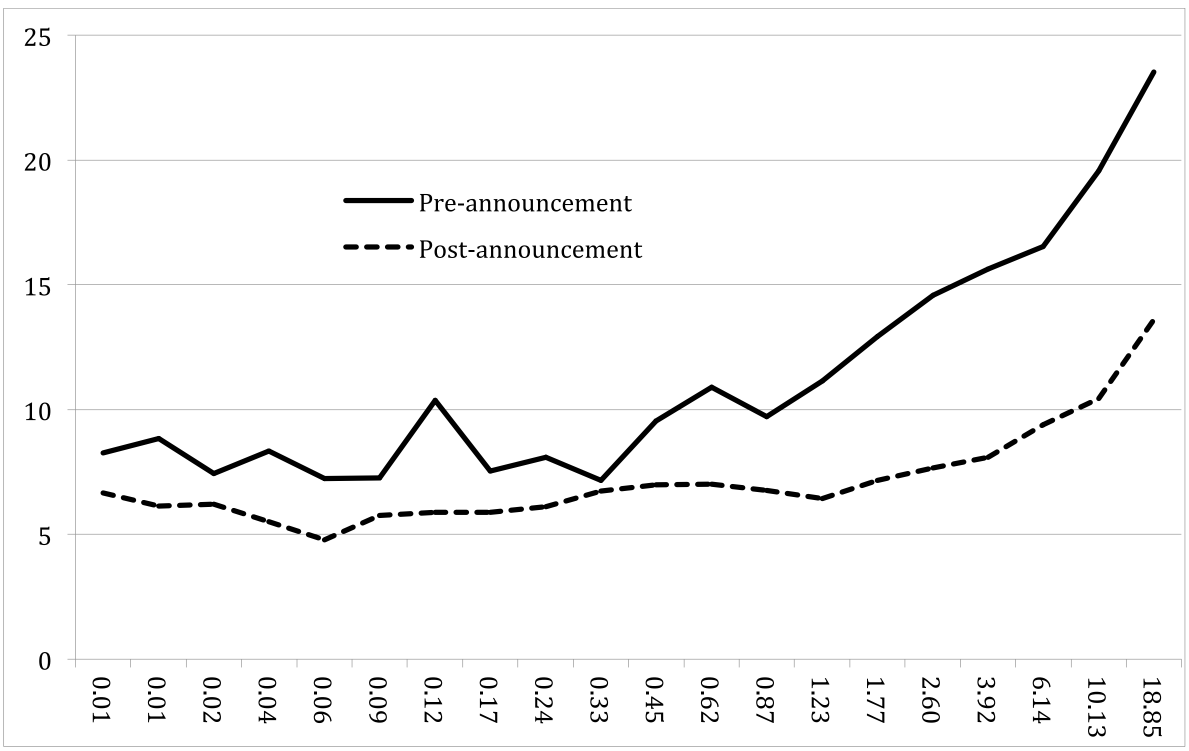


Figure 5

Out-of-Sample Returns in Risk Arbitrage

This graph shows the performance of different risk arbitrage portfolios. All the optimized portfolios are estimated out-of-sample using all eight deal characteristics shown in Table 7. The sample period runs from January 1995 to December 2012. The portfolios adjusted for non-proportional transaction costs have an initial portfolio size of USD 10 million and the used transaction cost functions are displayed in table 9 column 3.

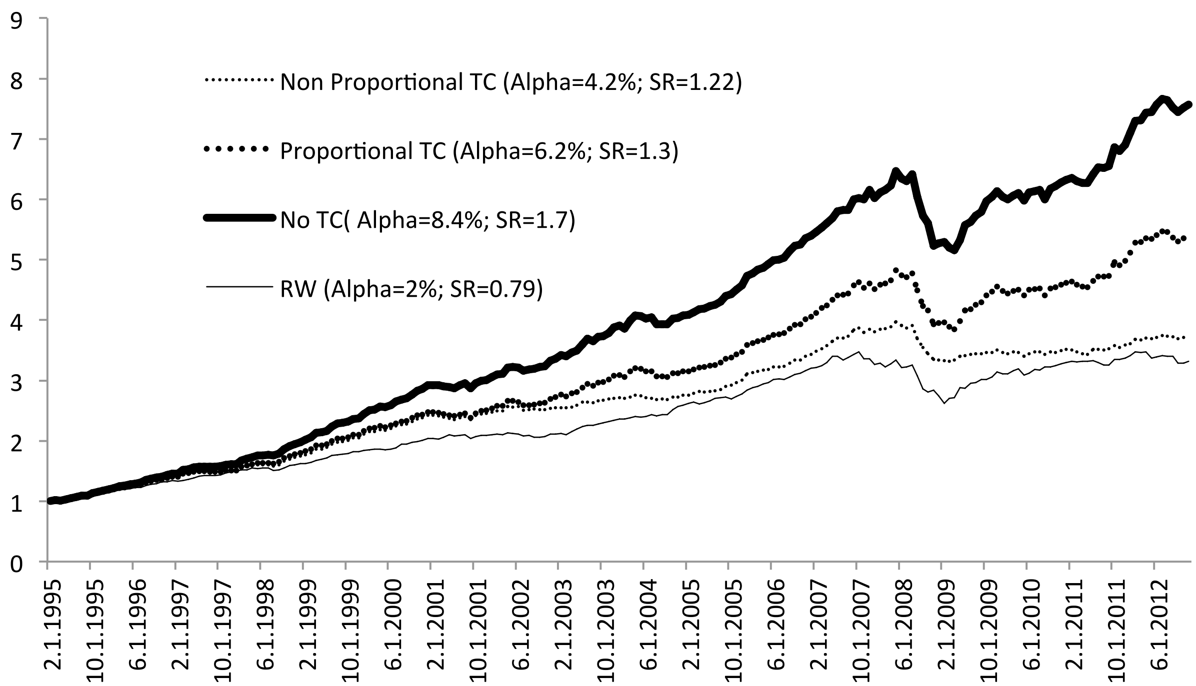


Figure 6

Scalability in Risk Arbitrage

This graph shows annual four factor alphas in the period from January 1995 to December 2012 for different levels of initial capital (in USD millions). All the optimized portfolios are estimated out-of-sample using all eight deal characteristics shown in Table 11 and the used transaction cost functions are displayed in table 9 column 3.