UK Evidence on the Profitability and the Risk-Return Characteristics of Merger Arbitrage

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ABSTRACT

With a large and comprehensive sample of 975 UK cash and stock mergers, this study is the first to provide rigorous empirical evidence on the profitability and the risk-return characteristics of the merger arbitrage strategy in a non-US context. When two linear pricing models namely CAPM and Fama and French's (1993) three-factor models are used as the benchmarks for risk adjustment, the Practitioner Arbitrage portfolio generates significant positive monthly risk-adjusted return of 0.88% and 0.93% respectively. The return to the portfolio is correlated with the market in non-linear way. In most market conditions the payoff to the portfolio is independent of market movements, but during severe market downturn, the payoff has significant positive correlation with the market. Using a contingent claim analysis to control for the non-linearity in the risk-return relation of the portfolio, we find that the portfolio can produce positive risk-adjusted return of 0.94% per month.

1. Introduction

After a merger or acquisition bid is announced, the target stock typically trades at a discount to the price offered by the bidder. The discount is termed arbitrage spread. Merger arbitrage, also commonly known as risk arbitrage, is the investment strategy designed to capture the arbitrage spread. In most cases, in which the bid goes through, the arbitrageur can earn handsome profit from the spread. In some rare events, in which the bid fails, the arbitrageurs may suffer disastrous losses. Thus the strategy is profitable but risky.

The extant studies that utilize a US sample have shown that merger arbitrage strategy is highly profitable on a risk-adjusted basis. The reported annual risk-adjusted returns to the strategy range from 7% in Baker and Savasoglu (2002) to more than 172% as in Dukes et al. (1992). While there is wide variation in the reported risk-adjusted returns mainly due to the differences in the way the return to the merger arbitrage portfolio is calculated, there is a consensus that the strategy performs very well on the US market. As far as the issue of how to adjust for risk in estimating risk-adjusted returns is concerned, most studies employ the two standard asset pricing models, the Capital Asset Price Model (CAPM) and the Fama and French's (1993) three-factor model. Mitchell and Pulvino (2001) nevertheless postulate that the risk-adjusted return, which is computed from these two models, may be biased because the models assume linear relationship between the return to the strategy and market-wide risk factors while in fact the relationship may be non-linear. On a large sample of 4750 US cash and stock mergers covering a long period from 1963 to 1998, Mitchell and Pulvino (2001) find strong evidence supporting the non-linear risk-return relation of the merger arbitrage strategy. Using the contingent claim approach to control for such non-linearity, the authors document that the merger arbitrage portfolio earns positive risk-adjusted returns of 10.3% per annum.

Outside the US market, the evidence about the profitability and the risk-return characteristics of merger arbitrage strategy is scant. To our best knowledge, there are only two studies employing a non-US sample. These studies by Karolyi and Shannon (1999) and Maheswaran and Yeoh (2005) focus on the Canadian market and the Australian market respectively. Compared to the US studies, these two studies have

very small sample size and cover a relatively short period of time. Karolyi and Shannon (1999) examine only 37 Canadian mergers for the year 1997; and Maheswaran and Yeoh's (2005) study is based on 193 Australian mergers for period of 1991-2000. Furthermore, these studies only consider cash mergers even though stock mergers are also popular. Thus, the results of these non-US studies should be subject to more rigorous confirmatory testing.

Due to the limited sample of the non-US studies, we are not sure whether the findings about the profitability and the risk-return characteristics for the US sample are the universal feature of the merger arbitrage strategy or just something peculiar to the US market. For example, the non-linear risk-return relation is found only in the US. Maheswaran and Yeoh (2005) also investigate such non-linear pattern in the Australian market but find no supporting evidence. The result of the Australian study can be interpreted in two ways. On one hand, the non-linear pattern may not be present for the Australian market. On the other hand, the sample of the study may be too small to detect the pattern.

Thus, we contribute to the extant literature on merger arbitrage with a more rigorous empirical investigation of a non-US sample. This study is the first to examine the profitability as well as the risk-return characteristics of merger arbitrage strategy on the UK merger and acquisition market, the second most active market in the world (after the US) (Sudarsanam, 2003). On a large and comprehensive sample of 975 cash and stock mergers over 20-year period from 1987 to 2006, this study is also the first to provide rigorous empirical testing in a non-US context.

Applying the calendar-time portfolio approach, three merger arbitrage portfolio return series are created. In the first series, the returns from the investment in individual mergers are equally weighted; in the second series the weight is based on the market value of the target firms. The third series, named as the Practitioner Arbitrage (PA) portfolio, is generated from the second series by imposing the restriction that the weight of each position in the portfolio does not exceed 10%. The 10% limit follows the standard rule of thumb employed by many real world merger arbitrageurs to ensure that the portfolio is insulated from any possible catastrophic loss resulting from the failure of a single bid (Moore et al., 2006). Since the Practitioner Arbitrage (PA) portfolio return

series closely mirrors the real world, our analysis will focus on this series. The analysis conducted on the other two series is also reported to provide a benchmark to compare with the results of the previous studies[1].

The result shows that merger arbitrage strategy also performs very well on the UK market. With the CAPM and Fama and French's (1993) three-factor models, the risk-adjusted return to the PA portfolio is estimated to be around 0.9% per month or 11.35% per annum. These estimates assume linear risk-return relation and, as a consequence, are likely to be biased if the relation is in fact non-linear. Applying a piecewise linear model to investigate the non-linearity, we find strong supporting evidence. Specifically, when the monthly market excess return is above -9.3%, the market beta of Practitioner portfolio is very close to zero (0.086). The market beta of the Practitioner portfolio, nevertheless, increases almost 7 times (to 0.62) when the monthly market excess return is below -9.3%. This result indicates that the returns to the strategy is market neutral in most market conditions but have significant positive systematic risk during severe market downturn. The asymmetry in the payoffs to the strategy in different market conditions is similar to the finding reported by Mitchell and Pulvino (2001) for the US market. As the result, the non-linear risk-return relation is not unique to the US market but may be a universal feature of the merger arbitrage strategy.

When the non-linear pattern is detected, as suggested by Glosten and Jagannathan (1994), the contingent claim approach is a better way to adjust for risk compared to the standard linear asset pricing models. Under the contingent claim analysis, the risk-adjusted return to the PA portfolio is estimated to be 0.94% per month or 11.88% per annum, which is slightly higher than the risk-adjusted return estimated when the linear risk-return relation is assumed.

This paper is organized as follows. Section 2 describes different aspects of a typical merger arbitrage investment and reviews the literature about the profitability and the risk-return characteristics of the merger arbitrage strategy. Section 3 articulates the data and sample selection process. Section 4 discusses the methodology for the empirical tests. Section 5 presents the empirical results. Section 6 concludes and discusses future research implications.

[1] Except for Mitchell and Pulvino (2001), the previous studies only report the result for the equally weighted and value weighted portfolio return series.

2. Literature Review

2.1. Description of merger arbitrage strategy

Merger arbitrage is an investment strategy designed to profit from the arbitrage spread. The particular trading tactics employed by an arbitrageur depends on the form of payment offered to the target shareholders. Cash and stock are two primary forms of payment in a merger. In cash mergers, the bidder offers cash to the target shareholders in exchange for the target stocks. In stock mergers , the target shareholders receive a number of the bidder's stocks for each target stock. To set up an arbitrage investment in a cash merger, the arbitrageur simply buys the target stock and sells it to the bidder for the offer price when the bid is completed. The investment in a stock deal involves buying the target stock and at the same time shorting the bidder stock. At the deal completion date the arbitrageur exchanges the target stock for the bidder stock to cover the short position[2]. In all cases, the structure of the merger arbitrage investment warrants that the arbitrageur can profit from the arbitrage spread if the bid goes through.

Two fundamental aspects of the strategy must be noted. The first aspect refers to the information set utilized by the arbitrageur. The merger arbitrage position is set up only after the merger or the bid is officially announced. In other words, the arbitrageur utilizes only publicly available information about the bid. Hetherington (1983) insists that merger arbitrage is not an insider game but utilizes only public information. Och and Pulvino (2005) state that arbitrageurs never invest in rumours; they only invest when the definitive agreement about the merger or a tender offer is announced. According to Moore (1999) and Moore et al., (2006), arbitrageurs do not bet on whether the bid occurs, instead they speculate on whether the bid will be consummated within an expected period of time.

The second aspect is about the risk in the merger arbitrage strategy. Merger arbitrage is a risky investment strategy because there is uncertainty about the final outcome of the bid. In case the bid is completed at the original or a higher offer price, the arbitrageur can make handsome profit from the arbitrage spread. If the bid is

[2] In some stock mergers that contain option-like terms i.e. collar deals, since the exchange ratio depends on levels of the bidder stock price and the target stock price at a pricing period near the deal completion date, the merger arbitrage trading tactics in these deals involves dynamic hedging. Please see Fuller (2003) and Officer (2004) for the full description of collars.

prolonged or revised downward, the arbitrageur gets smaller return or may suffer a loss. The worst scenario for the arbitrageur is when the bid is called off. In such cases, as the target stock price may fall all the way back to level of 30-40 days[3] prior to the announcement date when no information about the bid is factored into the price, the losses are usually much larger than the gains. Since substantial losses usually happen when the bid fails to complete, this risk in merger arbitrage strategy is often termed as the "deal completion" risk. Given the fact that the probability of bid failure is only around 10% (Branch and Wang, 2003; and Baker and Savasoglu, 2002), in most cases the arbitrageur can earn positive returns, the incidence of failed bid is rare but can result in disastrous losses.

Figure 1 depicts the stock price movement of the target in two cash mergers. In Panel A of Figure 1, Preussag AG completed the acquisition of Thomson Travel Group PLC after 68 days. An investment in the target stock from one day after the deal was announced to the deal consummation date would yield an annualized return of 16.62%. In Panel B, the bid for Enodis PLC by Middleby Corp failed after 67 days. A similar investment in the target stock in this case would result in a substantial annualized loss of -73.35%.

[Insert Figure 1]

Because of the uncertainty about the final outcome and the terms of the bid, merger arbitrage can also be viewed as a risk-shifting strategy whereby the target shareholders, who do not want to bear the "deal completion" risk, sell to the arbitrageurs, who are willing to. In this sense, the merger arbitrageurs provide the insurance service against the "deal completion" risk and the existence of a positive arbitrage spread reflects the premium for such service.

2.2. Profitability and Risk-Return Characteristics of Merger Arbitrage Strategy

The most important issue in evaluating the profitability of an investment strategy is how to adjust the returns from the strategy for the risk of the strategy. Though an investment strategy can generate huge return, it is not profitable if it bears too much

[3] In Schwert (1996), on average the target stock price starts to increase 41 days prior to the date when the deal is officially announced. The stock price run-up preceding the announcement date may result from insider trading or leakage of information or bidder's setting up toeholds.

risk. Thus the performance of merger arbitrage strategy should be considered on a risk-adjusted basis. In finance literature, two commonly used pricing models to benchmark the returns of an investment strategy against its risk are the Capial Asset Pricing Model (CAPM) and the Fama and French's (1993) three-factor model. Employing these models, the extant studies have documented that merger arbitrage strategy produces substantial positive risk-adjusted returns. In other words, the strategy is highly profitable.

The risk-adjusted returns earned by merger arbitrage reported by 9 studies are summarized in Table 1. Interestingly, the table shows that merger arbitrage strategy yields remarkable returns in excess of risk in several markets. For the US market where most studies are conducted (7 out of 9), the return in excess of risk is positive ranging from 7% in Baker and Savasoglu (2002) to more than 172% in Dukes et al. (1992). The huge variation in the reported returns can be attributed to the differences in the way the returns to the strategy are calculated[4]. On 37 Canadian cash and tender offers, Karolyi and Shannon (1999) report merger arbitrage returns of 33.90% in excess of the CAPM benchmark for risk. Maheswaran and Yeoh (2005) also find risk adjusted returns of 9.90% - 10.69% on the merger arbitrage portfolio consisting of 193 Australian cash mergers.

[Insert Table 1 here]

Mitchell and Pulvino (2001) posit that the excess return reported by the studies that employ CAPM and Fama and French's (1993) three-factor model may be biased because these two models assume linear relation between merger arbitrage returns and the systematic risk factors while the relation in fact might be non-linear. As the main risk in merger arbitrage strategy comes from the uncertainty about the bid outcome, which is specific for each bid, it should be expected that the strategy has little systematic risk. However, the returns from the strategy may be correlated with the market returns during severe market downturn. This is a plausible scenario if the probability of bid failure increases when the whole market is falling. A bidder that is willing to pay £3.00 for each target stock when the FTSE 100 index is at 6000 may be willing to pay only £2.50 when the index is at 5500. Thus, during severe market

[4] More detail about the way to calculate the merger arbitrage returns is discussed in section 4

downturn, there is higher chance that the bid might fail because the bidder abandons the bid. Since bid failure can result in big losses for the merger arbitrageurs, the strategy might have positive systematic risk when the market is falling. Based on this argument, Mitchell and Pulvino (2001) conjecture that the strategy has very little systematic risk or is market neutral during normal market conditions but might have significant positive systematic risk during severe market downturn.

On a sample of 4750 US cash and stock mergers from 1963 to 1999, Mitchell and Pulvino (2001) test the non-linear pattern in the risk-return relation of merger arbitrage strategy. They find that when market return is more than 4% in excess of the risk-free rate, the strategy contains approximately zero systematic risk. However, when the market return is below that threshold, the systematic risk becomes both statistically and economically significant. Because of the non-linear risk-return relation the risk-adjusted return reported by those studies employing linear pricing model may not be accurate. Glosten and Jagannathan (1994) argue that when such non-linear pattern exists, contingent claim approach is a better way to estimate the risk-adjusted return. Following this approach, Mitchell and Pulvino (2001) document that the merger arbitrage strategy produces substantial annualized risk adjusted returns of 10.3%.

Maheswaran and Yeoh (2005) also investigate the non-linear risk-return relation for the merger arbitrage portfolio consisting of 193 Australian cash mergers from 1991 to 2000. However, they found no evidence for the non-linear pattern. For the Australian sample, merger arbitrage portfolio is risk neutral in every market condition. Thus the non-linear pattern in the risk-return relation of merger arbitrage strategy is only documented for the US market.

While there is ample evidence about the profitability as well as the risk-return characteristics of merger arbitrage strategy in the US market, the evidence for non-US market is scant. To our best knowledge, for the non-US samples, there are only the two studies by Maheswaran and Yeoh (2005) and Karolyi and Shannon (1999) conducted on the Australian and Canadian market respectively. However, these studies are based on relatively small sample compared to their US counterparts. As shown in Table 1, the sample size for the study on Canadian market is only 37 and the figure for the one on the Australian market is only 193. Furthermore, these studies only consider cash

mergers while stock mergers are also popular. Thus, the results reported by the non-US studies may not be robust. Consequently, we are not sure whether the findings about the profitability and the risk-return pattern documented in the US studies are the universal characteristics of the merger arbitrage strategy or only something eccentric to the US market.

Surprisingly, given that the UK is the second most active merger and acquisition market in the world (Sudarsanam, 2003), there has not been any research on merger arbitrage utilizing a UK sample. This represents a gap in the literature. This study fills this gap by exploring the profitability and the risk-return characteristics of the merger arbitrage portfolio constructed on UK mergers. As shown later, the sample size of this study is much larger than in other non-US studies and is comparable to the US ones. Thus this study is the first to document robust empirical evidence on the profitability and the risk-return characteristics of the merger arbitrage strategy outside the US market.

3. Data and Sample Description

While the previous studies on the non-US markets only consider samples of cash mergers, in this study we also include stock mergers in our UK sample. The inclusion of two most popular types of merger in the sample would ensure that our simulated merger arbitrage return series closely mirrors the real world. Data about the UK mergers and acquisitions are taken from Thomson on-line SDC database. Because SDC recorded only a small number of deals prior to 1987, our sample period starts from 01/01/1987 and ends at 31/12/2006. To be included in our initial sample, several criteria must be met. First, the deal's consideration structure is either pure cash or pure stock. In a cash merger, the offer price paid for each target stock is fixed and does not depend on the level of the bidder's stock price. This means that the payment to the target shareholders in cash merger is not necessary made in cash. For example, the merger, in which Whittington Group PLC paid £0.95 in common stocks for each share of Ross Group PLC, is also classified as a cash merger. Even though the target shareholders receive the bidder stock in exchange for target stock, this case is not a stock merger. In a stock mergers, the number of the bidder stock offered to the target shareholders for each target stock is fixed. In this particular case, the number of the bidder stocks however are

not known in advance, only the value of the offer for each target stock is fixed and the number of bidder stocks in exchange for each target stock is known only when the bid is completed. Thus, the case is categorized as a cash merger. Second, for cash mergers, the target must be a public company listed on a UK stock exchange; for stock mergers, both bidder and target are required to be publicly traded companies. Third, the bidder is seeking to take full control of target firm. Under Section 429 of the UK Company Act (1985), if a bidder controls over 90% ownership interest of the target firm, the bidder can buy out any outstanding minority shareholders at the original offer price (Kenyon-Slade, 2004). The third requirement is therefore equivalent to the bidder seeking to purchase more than 90% of the target firm‘s outstanding shares. These criteria result in the initial sample of 1166 mergers and acquisitions.

Among these deals, 29 deals are excluded because they are just rumours or bidders' intention. The information about the announcement date and the resolution date are missing for a number of deals. After doing a search on Perfect Filings and Factiva to fill in the missing information, we discard further 60 deals. For 54 deals, the announcement date and the resolution date as recorded by SDC are the same making it impossible to invest in those deals.

The final step in selecting the sample of UK mergers and acquisitions is to get the financial data for target and bidder firms. We require that data about share price and market value over the offer period is available from Datastream for target firms in case of cash mergers and for both target and bidder firm in case of stock mergers. This requirement further reduces the initial sample by 48 deals. The final sample consists of 975 UK cash and stock mergers. Since there is no deal in January 1987, the sample starts from 01/02/1987 and ends at 31/12/2006.

Table 2 presents some descriptive statistics for the sample of UK mergers. More than 76% of the deals in the sample are cash mergers. The percentage of cash mergers is similar to a typical US sample (Mitchell and Pulvino, 2001; and Baker and Savasoglu, 2002). On average it takes 78 days for a merger to be completed or terminated. As for transaction value, the mean (£306.4 millions) is almost 8 times larger than the median (£36.9 millions) implying that there are a few very large deals in the sample that skew this variable.

[Insert Table 2 here]

4. Methodology

4.1. Portfolio Construction

There are two approaches to calculate the return to merger arbitrage portfolio: the event-time portfolio approach and the calendar-time portfolio approach. In the event-time approach, the return from investing in a single merger is first calculated for the period starting a few days after the merger announcement date and ending at the resolution date defined as the date in which the merger is officially consummated or terminated. The return from a single merger is then annualized and the return of the event-time merger arbitrage portfolio is simply the average of the annualized returns from all mergers in the sample. The event-time approach faces two serious problems. First, the process of annualizing return overestimates the actual return of the merger arbitrage portfolio because it implicitly presumes that the return from a single merger can be earned on a continual basis (Dukes et al., 1992). Second, as pointed out by Mitchell and Stafford (2000), since merger events cluster through time and by industry, the cross-sectional dependence among the returns to different arbitrage positions results in incorrect inferences about the statistical significance of the portfolio risk-adjusted return.

Because of the two problems associated with the event-time approach, this study like the recent studies in the literature will employ the calendar-time portfolio approach to calculate merger arbitrage portfolio return. In the calendar-time approach, a merger is included in the portfolio starting one day after the merger announcement and held in the portfolio until the resolution date. For successful bids, the resolution date is the date on which the bid is declared to be effective or unconditional in case the effective date is not available in SDC. For failed bids, the resolution date is the day after the date the bid is withdrawn. Using the day after the announcement date as the beginning date for the investment in a merger is consistent with the view that merger arbitrageurs only trade on public information (Moore, 1999; and Moore et al., 2006). Similarly, using the day after the withdrawn date as the resolution date for merger arbitrage investment in failed bids insured that the arbitrageurs do not exit the bid before the bidder's decision to withdraw from the bid is publicly announced. The portfolio return at each point of time

is the weighted average of the returns from the investments in all active bids in the portfolio at that time. Depending on how the returns from individual investment are weighted, different merger arbitrage return series can be generated. As shown below, in this study we will consider 3 return series.

For each day in the sample period, we calculate the daily return for all active bids in the portfolio. The return from the arbitrage position in a single bid on day *t* (day *0* is the announcement date) is the ratio of the change in the position value on day *t* to the position value on day *t-1*. As the particular investment tactics are dependent on the bid's form of payment, the return calculation differs between cash mergers and stock mergers.

For cash mergers, because the arbitrage position includes only a long position in the target stock, the position value per one stock is just the market price of the target stock. The change of the position value at day *t* is computed based on the changes in the target stock price and the dividend paid by the target firm. The equation to calculate the daily return to a position in a cash deal on day *t* is:

$$R_{it} = \frac{P_{it}^{T} + D_{it}^{T} - P_{it-1}^{T}}{P_{it-1}^{T}} \quad (1)$$

where R_{it} is the return to the investment in bid *i* on day *t* , P_{it}^{T} and P_{it-1}^{T} are the target stock price at the close of the market on day *t* and *t-1* respectively (superscript *T* refers to "target") , D_{it}^{T} is the dividend paid by the target firm of deal *i* on day *t.*

The merger arbitrage position in a stock merger includes a long position in the target stock and a short position in the bidder stock. To capture the arbitrage spread, for every long position in one target stock, arbitrageurs short d bidder stocks, where d is the exchange ratio i.e. the number of bidder stocks in exchange for one target stock. In practice, the arbitrageurs have to put the short proceeds as the cash collateral and may earn interest on the cash collateral (D'Avolio, 2002). Assuming that the rate of return on the cash collateral is the risk free rate and the amount of the cash collateral is marked to market on daily basis to match with the movement of the bidder stock price, the interest on the cash collateral on day *t* per one bidder stock being shorted is $r_{ft} P_{it-1}^{B}$, where r_{ft} is the daily risk free rate and P_{it-1}^{B} is the bidder stock price at the close of the market on

day *t-1* (superscript B refers to "bidder"). The value of the arbitrage position is simply the amount that arbitrageurs receive if they choose to close the position. In particular, arbitrageurs receive the cash from selling the target stock, the cash collateral and the interests on the collateral; arbitrageurs have to pay to buy the bidder stocks. The change in the value of the arbitrage position is computed based on the movement of the bidder and target stock price, the dividend paid by the bidder firm and the target firm and the interest on the cash collateral. The final equation to calculate the daily return to the arbitrage position in a stock deal is:

$$R_{it} = \frac{(P_{it}^{T} + D_{it}^{T} - P_{it-1}^{T}) - d\,(P_{it}^{B} + D_{it}^{B} - P_{it-1}^{B} - r_{ft} P_{it-1}^{B})}{P_{it-1}^{T} - d\,[P_{it-1}^{B} - P_{it-2}^{B}(1 + r_{ft-1})]} \quad (2)$$

The daily return of the merger arbitrage portfolio is the weighted average of the daily return from all active bids in the merger arbitrage portfolio. The formula to calculate the daily portfolio return is:

$$R_{pt} = \sum_{i=1}^{N_t} w_{it} R_{it} \quad (3)$$

where R_{pt} is the daily portfolio return, w_{it} is the weight of the arbitrage position in bid i on day t in the portfolio and N_t is the number of active bids in the portfolio on day t. In this study, we employ three weighting schemes to generate three series of merger arbitrage returns. The first series is produced when the portfolio is equally weighted. For the second series, the portfolio is weighted by the market value of the target firms. The third series is created directly from the second series by imposing the restriction that the weight of the investment in each bid does not exceed 10% of the portfolio value. In a survey of 25 merger arbitrage funds, Moore et al. (2006) find that the 10% limit on each position in the portfolio is the standard rule of thumb employed by most arbitrageurs. The limit ensures that the portfolio is insulated form catastrophic losses caused by the failure of a single bid. In setting up the third series, due to the 10% limit, if there are only a few active bids in the portfolio, some portion of the portfolio will not be invested and remain in cash. If that is the case, we assume that the cash portion of the portfolio is invested in the risk-free bond.

Because among the three series, the third one most closely resembles the practical arbitrage portfolio, we call the third series the Practitioner Arbitrage (PA)

portfolio return series. The first two series are named after the way they are weighted as the equally weighted portfolio return series and the value weighted portfolio return series.

Finally, due to the econometric problems in the estimation of the asset pricing model using daily return pointed out by Scholes and Williams (1977), like most research in the merger arbitrage literature this project employs the monthly return series. The portfolio monthly return is calculated directly from the daily returns as followings:

$$R_{pj} = \prod_{t=1}^{K_j} (1 + R_{pt}) \quad (4)$$

where R_{pj} is the return to the merger arbitrage portfolio in month j and K_j is the number of trading days in month j.

Table 3 presents some descriptive statistics for the annualized time series of monthly returns for the three arbitrage portfolios, the FTSE All Shares index as the proxy for the market portfolio and the risk-free bond. As shown, the annual compound returns to arbitrage portfolios ranging from 14.05% to 23.65% are greater than the returns to the market portfolio which is 10.57%. Furthermore, all three arbitrage portfolios have Sharpe ratio greater than the market portfolio. Figure 3 depicts the value over the sample period of £1 investment in the three arbitrage portfolios and the market portfolio starting from 01/02/1987. At the 31/12/2006, the investment in the Practitioner arbitrage portfolio grows into £31.6 but the investment in the market portfolio only translates into £7.5. These initial descriptive statistics indicates that the merger arbitrage strategy seems to perform well in the UK market.

[Insert Table 3 here]

[Insert Figure 3 here]

4.2. Empirical tests

First, similar to most previous studies on merger arbitrage, we employ two asset pricing models namely CAPM and Fama and French's (1993) three-factor model to estimate risk-adjusted returns earned by merger arbitrage portfolio.

CAPM:

$$R_{Merg.Arb} - R_f = a + b_{Mkt}(R_{Mkt} - R_f) \quad (5)$$

Fama and French's (1993) three-factor mode:

$$R_{Merg.Arb} - R_f = a + b_{Mkt}(R_{Mkt} - R_f) + b_{SMB}SMB + b_{HML}HML \quad (6)$$

where $R_{Merg.Arb}$ is the monthly return to a portfolio of merger arbitrage investments for the UK market, R_f is the risk-free rate, R_{Mkt} is the return to the market portfolio. In this study, we measure risk-free rate using three-month UK Government bond, and use the FTSE All Share index as the proxy for market portfolio. SMB is difference in returns between a portfolio of small stocks and a portfolio of big stocks, HML is the difference in returns between a portfolio of high book-to-market stocks and a portfolio of low book-to-market stocks. The construction of HML and SMB factor for the UK market follows Liew and Vassalou (2000). b is the systematic risk associated with different risk factors and is estimated with the data. The intercept a measures the average monthly risk-adjusted return. Given the existing evidence, we expect that a is significantly positive.

The application of CAPM and Fama and French (1993) three-factor model assume that the risk-return relation is linear. Mitchell and Pulvino (2001), nonetheless, find that the risk-return pattern of the merger arbitrage portfolio is non-linear for the US sample. In particular, the return to the merger arbitrage portfolio has little systematic risk in rising or flat market but has significantly positive systematic risk in severely declining market. In this study, we also investigate whether the UK merger arbitrage portfolio exhibits any non-linear risk-return pattern by estimating the following piecewise linear model:

$$\begin{aligned} R_{Merg.Arb} - R_f = {} & (1-l)[a_{Mkt.Low} + b_{Mk.Low}(R_{Mkt} - R_f)] \\ & + l[a_{Mkt.High} + b_{Mkt.High}(R_{Mkt} - R_f)] \end{aligned} \quad (7)$$

where l is a dummy variable equal to one if the market return is above a threshold level R^*_{Mkt} and 0 otherwise. For continuity, we impose the following restriction on the model:

$$a_{Mkt.Low} + b_{Mk.Low}(R^*_{Mkt} - R_f) = a_{Mkt.High} + b_{Mkt.High}(R^*_{Mkt} - R_f) \quad (8)$$

If a non-linear pattern similar to the one found in the US by Mitchell and Pulvino (2001) is detected, then the payoff pattern of the merger arbitrage portfolio is akin to writing an uncovered put option on the market index. In particular, during the normal market condition, the intercept $\alpha_{Mkt.High}$ should be positive reflecting the put premium and the systematic risk $\beta_{Mkt.High}$ should be close to zero. Nonetheless, during severe market downturn, the estimate of $\beta_{Mkt.Low}$ should be significantly greater than zero. Figure 2 depicts a graphical presentation of such non-linear patter in the risk-return relation of the merger arbitrage portfolio assuming a negative threshold.

When the risk-return relation is non-linear, Glosten and Jagannathan (1994) suggest that the risk-adjusted return should be estimated using the contingent claim approach. The general idea behind the approach is that the payoffs from £1 investment in the merger arbitrage portfolio can be replicated by a portfolio of an option on the market index and a risk-free bond. The difference between the cost of the replicating portfolio and the £1 investment represents the risk-adjusted return. More details on the contingent-claim approach applied to merger arbitrage portfolio will be presented if the non-linear risk-return pattern is detected for the UK sample.

5. Empirical Results

In this section, we present the empirical results about the profitability and the risk-return characteristics of merger arbitrage strategy on the UK market. Since the Practitioner Arbitrage portfolio most closely mirrors the real world, our discussion will focus mainly on this portfolio. As most of the previous studies have documented results only for equally weighted and value weighted arbitrage portfolio, to provide a benchmark for comparison we also report the results for these two arbitrage portfolios.

5.1. Benchmarking merger arbitrage returns using standard linear asset pricing models

To assess the profitability of the merger arbitrage portfolio in the UK, the first step is to benchmark the portfolio returns against the two standard linear asset pricing models namely CAPM and Fama and French's (1993) three-factor model. Panel A of Table 4 shows the result for the entire 239 months (20 years) of the sample period. When CAPM is used as the benchmark to adjust for risk, all three arbitrage portfolios generate significantly positive risk adjusted returns ranging from 0.6% per month for

the value-weighted portfolio to 1.2% per month for the equally weighted portfolio. The Practitioner Arbitrage portfolio also earns 0.9% returns per moth or 11.35% per annum in excess of risk. This result indicates that the strategy is highly profitable in the UK market and is consistent with the result reported in other markets.

As far as risk is concerned, the merger arbitrage portfolios have significantly positive systematic risk. However, coefficient estimates indicate that the magnitude of the systematic risk is quite small. For the Practitioner Arbitrage portfolio, the estimation shows that when the market moves 1%, the portfolio returns only move 0.14% in the same direction. Thus, the merger arbitrage portfolio is close to market neutral in the UK. This result is also consistent with the findings reported in other markets.

The result is similar when the Fama and French's (1993) three-factor is used as the benchmark to estimate risk. In fact, the coefficient estimates of the two additional factors in this model, that is, the SMB and HML, are not statistically different from zero. An F-test on these two factors, which is not reported here for brevity, also shows that the two factors are jointly insignificant. The magnitude of risk-adjusted return is almost the same as the one estimated using CAPM. As the result, Fama and French's (1993) three-factor model does no better job than the single factor CAPM in explaining the merger arbitrage return in the UK. For that reason, our analysis from now on will focus mainly on the CAPM-type model to adjust for risk.

To have some initial idea about whether there exists a non-linear pattern in the risk-return relation of the merger arbitrage portfolio similar to the one found in the US by Mitchell and Pulvino (2001), Panel B of Table 4 presents the results on the sub-sample where the excess market returns is less than -4%. Compared to the whole sample, the estimates in this sub-sample change dramatically. The coefficient estimates of the arbitrage portfolio's sensitivity with the market portfolio are almost five times larger than those in the complete sample. This is true for all three arbitrage return series. The R-squared of the regression also increases from around 4.4% for the Practitioner Arbitrage portfolio to more than 28%. This result implies that the correlation between the merger arbitrage portfolio returns and the market is much larger in market downturn than in other market conditions. Also, during severe market downturn, the market movement can explain much larger proportion of the variation in the returns to merger

arbitrage portfolios. Thus, the non-linear risk-return relation of the merger arbitrage strategy may also present in the UK market.

5.2. Piecewise linear model

To further investigate the non-linearity in the risk-return relation of the merger arbitrage portfolios, we estimate the piecewise linear model as presented in equation (7) and (8). One issue associating with the estimation of the model is to identify the threshold which separates market downturn condition from normal market conditions. In this study, we define the threshold as the value that minimizes the sum of squared residuals. Using the Practitioner arbitrage return series, we estimate the threshold to be -9.3%.

Panel A of Table 5 presents the result for the estimation of the piecewise linear model. The result clearly indicates that the risk-return relation of all three arbitrage return series is highly non-linear. In normal market conditions where the market excess return is above -9.3%, the Practitioner Arbitrage portfolio earns around a 1% rate of return in excess of the risk-free rate per month and its market beta, albeit significantly positive, is very close to zero (0.086). However, the market beta of the Practitioner Arbitrage portfolio increase by more than 7 times to 0.62 when the market excess returns is less than -9.3%. Similar pattern is found for the value weighted and equally weighted portfolio. Figure 4 depicts a graphical presentation of the result of the piecewise linear model estimation.

It is noted that if we impose the restriction that the downmarket beta is equal to upmarket beta, the piecewise linear model boils down to the standard CAPM. In other words, CAPM is nested within the piecewise linear model. Therefore, to assess the significance of the latter against the former, we perform an F-test, in which the unrestricted model is the piecewise linear model and the restricted model is the standard CAPM. As shown in Table 6, the test points out that the piecewise linear model is significantly different from CAPM. This result further confirms the non-linearity in the risk-return relation of the merger arbitrage portfolios.

The economic rationale behind the non-linear risk-return relation of the merger arbitrage strategy is that the risk of bid failure increases during severe market downturn. Because the target stock price often correlates with the market movements, when the

market is falling it is likely that the target stock price follows suit. In such condition the bidder may feel that he overpays for a depreciating asset and may renege on the bid. This scenario is true, nevertheless, mainly for those bids, in which the bidder pays cash in exchange for the target stock. In case the bidder uses his own stock in exchange for the target stock, because the price of the bidder's stock also falls during market downturn, he would not necessarily overpay for the depreciating target stock. Given that the increasing risk of bid failure during severe market downturn is mainly associated with cash mergers not with stock mergers, it would be expected that the non-linearity risk-return pattern will be stronger when the sample is limited to cash mergers than when to stock mergers.

Panel B and C of Table 5 present the estimates of the piecewise linear model when the sample is restricted to either cash or stock mergers. As anticipated, the non-linearity pattern is much stronger for the merger arbitrage investment in cash mergers than the investments in stock mergers. For the Practitioner Arbitrage portfolio return series, the downmarket beta is about 4 times larger than the upmarket beta when the sample is limited to cash mergers. When only stock mergers are considered, the portfolio's beta is not significantly different from zero at 5% level in every market conditions. The result indicates that the portfolio of cash mergers is long in market risk in market downturn but is close to market neutral in normal market condition while the portfolio of stock mergers is market neutral in all market conditions.

The result in this study about the non-linear risk relation of the merger arbitrage strategy is similar to the findings of Mitchell and Pulvino (2001) for the US market. This study is the first to document such risk-return characteristics of the merger arbitrage strategy using a non-US sample. This implies such non-linearity seem to be a more universal characteristic of the merger arbitrage portfolio, rather than something eccentric to the US market.

5.3. Contingent claim approach to estimate risk-adjusted returns

Since the non-linearity is found to be inherent in the true risk-return profile of the merger arbitrage portfolio for the UK market, the reported risk-adjusted returns using the linear pricing models as the benchmark for risk adjustment may be biased. Following Mitchell and Pulvino (2001), we will use the contingent claim approach to

re-estimate the risk adjusted returns of the merger arbitrage portfolio. The approach takes into account the non-linear pattern, therefore provides more accurate measures of the risk-adjusted returns. The general idea of the approach is that the payoffs to £1 investment in the merger arbitrage portfolio can be replicated using a portfolio of an option on the market index and a risk-free bond. If the cost of the replicating portfolio is £(1+x) then x measures the risk-adjusted return.

To set up the replicating portfolio, the first step is to examine the payoff pattern of £1 investment in the merger arbitrage portfolio. Because of the non-linear risk-return relation, the payoff to the arbitrage portfolio in severe market downturn differs from the payoff in normal market conditions. In particular, when the market excess returns is above a threshold (-9.3%), the payoff to the portfolio depends very little on the market movement. For the Practitioner Arbitrage portfolio, the upmarket beta is only 0.086, which is very close to zero. Thus in practical terms, we can set the upmarket beta to be zero. From equation (7), we can write the average monthly payoff to the £1 investment in the merger arbitrage portfolio when the market excess return is above the threshold as: $1+R_f + \alpha_{Mkt.High}$, where R_f is the monthly risk-free rate and $\alpha_{Mkt.High}$ is the upmarket intercept reflecting the average monthly rate of return in excess of risk-free rate to the arbitrage portfolio in normal market condition. By substituting equation (8) to equation (7), the average monthly payoff to £1 investment in the merger arbitrage portfolio when the market excess return is below the threshold as be written as $1+R_f + \alpha_{Mkt.High} + \beta_{Mkt.Low}(R_{Mkt} - R^*_{Mkt})$, where $\beta_{Mkt.Low}$ is the downmarket beta, R_{Mkt} is the monthly rate of return to the market portfolio and R^*_{Mkt} is the market return threshold ($R^*_{Mkt} - R_f = -9.3\%$). The average monthly payoffs to £1 investment in the merger arbitrage portfolio are summarized as follows:

	$R_{Mkt} > R^*_{Mkt}$	$R_{Mkt} < R^*_{Mkt}$
Payoff to the portfolio	$1+R_f + \alpha_{Mkt.High}$	$1+R_f + \alpha_{Mkt.High} + \beta_{Mkt.Low}(R_{Mkt} - R^*_{Mkt})$

This payoff pattern can be replicated with a portfolio that is long in a risk-free bond and is short in $\beta_{Mkt.Low}$ number of put options on the market index. Because we try to replicate the monthly payoff pattern, both the risk-free bond and the put option have one month time to maturity. The face value of the bond is $1+R_f + \alpha_{Mkt.High}$. If we assume

current market index is 1, the exercise price or the option is (1+ R^*_{Mkt}). In all market condition the bond will pay 1+R_f + $\alpha_{Mkt.High}$. Since the market index in one month is 1+ R_{Mkt}, the payoff to the short position in $\beta_{Mkt.Low}$ number of put options is 0 when the market return is about the threshold and is $\beta_{Mkt.Low}(R_{Mkt} - R^*_{Mkt})$ when the market return is below the threshold. It is easy to check that the payoff to the replicating portfolio is exactly the same as the payoff to the £1 investment in the merger arbitrage portfolio.

The final step in calculating the risk-adjusted return under the contingent claim approach is to figure out the cost of the replicating portfolio, which is simply the price of bond less the premium receive from shorting the put option. Assuming that Black-Scholes option pricing model is applicable, the cost of the replicating portfolio is therefore:

$$\frac{1+R_f+a_{Mkt.High}}{1+R_f} - b_{Mkt.Low}P(X,S,R_f,s,T-t) \quad (9)$$

where $P(X,S,R_f,s,T-t)$ is the Black-Scholes price of the market index put option. The current market index level (S) is 1, the exercise price of the option (X) is 1+R^*_{Mkt}, the risk-free rate (R_f) is 6.91% (sample average), the time to expiration date (T-t) is one month; and finally the volatility of the index calculated from the historical data is 15.78%. Plugging in these inputs to the Black-Scholes formula and the parameter estimates from the piecewise linear model to equation (9), the cost of the replicating portfolio can be easily computed.

Table 7 presents the results of the estimation of the risk-adjusted return using the contingent claim approach for the all three merger arbitrage return series. For the Practitioner Arbitrage portfolio, the cost of the replicating portfolio is £1.0094, which is £0.0094 more expensive than the investment in the merger arbitrage portfolio. This implies that the Practitioner Arbitrage portfolio generates 0.94% return in excess of risk per month. Compared to the result using CAPM and Fama and French's (1993) three-factor linear model as the benchmark for risk adjustment, the magnitude of the risk adjusted return under the contingent claim approach is slightly higher. This is also true for the value weighted and the equally weighted portfolio. The result confirms again that merger arbitrage is highly profitable in the UK.

6. Conclusion and Future Research Implications

On a large and comprehensive sample of 975 UK cash and stock mergers over the period of 1987-2006, this study is first to provide robust empirical evidence about the profitability and the risk-return characteristic of the merger arbitrage strategy in a non-US context. This is also the first merger arbitrage study for the UK market. The result shows that the Practitioner Arbitrage portfolio earn significant positive monthly risk-adjusted returns of 0.88% and 0.93% when CAPM and Fama and French's (1993) three-factor model are used as the benchmark for risk adjustment respectively. Employing a piecewise linear model, we find strong evidence about the non-linear pattern inherent in the risk-return relation of the merger arbitrage strategy. In particular, the payoff to strategy is independent of market movement in normal market conditions but positively correlates with the market during severe market downturn. Such non-linearity however applies mainly to the portfolio of cash mergers; the return to the portfolio of stock mergers is market neutral in all market conditions.

Since the relation between the return to the merger arbitrage portfolio and the market risk factor is found to be non-linear, the risk-adjusted return calculated on the assumption of linear relation is likely to be biased. Following Mitchell and Pulvino (2001), we apply the contingent claim approach to control for the non-linearity in computing risk-adjusted returns. Under contingent-claim analysis, the payoff of £1 investment to the merger arbitrage portfolio is replicated using a portfolio of a risk-free bond and a number of put options on the market index. The cost of setting up the replicating portfolio is then compared with the £1 investment to come up with the risk-adjusted return. The result shows that when the non-linearity is controlled for, the Practitioner arbitrage portfolio generates positive risk-adjusted return of 0.94% per month.

The fact that the merger arbitrage portfolio can generate positive risk-adjusted return when different risk-return models are applied raises a question of why such return is not arbitraged away. In an efficient market where an opportunity to earn positive return in excess of risk exists, professional arbitrageurs will rush to take the opportunity making the opportunity disappear. Thus the persistence of positive risk-adjusted returns generated by merger arbitrage strategy over the sample period of 20 years is quite

puzzling. Attempt to explain such puzzles can be fruitful venue for future research into merger arbitrage on the UK market.

There are three possible ways to explain the persistence of the positive risk-adjusted returns. First, transaction costs may prevent the arbitrageurs from taking the opportunity. Second, the limited arbitrage effects as proposed by Shleifer and Vishny (1997) may be present in the merger and acquisition context. The standard financial theory often assumes that the professional arbitrageurs is diversified and get unlimited access to capital. However, Shleifer and Vishny (1997) posit that in reality arbitrageurs may not be well diversified and capital-constrained. This feature of the real world arbitrageurs might help explain the existence of positive risk-adjusted returns. Third, the merger arbitrageurs can earn positive risk-adjusted return because they can play an active role in the merger process by influencing the outcome and the terms of the deal. Cornelli and Li (2002) and Gomes (2001) provide theoretical explanations for such active role; Hsieh and Walkling, (2005) report supporting empirical evidence for the active role in the US context.

REFERENCE

Baker, M. and Savasoglu, S. (2002), 'Limited Arbitrage in Mergers and Acquisitions', *Journal of Financial Economics*, Vol. 64, No. 1, pp. 91-115.

Branch, B. and Yang, T. (2006), 'A Test of Risk Arbitrage Profitability.', *International Review of Financial Analysis*, Vol. 15, No. 1, pp. 39-56.

Cornelli, F. and Li, D.D. (2002), 'Risk Arbitrage in Takeovers.', *Review of Financial Studies*, Vol. 15, No. 3, pp. 837-868.

D'Avolio, G. (2002), 'The Market for Borrowing Stock', *Journal of Financial Economics*, Vol. 66, No. 2-3, pp. 271-306.

Dukes, W.P., Frohlich, C.J. and Ma, C.K. (1992), 'Risk Arbitrage in Tender Offers', *Journal of Portfolio Management*, Vol. 18, No. 4, pp. 47.

Fama, E.F. and French, K.R. (1993), 'Common Risk Factors in the Returns on Stocks and Bonds', *Journal of Financial Economics*, Vol. 33, No. 1, pp. 3.

Fuller, K.P. (2003), 'Why Some Firms Use Collar Offers in Mergers.', *Financial Review*, Vol. 38, No. 1, pp. 127-150.

Glosten, L. and Jagannathan, R. (1994), 'A Contingent Claim Approach to Performance Evaluation', *Journal of Empirical Finance*, Vol. 1, pp. 133-160.

Gomes, A. (2001), *Takeovers, Freezeouts, and Risk Arbitrage* Working paper, University of Pennsylvania,

Hetherington, N.S. (1983), 'Taking the Risk Out of Risk Arbitrage', *Journal of Portfolio Management*, Vol. 9, No. 4, pp. 24-25.

Hsieh, J. and Walkling, R.A. (2005), 'Determinants and Implications of Arbitrage Holdings in Acquisitions.', *Journal of Financial Economics*, Vol. 77, No. 3, pp. 605-648.

Jindra, J. and Walkling, R.A. (2004), 'Speculation Spreads and the Market Pricing of Proposed Acquisitions.', *Journal of Corporate Finance*, Vol. 10, No. 4, pp. 495-526.

Karolyi, A. and Shannon, J. (1999), 'Where's the Risk in Risk Arbitrage?', *Canadian Investment Review*, Vol. 12, pp. 12-18.

Kenyon-Slade, S. (2004), *Mergers and Takeovers in the US and UK: Law and Practice*, Oxford University Press,

Larcker, D.F. and Lys, T. (1987), 'An Empirical Analysis of the Incentives to Engage in Costly Information Acquisition : The Case of Risk Arbitrage', *Journal of Financial Economics*, Vol. 18, No. 1, pp. 111-126.

Liew, J. and Vasslou, M. (2000), 'Can Book-to-Market, Size and Momentum Be Risk Factors That Predict Economic Growth?', *Journal of Financial Economics*, Vol. 57, pp. 221-245.

Maheswaran, K. and Yeoh, S.C. (2005), 'The Profitability of Merger Arbitrage: Some Australian Evidence', *Australian Journal of Management*, Vol. 30, No. 1, pp. 111.

Mitchell, M. and Pulvino, T. (2001), 'Characteristics of Risk and Return in Risk Arbitrage', *Journal of Finance*, Vol. 56, No. 6, pp. 2135-2175.

Mitchell, M.L. and Stafford, E. (2000), 'Managerial Decisions and Long-Term Stock Price Performance.', *Journal of Business*, Vol. 73, No. 3, pp. 287.

Moore, K.M. (1999), *Risk Arbitage: An Investor 's Guide.* (1st edition), Wiley, New York.

Moore, K.M., Lai, G.C. and Oppenheimer, H.R. (2006), 'The Behaviour of Risk Arbitrageurs in Mergers and Acquisitions ', *Journal of Alternative Investments*, Vol. 9, No. 1, pp. 19.

Och, D.S. and Pulvino, T.C. (2005), 'Merger Arbitrage', in Jacobs, B. and Levy, K.N. (editor), *Market Neutral Strategies*, Wiley, New Jersey, pp. 107-130.

Officer, M.S. (2004), 'Collars and Renegotiation in Mergers and Acquisitions.', *Journal of Finance*, Vol. 59, No. 6, pp. 2719-2743.

Scholes, M. and Williams, J. (1977), 'Estimating Betas From Nonsynchronous Data ', *Journal of Financial Economics*, Vol. 5, No. 3, pp. 309-327.

Schwert, G.W. (1996), 'Markup Pricing in Mergers and Acquisitions,', *Journal of Financial Economics*, Vol. 41, No. 2, pp. 153-192.

Shleifer, A. and Vishny, R.W. (1997), 'The Limits of Arbitrage.', *Journal of Finance*, Vol. 52, No. 1, pp. 35.

Sudarsanam, S. (2003), *Creating Value From Mergers and Acquisitions - The Challenges* (1st edition), Prentice Hall, Harlow, England.

Thosar, S. and Trigeorgis, L. (1994), 'Post-Announcement Risk Arbitrage Returns in the Eighties: A Study of Optionable Takeover Stocks', *The Journal of Business and Economic Studies*, Vol. 2, No. 2, pp. 49.

TABLES

Table 1: Merger arbitrage abnormal returns

This table summarizes the results of 9 studies that apply the Capital Asset Pricing Model (CAPM) and Fama and French (1993) three-factor model (F&F) to calculate the risk-adjusted return to the merger arbitrage strategy. Two approaches are applied to calculate the merger arbitrage portfolio returns. In the event-time approach, the return to the investment in each bid is computed for the period starting a few days after the announcement date ending at the date, on which the bid is completed or terminated; the portfolio return is the average of the annualized returns from all bids in the sample. In the calendar-time approach, a merger deal is included in the portfolio at a few days after the announcement date and excluded from the portfolio at the date, on which the bid is competed or terminated. The portfolio return at each point of time is the average of the returns from all active bids in the portfolio at that time. The calendar time approach produces a time series of merger arbitrage portfolio returns.

Studies	**Sample**	**Annualized abnormal returns (a)**	
		CAPM	**F&F**
Event-time approach			
Larcker and Lys (1987)	111 US cash tender offers from 1977 to 1983	14.51%	N/A
Dukes et al. (1992)	761 US cash tender offers from 1971 to 1985	172%	N/A
Thosar and Trigeorgis (1994)	63 US cash tender offers from 1981 to 1987	42.08%	N/A
Karolyi and Shannon (1999)	37 Canadian cash tender offers in 1997	33.90%	N/A
Calendar-time approach			
Mitchell and Pulvino (2001)	4750 US cash and stock deals from 1963 to 1999	9.90%	9.25%
Baker and Savasoglu (2002)	1901 US cash and stock deals from 1981 to 1996	9.77%	7.31%
Jindra and Walkling (2004)	362 US cash tender offers from 1981 to 1995	N/A	26.82%
Maheswaran and Yeoh (2005)	193 Australian cash deals from 1991 to 2000	10.69%	9.90%
Branch and Wang (2006)	1309 US cash and stock deals from 1990 to 2000	22.42%	N/A

Table 2: Sample Description

This table presents a summary of the mergers used in this paper. Only pure cash and pure stock mergers are included. The deal duration is the number of days from the announcement date to the date when the deal is completed or terminated. The deal value in GBP is recorded in SDC. For deal duration and deal value, the figure in the parentheses is median, the other one is mean.

Year	Number of deals announced	Percentage of cash deals	Average Deal Duration (days)	Avergage Deal Value (£ millions)
1987	21	52.38%	68 (46)	292.8 (30.8)
1988	27	81.48%	123 (62)	464 (62.4)
1989	41	78.05%	100 (67)	245.9 (43.4)
1990	27	77.78%	161 (70)	63 (15.8)
1991	47	65.96%	61 (50)	67.7 (17.5)
1992	24	62.50%	75 (56)	23.6 (14.4)
1993	24	58.33%	88 (60)	60.2 (9.7)
1994	21	57.14%	56 (43)	72.1 (19.4)
1995	26	76.92%	86 (60)	183.5 (23.7)
1996	25	48.00%	65 (56)	193.2 (47.4)
1997	50	68.00%	72 (60)	366.3 (50.9)
1998	73	72.60%	69 (64)	225.8 (31.2)
1999	105	78.10%	73 (70)	167.3 (38)
2000	82	78.05%	69 (66)	352.2 (47)
2001	39	74.36%	69 (65)	401.7 (15.8)
2002	45	84.44%	76 (55)	224.7 (17.8)
2003	74	83.78%	88 (49)	170.5 (30.3)
2004	41	75.61%	67 (52)	215.2 (39.9)
2005	68	89.71%	80 (67)	413.1 (92.7)
2006	115	86.09%	69 (62)	829.5 (99.9)
Complete Sample	975	76.21%	78 (62)	306.4 (36.9)

Table 3: Annual Arbitrage Portfolio Return Series

This table presents the annual return series for 3 merger arbitrage portfolios. In the equally weighted portfolio, the returns from individual bids are equally weighted. In the value weighted portfolio, the weight of each individual bid is based on the market value of the target firm. The Practitioner portfolio is created from the value weighted portfolio by imposing the 10% limit on the weight of individual bid.

Year	Market Portfolio Return	Risk-free Rate	Practitioner Portfolio Return	Equally Weighted Portfolio Return	Value Weighted Portfolio Return
1987	0.07%	8.50%	-5.57%	-21.35%	-15.04%
1988	11.53%	9.53%	14.22%	49.73%	25.48%
1989	36.09%	13.14%	7.79%	3.28%	11.74%
1990	-9.72%	14.20%	0.06%	-5.45%	1.32%
1991	20.80%	11.05%	41.22%	41.84%	21.43%
1992	20.49%	9.11%	13.94%	21.97%	12.59%
1993	28.39%	5.28%	17.40%	25.60%	20.95%
1994	-5.85%	5.19%	37.99%	82.74%	31.97%
1995	23.85%	6.46%	14.85%	25.17%	24.05%
1996	16.70%	5.87%	20.90%	34.04%	15.99%
1997	23.56%	6.53%	10.91%	9.38%	6.79%
1998	13.77%	7.05%	57.58%	46.65%	62.50%
1999	24.20%	5.14%	32.44%	42.13%	43.66%
2000	-5.90%	5.88%	33.59%	30.97%	1.79%
2001	-13.29%	4.94%	12.82%	11.67%	0.94%
2002	-22.68%	3.90%	33.65%	61.29%	23.87%
2003	20.86%	3.60%	18.95%	26.92%	7.12%
2004	12.84%	4.45%	0.49%	-0.73%	-24.35%
2005	22.04%	4.61%	9.73%	12.08%	7.30%
2006	16.75%	4.66%	22.62%	20.07%	32.70%
Annually Compounded Rate of return	10.57%	6.91%	18.84%	23.65%	14.05%
Annual Standard Deviation of return	15.78%	0.82%	10.46%	15.18%	17.74%
Sharpe Ratio (Annual)	0.67	8.44	1.80	1.56	0.79

Table 4:Benchmarking merger arbitrage return series with linear pricing models

This table presents the result when the return to merger arbitrage portfolio is benchmarked against Capital Asset Price Model (CAPM) and Fama and French's (1993) model (F&F):

CAPM: $R_{Merg.Arb} - R_f = a + b_{Mkt}(R_{Mkt} - R_f)$

F&F: $R_{Merg.Arb} - R_f = a + b_{Mkt}(R_{Mkt} - R_f) + b_{SMB}SMB + b_{HML}HML$

where $R_{Merg.Arb}$ is the monthly return to the merger arbitrage portfolio, R_f is the risk-free rate, R_{Mkt} is the return to the market portfolio. In this study, we measure risk-free rate using three-month UK Government bond, and use FTSE All share index as the proxy for the market portfolio. SMB is difference in returns between a portfolio of small stocks and a portfolio of big stocks, HML is the difference in returns between a portfolio of high book-to-market stocks and a portfolio of low book-to-market stocks, b is the systematic risk associated with different risk factors, the intercept a measures the average monthly risk-adjusted returns

Dependent Variables	α	β_{Mkt}	β_{HML}	β_{SMB}	Adj.R^2	Sample Size
Panel A: Complete Sample						
Practitioner portfolio returns	0.0088	0.1475			0.044	239
	(0.0019)***	(0.0425)***				
Practitioner portfolio returns	0.0093	0.1449	-0.0979	0.0257	0.045	239
	(0.0021)***	(0.0473)***	(0.1008)	-0.064		
Value weighted portfolio returns	0.0056	0.2914			0.063	239
	(0.0032)*	(0.0707)***				
Value weighted portfolio returns	0.0059	0.2882	-0.1415	0.0390	0.061	239
	(0.0035)*	(0.0792)***	(0.1687)	-0.107		
Equally Weighted portfolio returns	0.0123	0.2475			0.061	239
	(0.0028)***	(0.0609)***				
Equally Weighted portfolio returns	0.0133	0.2507	-0.1384	0.0502	0.064	239
	(0.0030)***	(0.0684)***	(0.1456)	-0.092		
Panel B: Market Excess Return < - 4%						
Practitioner portfolio returns	0.0382	0.4914			0.287	36
	(0.0106)***	(0.1265)***				
Practitioner portfolio returns	0.0357	0.5105	0.2018	0.1755	0.276	36
	(0.0113)***	(0.1306)***	(0.2179)	(0.1507)		
Value weighted portfolio returns	0.0457	0.7381			0.160	36
	(0.0223)**	(0.2662)***				
Value weighted portfolio returns	0.0398	0.7639	0.3838	0.3148	0.132	36
	(0.0240)	(0.2768)***	(0.4618)	(0.3192)		
Equally Weighted portfolio returns	0.0715	0.9560			0.381	36
	(0.0169)***	(0.2013)***				
Equally Weighted portfolio returns	0.0693	0.9744	0.1627	0.1978	0.354	36
	(0.0183)***	(0.2105)***	(0.3512)	(0.2428)		

*, **, *** indicate significance at 10%, 5% and 1% levels, respectively

Table 5: Piecewise linear model

This table presents the result in estimating the piecewise linear model relating the merger arbitrage return to market return:

$$R_{Merg.Arb} - R_f = (1-l)[a_{Mkt.Low} + b_{Mk.Low}(R_{Mkt} - R_f)] + l[a_{Mkt.High} + b_{Mkt.High}(R_{Mkt} - R_f)]$$

where $R_{Merg.Arb}$ is the monthly return to the merger arbitrage portfolio, R_f is the risk-free rate, R_{Mkt} is the return to the market portfolio, l is a dummy variable equal to one if the market return is above a threshold level R^*_{Mkt} and 0 otherwise. Results are presented for the threshold level of -9.3%. For continuity, we impose the following restriction on the model:

$$a_{Mkt.Low} + b_{Mkt.Low}(R^*_{Mkt} - R_f) = a_{Mkt.High} + b_{Mkt.High}(R^*_{Mkt} - R_f)$$

Dependent Variables	α_{MktLow}	$\alpha_{MktHigh}$	β_{MktLow}	$\beta_{MktHigh}$	Adj. R^2
Panel A: Complete Sample					
Practitioner portfolio returns	0.0591	0.0096	0.6184	0.0859	0.075
	(0.0171)***	(0.0019)***	(0.1648)***	(0.0467)*	
Value weighted portfolio returns	0.0971	0.0070	1.1476	0.1793	0.099
	(0.0284)***	(0.0032)***	(0.2733)***	(0.0775)***	
Equally Weighted portfolio returns	0.1183	0.0140	1.2400	0.1176	0.130
	(0.0240)***	(0.0027)***	(0.2312)***	(0.0656)*	
Panel B: Cash Deals					
Practitioner portfolio returns	0.0273	0.0065	0.3577	0.1337	0.095
	(0.0132)**	(0.0015)***	(0.1273)***	(0.0361)***	
Value weighted portfolio returns	0.098832	0.007923	1.18308	0.2056	0.1449
	(0.0246)***	(0.0028)***	(0.2369)***	(0.0672)***	
Equally Weighted portfolio returns	0.1100	0.0110	1.2987	0.2341	0.15
	(0.0268)***	(0.0030)***	(0.2580)***	(0.0732)***	
Panel C: Stock Deals					
Practitioner portfolio returns	0.0339	0.0045	0.2766	-0.0392	0.006
	(0.0162)**	(0.0018)**	(0.1559)*	(0.0442)	
Value weighted portfolio returns	0.1228	0.0053	1.157069	-0.1063	0.0173
	(0.0488)**	(0.0055)	(0.4689)**	(0.1330)	
Equally Weighted portfolio returns	0.1397	0.0114	1.1878	-0.1925	0.0178
	(0.0525)***	(0.0059)*	(0.5049)**	(0.1432)*	

*, **, *** indicate significance at 10%, 5% and 1% levels, respectively

Table 6: F-test of the piecewise linear model against standard CAPM

This table presents the F-test of the piecewise linear model against standard CAPM. The unrestricted model is the piecewise linear model:

$$R_{Merg.Arb} - R_f = (1-l)[a_{Mkt.Low} + b_{Mk.Low}(R_{Mkt} - R_f)] + l[a_{Mkt.High} + b_{Mkt.High}(R_{Mkt} - R_f)]$$

The definition of all variables in the model is same as Table 5. By imposing the following linear restriction:

$$b_{Mkt.Low} = b_{Mkt.High}$$

The piecewise linear model becomes the standard CAPM

	Threshold $R_{Mkt} - R_f$	F-statistic
Practitioner portfolio	-9.30%	8.7446
		(0.0034)
Value weighted portfolio	-9.30%	19.69173717
		(0.0000)
Equally Weighted portfolio	-9.30%	10.48595411
		(0.0014)

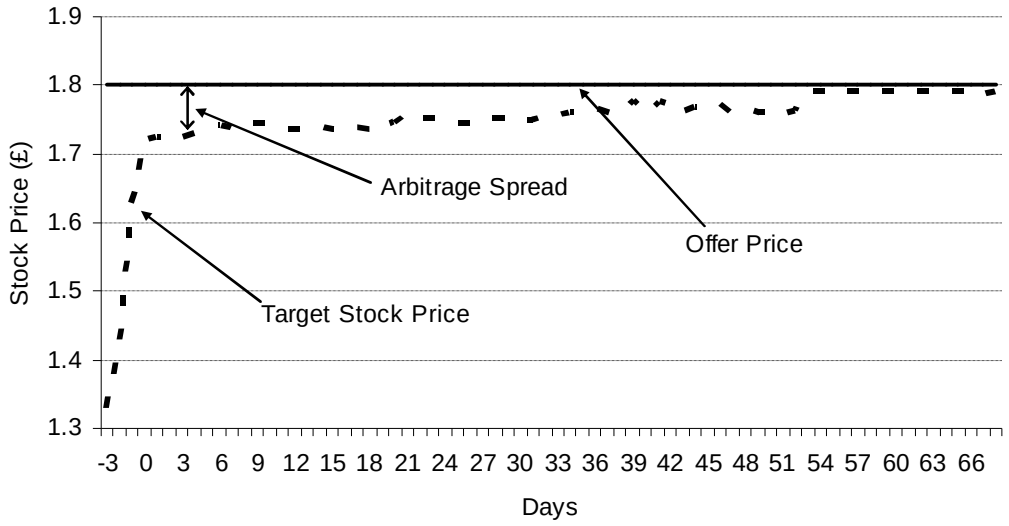
Table 7: Risk adjusted return estimation using contingent claim approach

This table presents the result in estimating the risk-adjusted return to the merger arbitrage portfolio using contingent claim analysis. The payoff to £1 investment to the merger arbitrage portfolio is replicated by a portfolio that is long in one risk-free bond with the face value of $1+R_f + \alpha_{Mkt.High}$ and short β_{MktLow} number of put options on the market index. The price of the put option is calculated using Black-Scholes fomula.

	Practitioner portfolio	Value weighted portfolio	Equally Weighted portfolio
$\alpha_{MktHigh}$	0.0096	0.007034	0.013954
β_{MktLow}	0.6184	1.1476	1.239951
Risk-free Rate (monthly)	0.56%	0.56%	0.56%
Price of the bond	1.0095	1.0070	1.0139
Inputs for Black-Scholes formula:			
Current Market Index	1	1	1
Exercise Price	0.9070	0.9070	0.9070
Time to expiration (years)	0.0833	0.0833	0.0833
Risk-free Rate (annually)	6.91%	6.91%	6.91%
Volatity (annually)	15.78%	15.78%	15.78%
Price of the put option	0.000173	0.000173	0.000173
Cost of the replicating portfolio	1.009425	1.006796	1.013661
Risk adjusted Returns (monthly)	**0.94%**	**0.68%**	**1.37%**

FIGURES

Panel A: Successful Merger - Preussag AG bid for Thomson Travel Group PLC



Panel B: Failed Merger - Middleby Corp bid for Enodis PLC

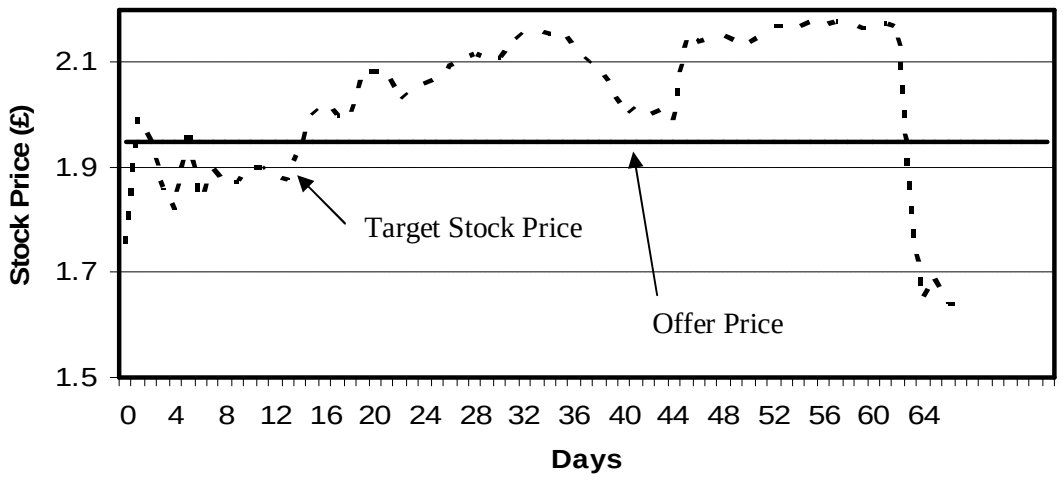


Figure 1: This figures plot the movements of target stock prices in two cash mergers. Panel A represents a successful merger; Panel B represent a failed mergers

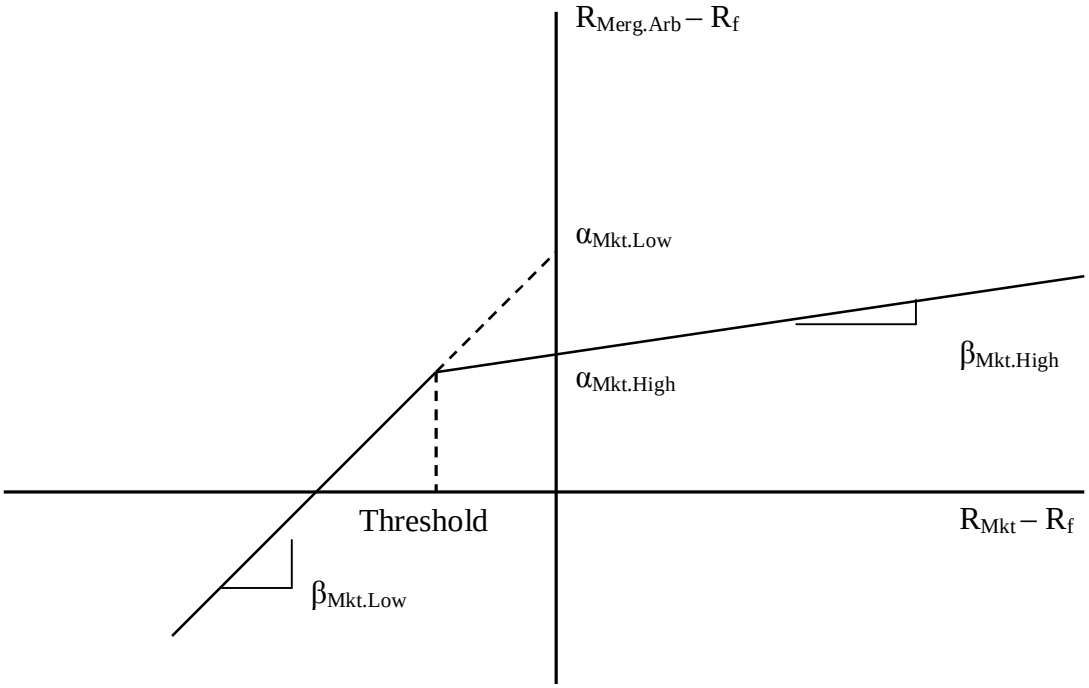


Figure 2: This figure plot the piecewise linear model specified in equation (3) and (4). $R_{Merg.Arb}$ is the monthly return to the merger arbitrage portfolio, R_f is the risk-free rate, R_{Mkt} is the return to the market portfolio. $\beta_{Mkt.Low}$ and $\alpha_{Mkt.Low}$ are the slope coefficient and the intercept when the different between the market return and the risk-free rate is below the threshold. $\beta_{Mkt.High}$ and $\alpha_{Mkt.High}$ are the slope coefficient and the intercept when the different between the market return and the risk-free rate is above the threshold.

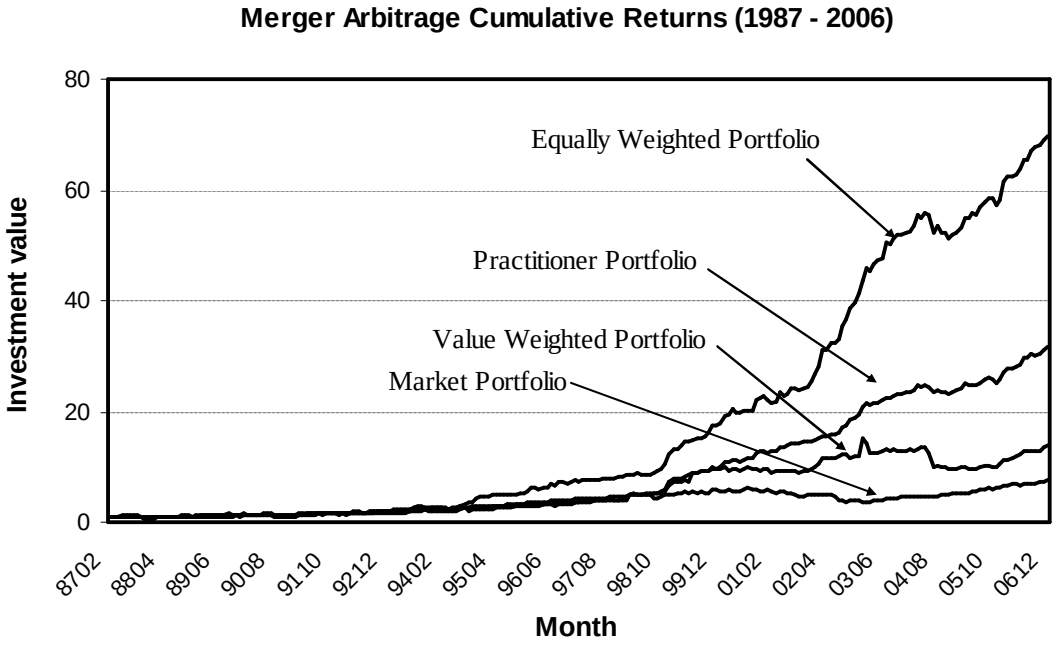


Figure 3: This figure plots the value, over the time period of 01/02/1987 to 31/12/2006, of £1 investment at 01/02/1987 in three merger arbitrage portfolio return series and the market portfolio.

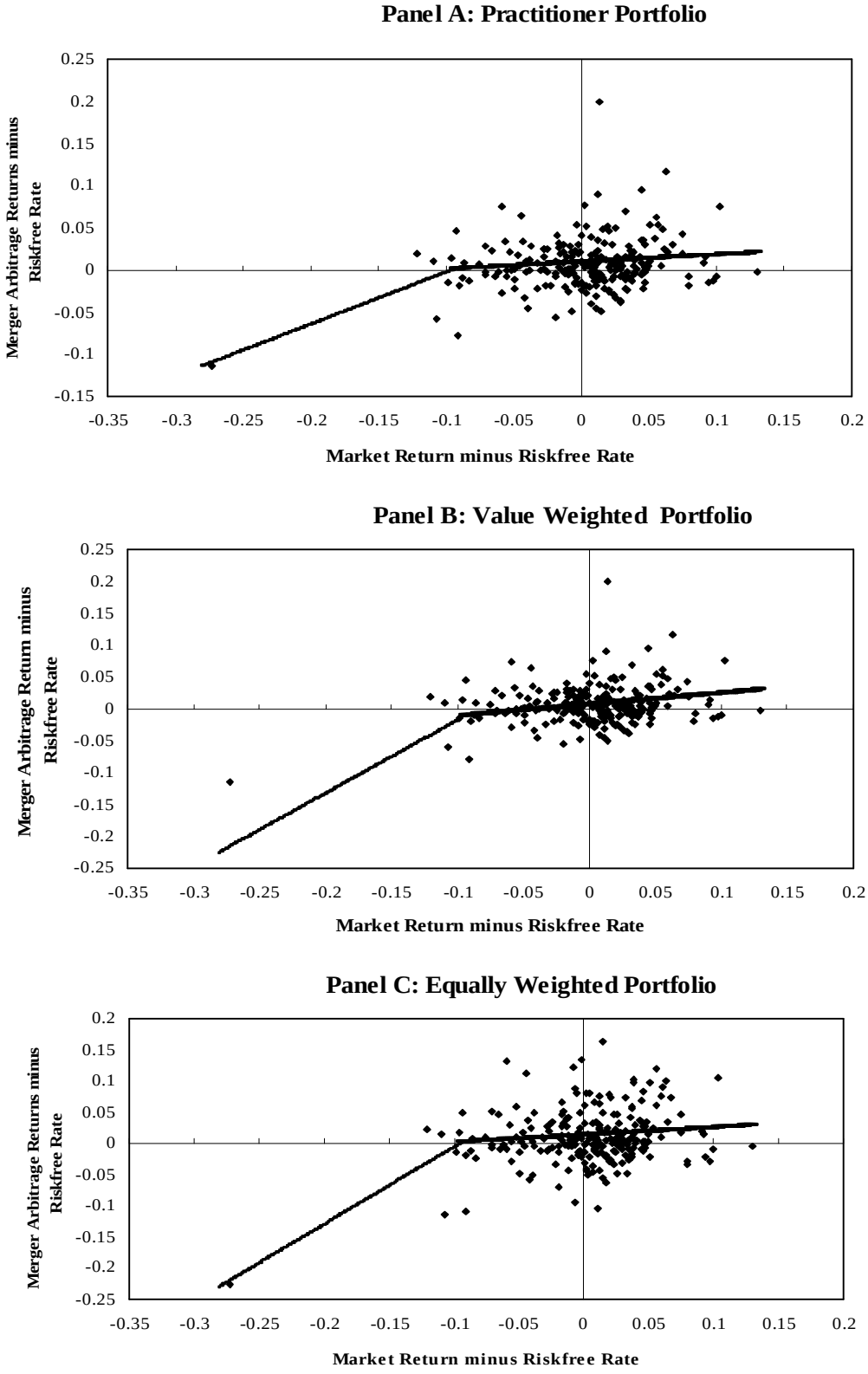


Figure 4: This figure depicts the merger arbitrage return series against the market returns. The fit line estimated from the piecewise linear model is also plotted