A MATHEMATICAL SOLUTION TO SEEKING ARBITRAGE OPPORTUNITY IN M&A

by

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Declaration

The work contained in this thesis is my own work unless otherwise stated.

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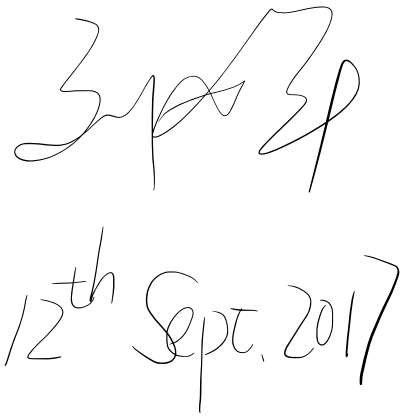

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Contents

1 Introduction

Mergers and acquisitions (M&A) usually represent the consolidation of companies or assets. One M&A deal may have different kinds of transactions, such as mergers, acquisitions, tender offers, acquisition of assets and so on. A merger is a deal that combines two existing firms to one new firm. After the merger deal has done, the acquired company will become one part of the acquiring company. Differently, the acquiring company usually only obtain the majority shares of stock of the acquired company in an acquisition deal. The acquired company does not need to change its name or structure at all.

In general, mergers and acquisitions aim to help companies expand its new segments or gain more market share. All these activities could increase efficiency to help deliver value to the shareholders. Pricing of M&A is difficult and this gives rise to arbitrage opportunities. A great mount of substantial trading will then be stimulated based on the corresponding investment strategies.

Merger arbitrageurs aim to seek abnormal returns around the event days of their target deals. All completing or withdrawn merger deals have announcement dates and closing dates. New information will be revealed when a new merger deal announces. The future distribution of returns on corresponding stocks will be then changed and make it potentially profitable to trade these stocks. The excess demand in the market arises both on announcement date and closing date, the

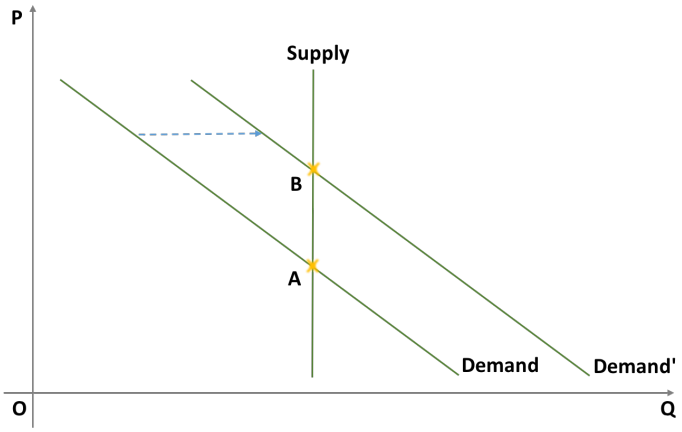


Figure 1: Supply and Demand curves for stocks

extra demand triggered by mergers could change the downward excess demand curves for stocks, thus the stock price changes. For example, we assume that the excess demand for longing a stock appears at a time. See Figure 1, the demand curve will moved right from *Demand* to *Demand*′. The equilibrium point will then move from A to B, which refers to the increase of stock price at this time.

In Figure 1, we assume the demand curve is skew and the supply curve is vertical. On the one hand, we know that the real capital market is incomplete. That is to say, there may be no

enough liquidity when the arbitrageurs want to buy or sell one stock. Thus the demand curve for acquirer stocks cannot be entirely elastic. On the other hand, if the acquiring company did not issue new shares, the supply of stock usually would not change during the merger negotiation period. Therefore the supply curve should be vertical during this time period.

There are a few different kinds of mergers in the market. In the cash-financed merger deals, the acquiring firms will pay a fixed amount of cash to acquire the target firms. Shares of the target firm will be exchanged to the shares of the acquiring firm in a stock-financed merger deals. It is usually a long period from the deal announcing to its end. The stock price sometimes changes a lot during the merger period. So the exchange ratio could be fixed or floating during the merger period to avoid great price changes. Fix-exchange ratio stock merger deals make sure the exchange ratio when the deals are announced.

A floating-exchange ratio stock merger offer generally specifies the value (V_{offer}) of each target share at the announcement date and the exchange ratio will be determined later after a pricing period. The pricing period is pre-specified on announcement date. The final exchange ratio is calculated by dividing the offer value (V_{offer}) by the acquirers average stock price during the pricing period.

A more complicated stock-financed merger type, named Collars, is also sometimes used to make sure that the total equity value of target firm will not be larger than the acquiring firms. It usually contains a floating-exchange ratio merger with boundaries on the exchange ratio, or a fixed- exchange ratio merger with boundaries on the value of the acquirer stock.

Whats more, the relative size of the acquirer and the target varies for different types of stock mergers. Acquirers prefer floating-exchange ratio stock merger to fixed-exchange ratio stock merger if its target size is relative small. Then it is hardly possible for the target firm to grow larger than the acquirers size to take a large proportion of the new firm. The relative size of target and acquirer of a collar deal will fall in between a floating stock merger and a fixed stock merger.

The relative sizes are also different for cash-financed merger deals and stock-financed merger deals. Usually the acquiring firm market size is relatively bigger in a cash-financed merger deal. The target firm prefers to exchange stocks rather than receive cash if its total market value reaches up to 10% or more of the acquirer's total market size. Under this condition, the shareholders of the target firm may have a significant influence on the new firm's business decisions after merger or acquisition.

Furthermore, compared with stock-financed merger, acquiring firms choose to use cash to pay if its stock traded in the market is undervalued. Only when the acquirer stock is overvalued will it be willing to issue new shares to exchange the shares of the target firms. Therefore, the new information for cash mergers revealed at announcement date is that the acquiring firm is undervalued. Merger arbitrageurs will long the acquirer stocks and the acquirer stock price will

then grow up after the announcement day. On the contrary, the stock price of acquiring firm who announce a stock merger plan will tend to decrease due to the price pressure triggered by short selling behavior of merger arbitrageurs.

From an economic perspective, trading strategies tracking mergers and acquisitions is also profitable around the closing date. From previous discussion, we know that the demand curve cannot be entirely elastic and the supply curve is vertical. For stock-financed mergers, new shares will be issued to exchange the target firm shares and the supply curve will shift to the right. Then the equilibrium in the equity market will shift from point A to point B in Figure 2. As a result, the stock price tends to decrease on closing date. But the supply curve might not be vertical during the merger period because the short selling of merger arbitrageurs provide extra liquidity in the market. So the stock prices might also go up around the closing date.

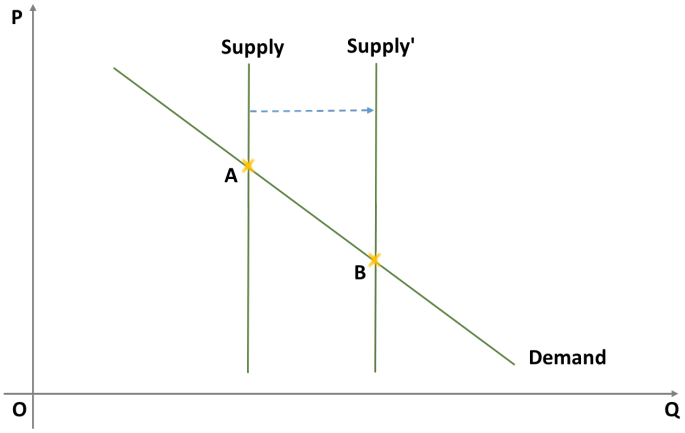


Figure 2: Supply and Demand curves for stocks

This paper tries to prove the existence of price pressure around the important event days and find a profitable trading strategy based on M&A events statistically. According to this topic, some useful literature papers are pretty useful to reference.

Michell, Pulvino and Staord (2002) tried several different methods to prove the existence of price pressure trigger by mergers and acquisitions from 1994 to 2000. In their work they explored the behaviors of acquirer stocks to find the results. On the one hand, they plotted the cumulative averaging abnormal return curves for all the varying types of merger deals to show the strange abnormal returns on event days. On the other hand, short interest was used to show the existence of trading stimulated by the announcement of mergers. Here, short interest represents the quantity of stock shares sold short by investors over some specific period which could reflect the arbitragers' trading behaviors.

Besides of this, Michell, Pulvino and Staord (2002) explored some specific merger and acquisition deals, acquirers of which were included in some important stock indexes. Then the peak of abnormal returns of stock mergers near the closing day was explained using similar methods. Fi-

nally they tried to calculate the magnitude of price pressure triggered by trading actions of merger arbitrageurs. It approximately contributed to one half of price increase around the announcement days during the time period from 1994 to 2000.

Merger arbitrage is known as risk arbitrage as well, because arbitrageurs need to take enormous risks to trade on portfolios tracking mergers and acquisitions. Michell and Pulvino (2001) have researched in this field early and shew that there existed around 4% excess returns for risk arbitrageurs per year. But this research used obsolete data during the period from 1963 to 1998. They also clarified that the excess returns generated by risk arbitrage were varying in depreciating, flat and appreciating markets.

Baker and Savasoglu (2003) demonstrated that merger arbitrage opportunities could not bring too high excess returns in actual. They proposed a conjecture that arbitrage opportunities in mergers and acquisitions were limited. In their opinions, risk arbitrageurs would face selling pressure when they wanted to short selling some stocks. From another point of view, risk arbitrageurs might not have enough capital to buy stocks. As a result, the foal of their arbitrage trading strategy would not be achieved in the end. More importantly, completion risk could influence the excess returns to risk arbitrage.

Otherwise, Cornelli and Li (2002) give different opinions. They believed the risk arbitrageurs knew their actions in the merger and acquisition deals. Therefore, risk arbitrageurs could predict the trend of stock price basing on more information they had.

Maheswaran and Yeoh (2005) give some Australian evidence to show the profitability of merger arbitrage during time period between January 1991 and April 2000. They constructed a merger arbitrage portfolio of all target firm stocks. The target stock was added into the portfolio two days after the announcing day and removed out right after the closing day. Both of the capital asset pricing model (CAPM) and Fama and French three-factor model were used to benchmark the portfolio with market portfolio. Then they still benchmarked the portfolio with transaction cost. In the end, the results exhibited positive excess returns to risk arbitrage.

According to constructing example trading portfolios, Dixon, Klabjan and Bang (2016) tried in their research as well to testify their deep neural network results. They used a five-layer feed-forward neural network to do deep learning. Then they used the model to predict the direction of stock price movements.

Both of Kim (2003) and Huang, Nakamori and Wang (2005) proposed to use support vector machine to analyze how to forecast the movement direction of some financial time series. Both of them used linear regression to classify the movements as up (positive), flat (zero) and down (positive). However Branch and Yang (2003) used a stepwise logistic regression method to estimate the prediction model, which has only two output, zero or one.

In the research of Branch and Yang (2003), they would like to predict whether a takeover deal

could be successful prior to merger closing day. Then risk arbitrageurs could select specific merger deals rather than all merger deals to trade. Thus the excess returns to merger arbitrage might become larger. Brown and Raymond (1986) did the similar work to predict the successful corporate takeovers as well but did not use the logistic machine.

In this paper, we will explore how to forecast the profitability of merger arbitrage on mergers and acquisitions as well. It is expected to have higher excess returns than the trading strategy considering all merger deals. What's more, both of the US market and the developed European market are selected in this paper to research and test because of the completeness of these two markets. And we will not distinguish the different types of stock-financed merger deals due to the lack of stock merger data.

The paper will be organized in 7 sections. Section 2 introduces all the methods, theories or models which will be used in the other parts. After that, Section 3 proves the existence of the price pressure around the announcement date and the closing date. Section 4 and Section 5 then show some key factors which could influence the profitability of the acquirer stocks. In the Section 6, a SVM approach will be first proposed to predict the profitability of the stocks of acquiring companies on its announcement date, a trading portfolio will be then constructed to test the effectiveness of regression results. Furthermore, Section 7 will try to explore acquirer stock performance for M&A deals after filtering out micro cap acquirers and targets. Finally, the conclusions and limitations will be presented in the end of this paper.

2 Methodology

2.1 Calculating Cumulative Average Abnormal Returns

We could use the variable, Cumulative Average Abnormal Return (CAAR), to test whether the arbitrage opportunity exists around specific event dates such as [1, Figure 3, Page 29]. And then CAAR curves can be plotted to prove the existence of price pressure triggered by merger and acquisition activities. Referring to the definition in [4, Event Study Methodology], CAARs could be calculated in the following three steps.

Daily abnormal returns (ARs) were first computed by using the market model

$$y = \alpha + \beta * x + \epsilon, \tag{2.1}$$

where parameters were estimated over a period of 150 days which begins 21 days after the completion date or ends 21 days before the announcement date [1]. The independent variable, x, represents the return of the market portfolio while the dependent variable, y, represents the return of the stock we test. Here, the regression coefficients α and β represent the intercept and the effect of market portfolio on the underlying stock. The error term ϵ represents the effect from other factors which might influence the return of the underlying stock. Then we have

$$r_{\text{stock}} = \alpha + \beta * r_{\text{market}} + \epsilon,$$

AR is just the difference between the real return and the estimated return on test date.

$$\text{AR}_t^i = r_t - \hat{r}_t = r_t - (\alpha + \beta * r_{\text{market},t}),$$

where t represent the test day number and i represent the sequence number of the deal or its corresponding acquirer's stock. Here we test the 20 days around the event day. Thus $t = -20, -19, ... -1, 0, 1, ..., 19, 20$, where $t = 0$ represents the event day. Average abnormal returns (AARs) were then obtained by averaging ARs of all companies in our test list

$$\text{AAR}_t = \frac{1}{n} * \sum_{i=1}^{n} \text{AR}_t^i,$$

where n refers to the total number of the merger deals we test. CAARs were finally calculated by geometric averaging all AARs from the first day to the test day

$$\text{CAAR}_t = \prod_{j=-20}^{t} (1 + \text{AAR}_j) - 1.$$

[1] In the following several sections, we assume to estimate the market model regressions without intercept to calculate ARs. In market model, valid observations need to be at least 50 to obtain convincing regression results. We use the 150-day window ending at 21 days prior to the announcement day in market model.

2.2 Find key factors influencing the abnormal returns

Referring to the discussion in [3, Section 2.1, Page7], a model of limited arbitrage was constructed. In this model, the merger offer either succeeds with probability π or fails with probability $1 - \pi$. The target shareholders would receive $1+p$ if the merger offer succeeds, otherwise they only receive 1. So p represents the premium when the deal succeeds. In the first case, for a large number of small investors with no transaction cost, the price following a takeover offer is:

$$P_1 = \mathbb{E}(\text{payoff per target share}) = 1 + \pi * p.$$

In the second case, for these investors face transaction costs, the price following a takeover offer is:

$$P_2 = 1 + \pi * p - c.$$

In the third case, for a limited number (A) of arbitrageurs without transaction costs, we assume the arbitrageurs maximize their utility with a coefficient of absolute risk aversion (γ) under the Markov mean-variance assumption. These arbitrageurs must bear completion risk. At the meanwhile, the selling shareholders must offer the arbitrageurs a risk premium to sell X shares. Therefore, the price following a takeover offer in this case is:

$$P_1 = 1 + \pi * p - \frac{X}{A} * \gamma * \pi(1 - \pi) * p^2.$$

Based on this model, Baker et al. tested the cross section implications of a limited number of arbitrageurs. Furthermore, we understand that company size is an essential factor influencing the excess returns of risk arbitrageurs. Otherwise, the industry sectors of acquiree or acquirer are quiet important as well.

2.3 Prediction the profitability of acquirer stock using logistic regression

We introduce a very simple model in machine learning, which uses a little concepts of Support Vector Machines (SVM). The logistic regression usually is used for solving binary classification problems in which the output or target (y) only takes value of zero or one. In this paper, we could define y to judge whether trading on some stock during a specific time period is profitable.

The independent variable (x) represents some features of the merger deals. It is denoted as $x = (1,\ x_1,\ x_2,\ \ldots,\ x_m)$, where m represents the number of features. Assume the total deal

number is n. Then we denote:

$$X = (x^1,\ x^2,\ \ldots,\ x^n) = \begin{pmatrix} 1 & 1 & \ldots & 1 \\ x_1^1 & x_1^2 & \ldots & x_1^n \\ x_2^1 & \ddots & \ddots & \vdots \\ \vdots & \ddots & \ddots & \vdots \\ x_m^1 & \ldots & \ldots & x_m^n. \end{pmatrix}$$

$$Y = (y^1,\ y^2,\ \ldots,\ y^n)$$

Next, we need to find the relationship between the matrix X and the vector Y.

Basic mechanics of Support Vector Machine

In machine learning method, the whole dataset will be separated into two sets, the training set and the testing set. We use samples in the training set to train our model while the testing set is used to detect the efficiency of our training model.

In our model here, a pair of $(x^i,\ y^i)$ is called a training example. The training set, $\{\ (x^i,\ y^i),\ i = 1,\ 2,\ \ldots,\ n\}$, contains all training examples. The domains of x^i and y^i are defined as $\mathcal{X} = \mathbb{R}^{(m+1)}$ and $\mathcal{Y} = \{0,\ 1\}$ respectively. Our training goal is to learn a function $h:\ \mathcal{X} \to \mathcal{Y}$ when the training set is given. The function h is called hypothesis here.

In our training, we would like to separate all deals into two part and pick out those acquirer or acquiree stocks worth to add into our trading portfolios. We could then imagine that the training feature variable exists in a m-dimensional space, $\mathcal{X}$. All points in training set are plotted in this space. The point x^i will be plotted in red if $y^i = 1$. Otherwise this point will be plotted in blue. For example, see in Figure 3. We need to find a hyperplane in this space to separate all blue spots

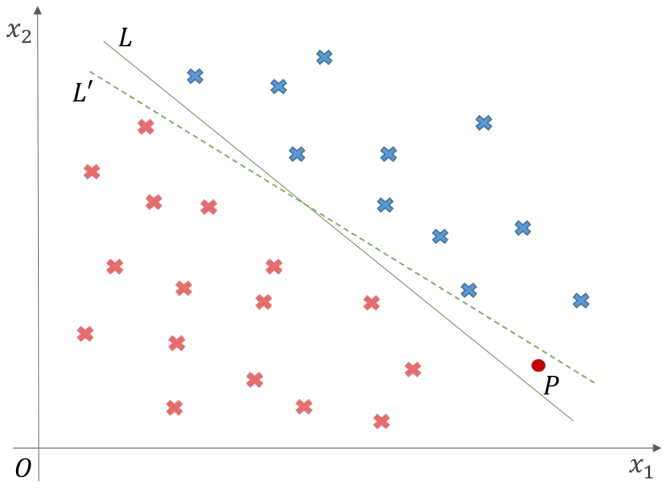


Figure 3: Support Vector Machine mechanics

and red spots, such as the green line (L) in the above figure. This hyperplane is called separating hyperplane which is correlated to the hypothesis, h.

Subsequently, we could test our results by classify the points in our testing set in $\mathcal{X}$ and comparing it with the real value of y. For example, seeing in Figure 3, point P belongs to the testing set. We use h after training to testify that it located over the separating hyperplane L, which means it should be plotted in blue. But it is plotted in red after checking its real value of y. Thus our training results is not perfect, the real separating hyperplane might be the dashed green line (L').

Logistic regression

Now we denote the class of samples with $y = 0$ or $y = 1$ as the negative or positive class. Then we assume:

$$\begin{aligned} \mathbb{P}(y \ = \ 1 \mid x; \theta) = h_\theta(x); \\ \mathbb{P}(y \ = \ 0 \mid x; \theta) = 1 - h_\theta(x). \end{aligned} \tag{2.2}$$

Then we take $y = 1$ if $h_\theta(x) > 0.5$ and $y = 0$ if $h_\theta(x) \leq 0.5$.

The Maximum Likelihood Estimate (MLE) method is used here to find the regression results. First we give the probability density function:

$$p(y \mid x; \theta) \ = \ h_\theta(x)^y (1 - h_\theta(x))^{1-y}.$$

Then the likelihood function will be:

$$\begin{aligned} L(\theta) &= p(Y \mid X; \theta) \\ &= \prod_{i=1}^{n} p(y^i \mid x^i; \theta) \\ &= \prod_{i=1}^{n} h_\theta(x^i)^{y^i} (1 - h_\theta(x^i))^{1-y^i}. \end{aligned}$$

The log likelihood function will be:

$$\begin{aligned} l(\theta) &= logL(\theta) \\ &= \sum_{i=1}^{n} y^i log \ h_\theta(x^i) \ + \ (1 - y^i) log(1 - h_\theta(x^i)). \end{aligned}$$

Therefore our goal is to find coefficients θ to the optimization problem:

$$\max_\theta l(\theta). \tag{2.3}$$

Logistic function

Assume $h_\theta(x) = g(z(x;\theta))$, then we expect the function g satisfying the conditions:

$$\begin{aligned} g(0) &= \frac{1}{2}; \\ g(+\infty) &= 1; \\ g(-\infty) &= 0. \end{aligned} \tag{2.4}$$

In order to fit these conditions in (2.4), the form of hypothesis h need to be changed. We use the logistic function or sigmoid function here:

$$g(z) \;=\; \frac{1}{1+e^{-z}}.$$

We also give the derivative of g:

$$\begin{aligned} g'(z) &= \frac{d}{dz}\frac{1}{1+e^{-z}} \\ &= \frac{1}{(1+e^{-z})^2}e^{-z} \\ &= (\frac{1}{1+e^{-z}})(1-\frac{1}{1+e^{-z}}) \\ &= g(z)(1-g(z). \end{aligned} \tag{2.5}$$

Coming back to the conditions (2.4), we know that $y = 0$ if $z(x;\theta)) < 0$ and $y = 1$ if $z(x;\theta)) > 0$. Therefore, the separating hyperplane is $z(x;\theta)) = 0$. In our model, we use a linear model for z:

$$z(x;\theta) \;=\; \theta^T x \;= \theta_0 \;+\; \theta_1 x_1 \;+\; \theta_2 x_2 \;+\; \ldots + \;\theta_m x_m.$$

Next to all of assumptions above, we could calculate the derivatives of the log likelihood function $l(\theta)$ to θ using Equation 2.5.

$$\begin{aligned} \frac{\partial l(\theta)}{\partial \theta_k} &= \sum_{i=1}^{n}[y^i\frac{1}{h_\theta(x^i)} + (1-y^i)(-\frac{1}{1-h_\theta(x^i)})]\frac{\partial}{\partial\theta_k}h_\theta(x^i) \\ &= \sum_{i=1}^{n}[y^i\frac{1}{g(\theta^T x^i)} - (1-y^i)\frac{1}{1-g(\theta^T x^i)}]\frac{\partial}{\partial\theta_k}g(\theta^T x^i) \\ &= \sum_{i=1}^{n}[y^i\frac{1}{g(\theta^T x^i)} - (1-y^i)\frac{1}{1-g(\theta^T x^i)}]g(\theta^T x^i)(1-g(\theta^T x^i))\frac{\partial}{\partial\theta_k}\theta^T x^i \\ &= \sum_{i=1}^{n}[y^i(1-g(\theta^T x^i)) - (1-y^i)g(\theta^T x^i)]\frac{\partial}{\partial\theta_k}\theta^T x^i \\ &= \sum_{i=1}^{n}[y^i - g(\theta^T x^i)]x_k^i \\ &= \sum_{i=1}^{n}[y^i - h_\theta(x^i)]x_k^i. \end{aligned} \tag{2.6}$$

Gradient Descent method

Gradient Descent is an effective method to find the solution to maximum or minimum optimization problem:

$$\max_{\theta} U(\theta) \ or \ \min_{\theta} C(\theta),$$

where U is called the utility function and C is called the cost function. We assume the utility function is smooth enough that its first-order exists. In this paper, we only discuss the maximum optimization problem and th utility function is the log likelihood function l, seeing 2.3.

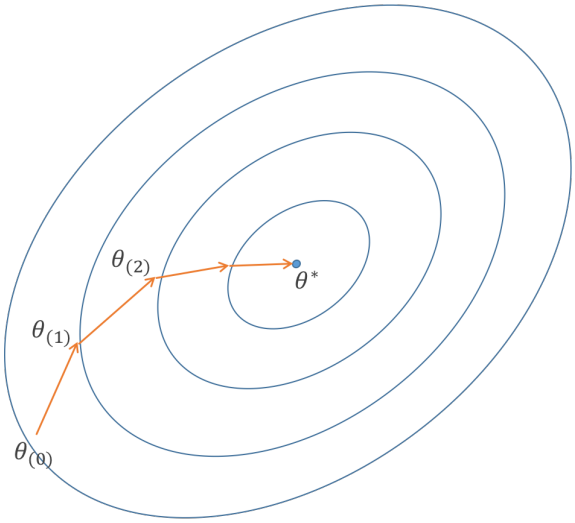


Figure 4: Gradient Descent mechanics

As we can see in Figure 4, an initial value should first be given as $\theta_{(0)}$. Then we calculate the gradient of utility function at point $\theta_{(0)}$. Given a step length γ, plot the tangent line at $\theta_{(0)}$. We then move to point $\theta_{(1)}$. Repeat this operation until the norm of gradient tending to zero, which means the utility function is maximized at θ^*. Therefore, the update rule for Gradient Descent will be

$$\theta \ = \ \theta + \gamma \frac{\partial U(\theta)}{\partial \theta}.$$

In our model, the step length γ is called learning rate and the tolerance is set to be ϵ. The utility function is the log likelihood function l. Using the derivative of l in Equation 2.6 the algorithm will be:

Algorithm 1 Batch Gradient Descent

While $||\Delta\theta|| > \epsilon$, do {

$\theta_k = \theta_k + \sum_{i=1}^{n}[y^i - h_\theta(x^i)]x_k^i, \ (for \ every \ k)$

}

This method using all training samples in every step update is called Batch Gradient Descent method. sometimes the speed of this algorithm will be very slow if n is too large. However, the

Stochastic Gradient Descent method provides a possible solution to this problem. Its algorithm is stated below:

Algorithm 2 Stochastic Gradient Descent

Loop {
    for $i = 1$ to m, {
        While $||\Delta\theta|| > \epsilon$, do {
            $\theta_k = \theta_k + [y^i - h_\theta(x^i)]x_k^i,\ (for\ every\ k)$
        }
    }
}

2.4 Constructing a merger arbitrage trading portfolio

This part we introduce one way to construct a dynamic portfolio of all stocks of acquiring or target companies, and indicate the different methods to benchmark the portfolio returns.

Firstly, we construct this merger arbitrage portfolio containing stocks of target firms or acquiring firms in a merger deal. The strategy might be longing or short selling a stock. Every stock will be added into the portfolio on the announcement date and immediately removed when the deal is completed or withdrawn. We denote a merger deal as active deal at time t if the stock of acquirer or target of this deal is contained in this merger arbitrage portfolio at this time point.

Technically, we will first mark all valid deal to be active if we would like to backtest the profitability of our merger arbitrage trading strategy. A matrix with columns representing test days (t) and rows representing deal numbers (i) is then constructed to present the state of merger deals on test days. Only those days during the merger period will be marked as active in the row of this valid deals[2].

After that, we need calculate the weights of stocks in active deals everyday. Both of equal-weighted and value-weighted portfolios will be considered in this paper. Returns for each active deal in the portfolio were computed by price returns,

$$R_t^i = \frac{P_t^i + D_t^i - P_{t-1}^i}{P_{t-1}^i},$$

where t represent the date number and i represent the deal number or its corresponding company's stock number. Then P_t^i and D_t^i refer to the price and the dividend per share of stock i at time t.

[2] We call the time period from the announcement day to the closing day of a merger as the merger period or the negotiation period in this paper.

We denote the weight of stock i at time t as w_t^i, then we have:

$$\text{Case 1}: w_t^i = \frac{1}{N_t},$$
$$\text{Case 2}: w_t^i = \frac{V_t^i}{\sum_{i=1}^{N_t} V_t^i},$$

where N_t indicates the total number of active deals at time t and V_t^i represents the total value of the firm i at time t. The weight in Case 1 is used for the equal-weighted portfolio and the weight in Case 2 is used for the value-weighted portfolio. The portfolio returns are finally calculated by the weighed average of all active deals,

$$R_{P_t} = \sum_{i=1}^{N_t} w_t^i * R_t^i.$$

Subsequently, two linear models could be used to benchmark the portfolio returns out of the non-systematic risk. The first linear model is the capital asset pricing model(CAPM):

$$\mathbb{E}(R_{P_t} - R_{f_t}) = \beta_M * \mathbb{E}(R_{M_t} - R_{f_t}),$$

where R_{f_t} is the return on the risk-free security and R_{M_t} is the return on the market portfolio at time t. The regression coefficient β_M refers to the effect of market portfolio on the merger arbitrage portfolio we construct.

The second linear model is the Fama and French three-factor model, which is constructed as following:

$$\mathbb{E}(R_{P_t} - R_{f_t}) = \beta_M * \mathbb{E}(R_{M_t} - R_{f_t}) + \beta_{SMB} * \mathbb{E}(SMB_t) + \beta_{HML} * \mathbb{E}(HML_t),$$

where SMB_t is the difference in returns between a portfolio of small stocks and a portfolio of big stocks and HML_t is the difference in returns between a portfolio of high book-to-market stocks and a portfolio of low book-to-market stocks at time t. The regression coefficients β_{SMB} and β_{HML} refer to the effects of SMB_t and HML_t on the excess return of merger arbitrage portfolio we construct, respectively.

3 The Existence of the Price Pressure

Completeness of a market is crucial for arbitrageurs because it promises the revealed information is effective. The US market and the developed European market are generally recognized as complete markets. So we focus on merger and acquisition deals in these two markets. The UK financial market is a special part in the Europe, and the FTSE index also separates UK market from the whole developed European market. Therefore the developed EU market will be divided into the UK market and one market containing other European developed countries to explore separately in the following sections. At the meantime, We use EU as the proxy of the developed European market except UK.

In this section, We try to examine existence of the the price pressure during the time periods from 2001 to 2016. As introduced in the Section 2.1, CAARs could be used to show the potential profitability of acquirer's stock around the event day, which is the direct evidence of the price pressure triggered by M&A. The data will be first described and the results follows.

3.1 Data description

The M&A deal list is obtained on Bloomberg. We only filter in the deals with public traded acquiring and target companies. And only Additional Stake Purchase, Company Takeover, Competing Bid, Cross Border, Going Private, Majority Purchase, Management Buyout, Mandatory Offer, Minority Purchase, Tender Offer or Squeeze Out deals will be selected. There is only cash-financed and stock-financed mergers, and not distinguish floating-exchange ratio stock mergers from fixed-exchange ratio stock mergers. The deals are summarized in Table 1.

Quantity	Cash	Stock	Others	Total
US	3037	1357	1672	6066
UK	951	263	266	1480
EU	2214	572	524	3310

Table 1: Sample summary

International Securities Identification Number (ISIN) code is a 12-character alpha-numerical code which could help identify the securities. Here we use ISIN codes to obtain the price data or market size of acquirers and target firms. The ISIN codes are downloaded with the deal list via Bloomberg. The deals without acquirer ISIN code will be filter out from our final deal list.

Then the time series data of stock price is obtained using DataStream function in Excel. We download the Total Return Index (RI) data which has been adjusted for the dividend during the time period from 2001 to 2006. Those deals will also be filtered out if its corresponding data cannot download successfully by this way. Then we get the valid deals for further exploration

and summarized in Table 2. We could see that the valid deals occupy the majority of all deals downloaded.

Quantity	No Company Code	No Data Found	Valid	Total
US Cash	262	30	2745	3030
US Stock	6	14	1337	1357
UK Cash	94	5	852	951
UK Stock	1	4	258	263
EU Cash	183	21	2010	2214
EU Stock	5	10	557	572

Table 2: Valid deals summary

In the method we introduced in the Section 2.1, we need use the return of market portfolio as benchmark to calculate CAARs. Here we replace the market portfolio as the value-weighted CRSP Stock Market Indexes (NYSE, AMEX, NASQAQ, ARCA) for US market. And for the developed EU market except UK and the UK market, we used FTSE Developed Europe Index and FTSE All-Share Index as the proxies of the market portfolios, respectively.

3.2 Results

Firstly, we focus on the acquirer stock performance for both cash and stock mergers in the UK market from 2001 to 2016. We set the test window from 20 days before the event day to 20 days after the event day. As Mark et al. constructed in [1, Table 2, Page 33], the intercept in equation 2.1 of CAAR model is ignored here as well. See results in Figure 5 and Figure 6.

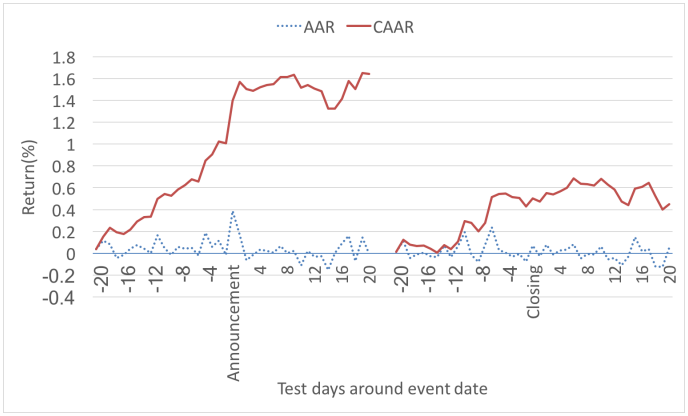


Figure 5: Acquirer stock performance for Cash mergers, UK, 2001-2016

In Figure 5, we could see that the cumulative abnormal returns rapidly increase near the announcement date, especially on the event day. But after approximately half percent average

abnormal return on announcement day, the CAAR curve begins to be relatively flat. When it comes to the CAAR curve around the closing day, the abnormal return continues going up until the event day, which proves the profitability of the acquiring firm stocks in cash-financed merger deals.

Because the acquiring company was usually undervalued, many risk arbitrageurs would long acquirers stock when new information revealed. Then the price pressure after the announcement day results in the increase of the acquirer's stock price during the pending negotiation period. Right after the deal is completed, terminated or withdrawn, arbitrageurs and traders will stop buying in the acquiring firm stocks or even to sell out the stocks. The stock price will then not rise up any more or even decrease. Therefore the perfect time to drop the stock for arbitrageurs is the day when the acquiring company announces to merge or acquire its firm successfully or unsuccessfully.

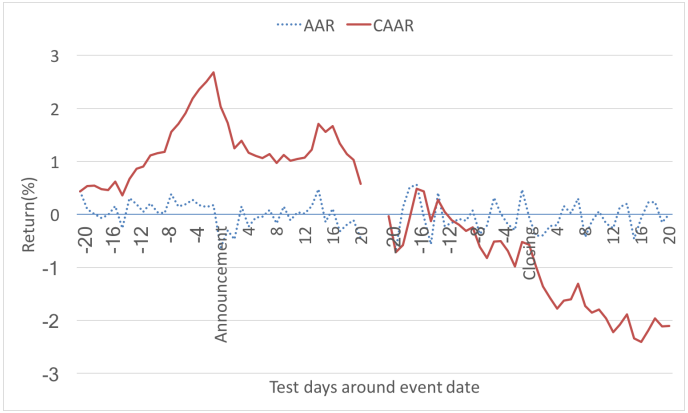


Figure 6: Acquirer stock performance for Stock mergers, UK, 2001-2016

Differently, in Figure 6, even though the cumulative abnormal return also gradually increases from the beginning, its curve goes down sharply after the announcement day. This is because the acquirer company under this condition is usually overvalued. Different from the cash-financed merger, we could see larger increase of CAAR before its M&A plan revealed. The persistent increasing CAAR show the overvaluing tendency of acquirer firms and it also may be operated by the acquirers to reduce their acquisition cost. Because the CAAR curve rises up more sharply and the amount of growth is also enormous before the announcement day. But there appear an negative half percentage decrease on the announcement day and the similar phenomenon last for 3 days, which represents the effect of price pressure triggered by selling out behaviors of arbitrageurs.

Once the deal was completed, these undervalued acquiring firms have to issue new shares to exchange for the target firms' stocks. As a result, their stock price would then decrease rapidly. So it is profitable to short the acquirer stock in stock mergers from the announcement day. But it is hard to say whether there is enough liquidity to let so many arbitrageurs to short.

Secondly, we focus on the acquirer stock performance for both cash and stock mergers in the developed European market except UK during the same period. See Figure 7 and Figure 8.

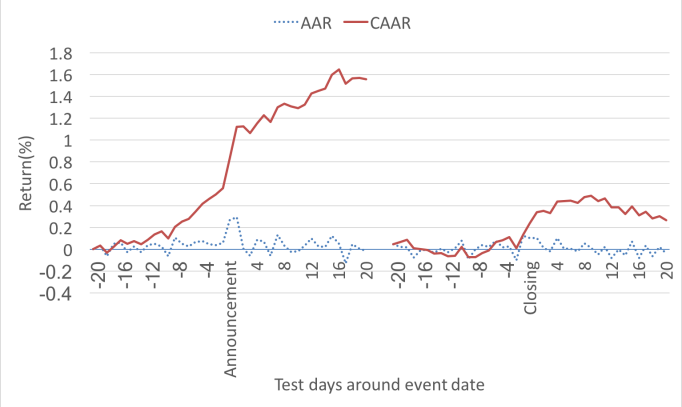


Figure 7: Acquirer stock performance for Cash mergers, EU, 2001-2016

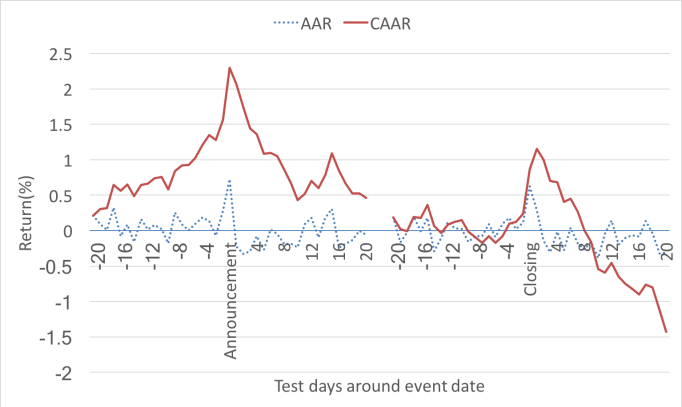


Figure 8: Acquirer stock performance for Stock mergers, EU, 2001-2016

In Figure 7 and Figure 8 listed above, the results are quite comparable with the results in the UK market. But there are also two obvious different points. On the one hand, the CAARs of cash mergers continue growing right after the announcement day, which shows the acquirers in other developed countries are more profitable than the acquirers in the UK market.

On the other hand, contrast to Figure 6, Figure 8 shew a significant positive abnormal return on closing day. For cash mergers, the completion risk will disappeared when the M&A deal was completed, so there might be a slight positive abnormal return right after the closing day. But for stock mergers, the total market value of the new firms usually became larger due to the new share issuing. Thus for those deals with companies involving in some important indexes, such as S&P 500, those funds tracking these indexes are in accelerating demands of the acquirer stocks after the closing day. But this phenomenon will only temporally appear when new shares issued on closing day, and it will soon fall back to the downward trend like in the UK market.

Finally, we focus on the acquirer stock performance for both cash and stock mergers in the US market from 2001 to 2016. See Figure 9 and Figure 10.

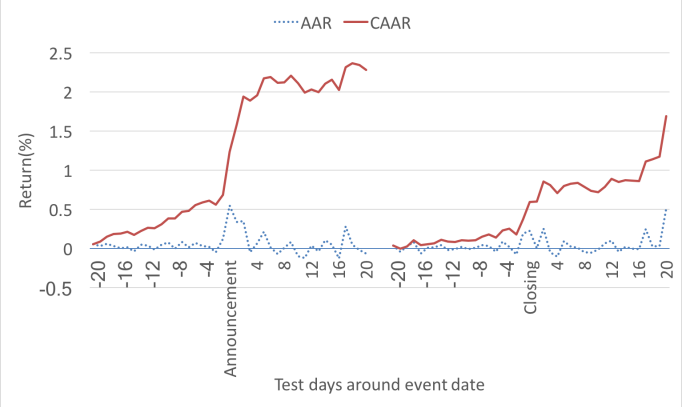


Figure 9: Acquirer stock performance for Cash mergers, US, 2001-2016

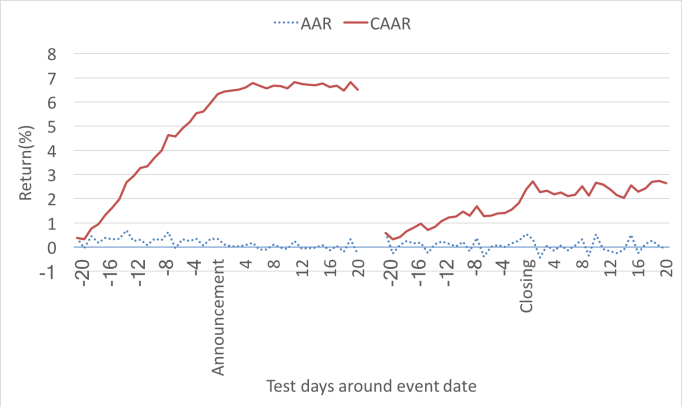


Figure 10: Acquirer stock performance for Stock mergers, US, 2001-2016

As seen from Figure 9 and Figure 10, the magnitude of the excess returns become quite larger than in the UK and EU market. That is to say, it is more profitable for merger arbitrageurs to trade in the US market if they have limited capital to invest.

From the perspective of the tendency of the abnormal returns, the results for cash mergers in the US market were similar to the results in the UK market. The moderate growth of CAAR before the announcement day shows that the acquiring firms in US market is undervalued and tends to come back to its real value as well. There may be many arbitrageurs seeking merge arbitrage opportunities in the US market, the price pressure around announcement day is quiet high so that the CAAR curve rises up approximately 1.5%. It also continue ascending gently until the deal is completed, terminated or withdraw. And the acquirer stocks may slightly jump later due to the disappear of completion risk of the deal. Interestingly, we could see a half percentage growth 20 days after the closing day. Actually it comes from one acquirer stock have a more than 1000%

abnormal return on that day. We will discuss this outlier later.

For stock mergers, the result is much different from the result in UK and EU market. There is no obvious decrease after the stock-financed merger deal appealing. But the cumulative abnormal return continues rising until the deal is completed, terminated or withdraw. There is also a small jump on closing date as a result of the extra demand from index funds. The CAAR curve immediately becomes flat later. So it is profitable to long acquiring firm stocks until the deal closing in the US market.

Interestingly, in Figure 10, the price pressure from short selling after event days seems not exist in the US market. The cumulative abnormal return was stable around 6.5% and 2.5%, respectively. It suggests that shorting acquirers stocks in a stock merger deal is only profitable in the developed European market.

3.3 Outlier

We discuss the special outlier deal now. This M&A deal was proposed by Direct Capital Investments Ltd to acquire company, DCI USA Inc, on 09/11/2004. And this deal was completed on 30/11/2004, which was a quick negotiation process. Actually we could discover DCI is the abbreviation of Direct Capital Investments. So these two company actually belonged to the same board of directors but were operated in different markets. The cumulative return curve is plot in Figure 11.

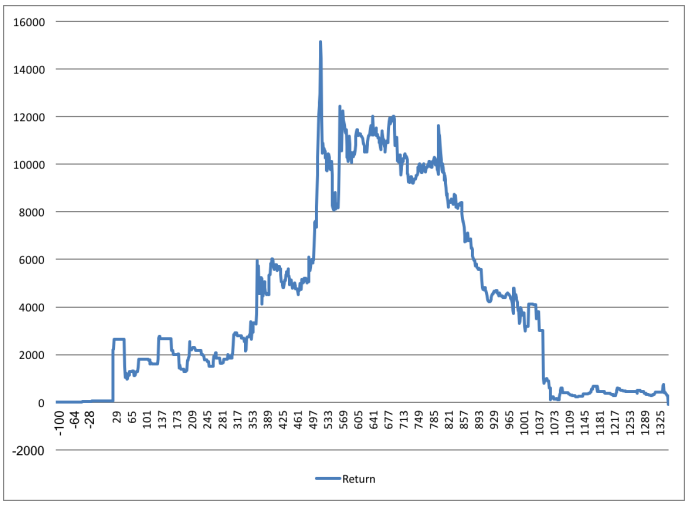


Figure 11: Cash merger outlier deal in the US market

The curve began with 100 days before the announcement day until the day when it went bankrupt. Before the M&A plan was appealed, its returns stabled at 0% on overwhelming majority of trading days. Most changes were price decrease, and the return reached at -98% on 04/02/2004. Everything looked normal until 20 days after closing date, its abnormal return raise up to 1413.14%.

But as seen in Figure 11, its cumulative return reached a peak at 15000%.

This kind of commercial manipulation is not very rare. Another example appears in a EU stock merger deal. Ignoring micro cap acquirers is One efficient way to prevent these outliers. Then we may benefit from M&A trading strategy risklessly.

4 Acquirer Industry Sector Affecting its Stock Performance

We try to find the evidence that some factors influence the abnormal returns on acquirer stocks in the next two sections. We could then explore the potential relationship between these factors and the profitability of the acquirer stocks in the following section, if it is testified that these factors truly have significant influence on the acquirer stock's profitability. From the discussion in Section 2.2, we only explore the influence of industry sectors and relative sizes between target and acquirer market values in this paper.

The first important influence element is the industry sector of the target and the acquirer firm. Companies from different industries will show different degrees of profitability or even exhibit varying trend when they refer to a M&A deal. In this section, we will apply the similar method using in the previous section to show the different behaviors of the acquiring firms' stocks around event days.

4.1 Data description

The merger deal list was also obtained on Bloomberg as the previous section. We classified these deals in different industry sectors including Basic Materials, Communications, Consumer Cyclical, Consumer Non-cyclical, Diversified, Energy, Financial, Industrial, Technology and Utilities.

Quantity	Basic Material	Communications	Consumer Cyclical	Consumer Non-cyclical	Diversified
US Cash	107	258	231	587	21
US Stock	77	197	72	204	31
UK Cash	68	96	80	156	11
UK Stock	49	21	20	49	1
EU Cash	122	212	162	317	35
EU Stock	31	56	39	70	18
	Energy	Financial	Industrial	Technology	Utilities
US Cash	100	520	461	420	37
US Stock	122	404	82	124	24
UK Cash	31	162	147	84	15
UK Stock	23	67	13	14	1
EU Cash	92	430	410	152	77
EU Stock	22	175	74	51	19

Table 3: Sample summary

The time period starts from 2001 and ends at 2016 as well. In the CAAR model, we again use the value-weighted CRSP Stock Market Indexes as the proxy of market portfolio for US market. FTSE Developed Europe Index and FTSE All-Share Index are seen as the proxies of the market portfolios for the developed European except UK market and the UK market, respectively.

We still use the ISIN codes to obtain the time series price data using the DataStream function in Excel. The deals without acquirer ISIN code or their corresponding data cannot download successfully by using ISIN code will be filtered out from our deal list. Here we still use the Total Return Index (RI) data to calculate the price returns of stock.

There are also some deals that its acquiring firms are difficultly identified to belong to one industry. In other words, some acquirers are classified as involving in more than one industries. These deals are removed from our list as well. Only those acquirers belonging to one industry are further explored in this section.

Finally, all the deals are summarized in Table 3. The number listed in the table are the quantity of valid deals in every industries. Invalid deals contains those with announcing or closing date out of range we focus and those deals declared to be invalid in Section 3.1.

4.2 Results

Initially, it is necessary to indicate that all the figures we plot using the model introduced in Section 2.1. All figures with sub label (a) or (b) are the averaging abnormal return (AAR) curves for acquirer stocks around the announcement day or the closing day, while the cumulative averaging abnormal return (CAAR) curves for acquirer stocks around the announcement day or the closing day are plotted in the figures with sub label (c) or (d).

In all the figures below, we use different colors to identify different industries, which is declared in Figure 12. In the following part, we define the colors for all CAAR curves as red, light green, purple, light blue, orange, dark blue, brown, green, dark purple and blue in order.

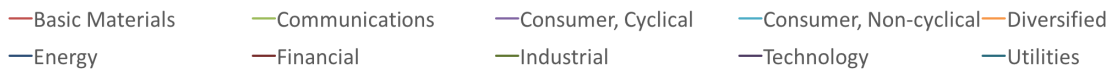
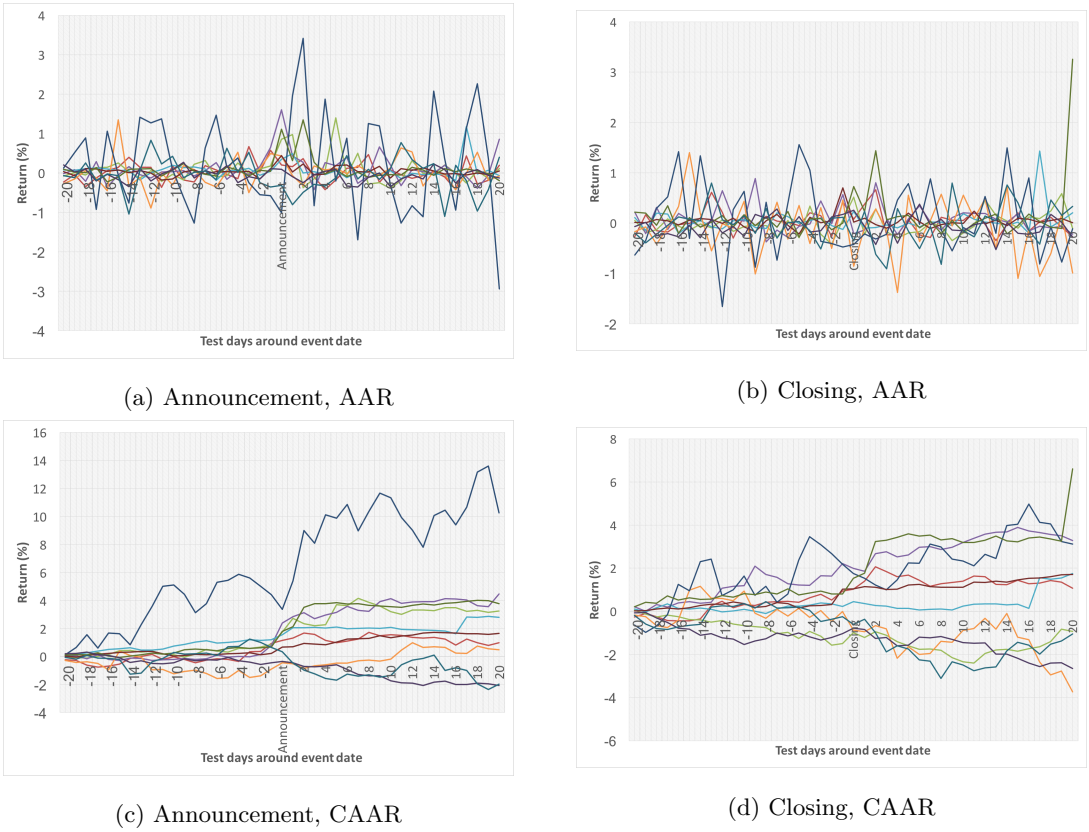


Figure 12: Legend for industry sectors

Firstly, we explore the acquirer stock performance for cash-financed and stock-financed merger deals in the US market from 2001 to 2016. We set the test window from 20 days before the event day to 20 days after the event day. The CAAR model is constructed totally the same as in the Section 3.2. See results in Figure 13 and Figure 14.

In Figure 13a, we could see the dark blue line, representing energy industry, is the most fluctuant. But it have more days in positive waves than in negative waves and the heights of many



(a) Announcement, AAR

(b) Closing, AAR

(c) Announcement, CAAR

(d) Closing, CAAR

Figure 13: Acquirer stock performance for Cash mergers, Industry sectors, US

positive peaks reach at 2%, even 3%. Then we could see in Figure 13c, the cumulative averaging abnormal return for energy acquirers are obviously higher than acquirers in other industries.

Furthermore, the orange line, green line and light green line perform stronger than others as well. Especially during the days around announcement day, the diversified, industrial and communication acquirers behave better than all industries except the energy acquirers. It is also shown in Figure 13c that acquiring companies in these three industries exhibit higher CAAR after the announcement day.

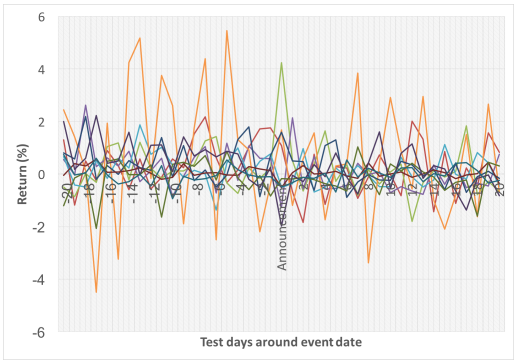
Differently, the blue line and the dark purple line are below the axis after the announcement in Figure 13c, which means utility and technology acquirers seem to be unpopular when they declare a M&A plan. The proper reason to explain this phenomenon is high failure rate for companies in these two industry in the US market.

When it comes to the window around closing day, all lines in Figure 13b fluctuate between the -1% and 1% approximately. The dark blue CAAR curve also behaves excellent. Even though it reaches to less than -1% once, it still have 4-day high abnormal returns exceeding 1%. Combined with the energy acquirers' performance around announcement day, it is very profitable to buy in these companies' stock during the negotiation period.

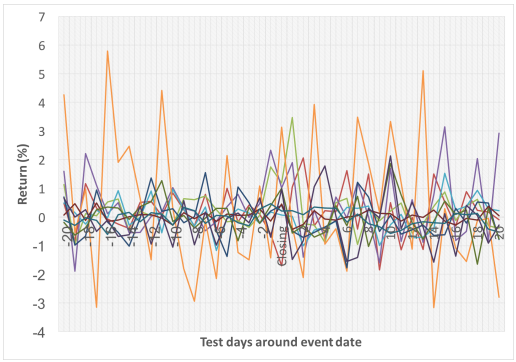
The orange, green and light green AAR curves perform outstanding again. But only the green line locates above the axis before closing day in Figure 13d. The orange and light green lines locate blow the axis. Therefore it is hard to say if it still profitable to hold the acquiring firm's stock during the merger period in the diversified and communication industries.

What's more, the blue CAAR curve stays over the zero line before the closing day. It also becomes uncertainty to benefit from investing in utility acuqirers. But the falling dark purple line demonstrates that buying in technology acquirer stock is not advisable. In general, it is necessary to find the possible relationship between the industry sectors and the acquirer stock's profitability in the US market.

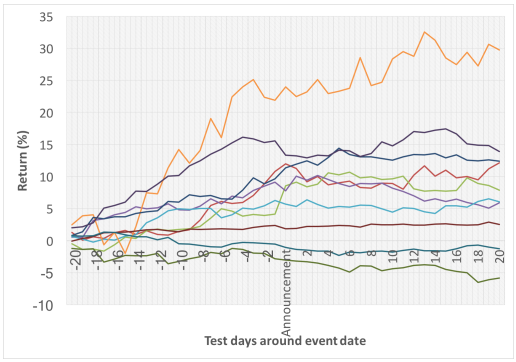
The strange behavior of industrial acquirer around the closing date actually has been explain in previous discussion. There is one outlier that has a extreme high abnormal return 20 days after the deal was completed. In the Section 3.3, the acquiring firm, Direct Capital Investments Ltd, actually is an industrial firm. Thus we discover a extremely high averaging abnormal return in Figure 13b. The industrial CAAR curve will then look normal and flat after the completion day, if we ignore this deal influence.



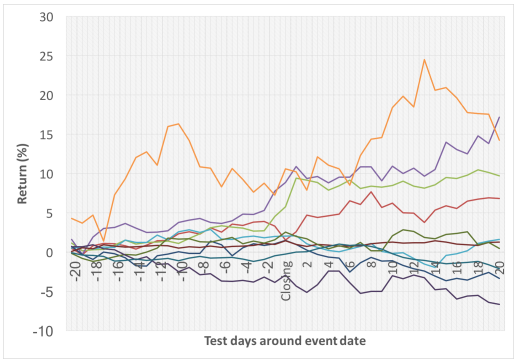
(a) Announcement, AAR



(b) Closing, AAR



(c) Announcement, CAAR



(d) Closing, CAAR

Figure 14: Acquirer stock performance for Stock mergers, Industry sectors, US

In the previous discussion, we know that the acquirer prefer to choose the stock-financed merger

offer of it is overvalued. And when new information appealed, arbitrageurs and traders will sell out some shares immediately. So the stock price usually falls down on the announcement day. But in the US market, the acquirer stocks performance excellent in average and there is no obvious decrease in Figure 10. The CAAR curve even continues rising up during the negotiation period. But it may vary for acquiring firms from different industry sectors.

In Figure 14a, the orange, red, dark blue and light green lines show a positive AAR on the announcement day. We could find that the orange, dark blue and light green CAAR curves also have a upward tendency after the announcing day in Figure 14c. After the announcement day, the red AAR curve stays below zero line for a few days. So its CAAR curve has a downward trend after the event day, which coincides with our expectation.

Due to the rebalancing demand from fund managers, acquirer stock will appreciate after it issues new shares to exchange target stocks. Therefore, we could discover all AAR curves except the red line have a positive peak on closing day in Figure 14b. Later in Figure 14d, most curves continue moving upward which is coincide with the averaging result in Figure 10. It may be because many small companies acquired relative larger companies and were expected to benefit a lot during the financial crisis in 2008. Otherwise, the investors in the US think highly of these acquirer future performance.

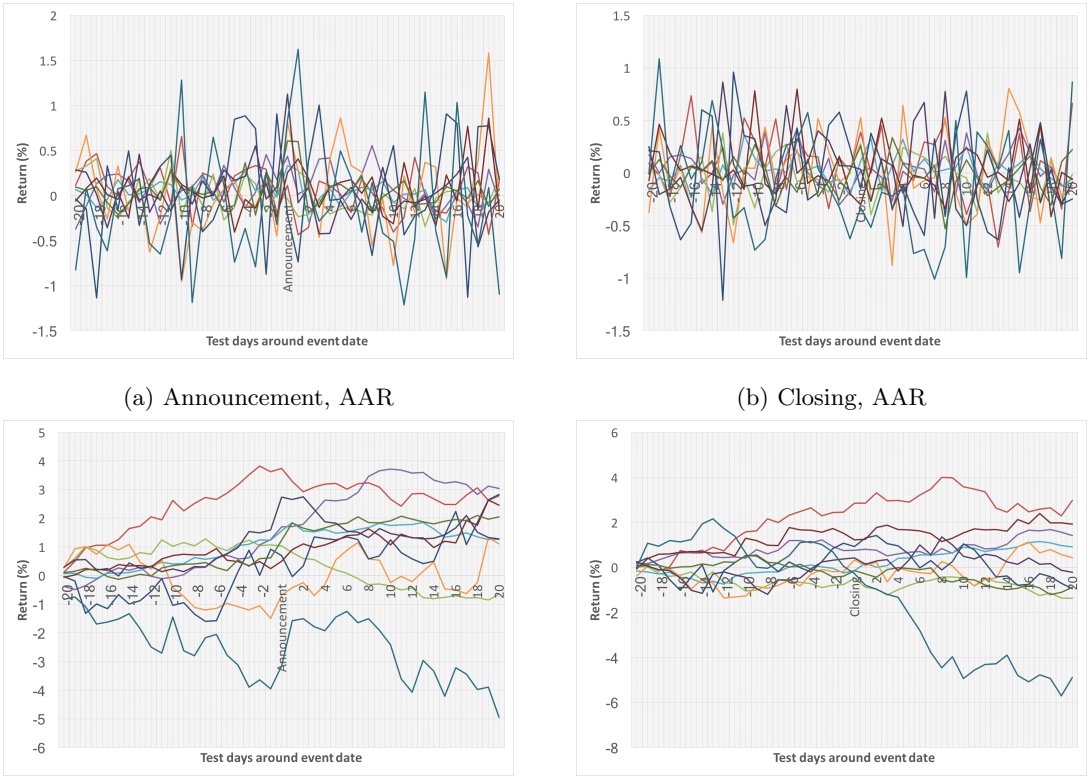
Significantly, all the orange lines in Figure 14 exhibit larger fluctuation than other lines. The orange line represents the performance of acquiring firms in diversified industry. Remind of the orange curves in Figure 13, diversified acquirer stocks behave distinctly in the US market. Even for the stock-financed merger deals, it is also pretty profitable.

It is very interesting to see the brown lines both in Figure 13 and Figure 14. We could come to the conclusion that financial company stocks behave stable when they plan to merger or acquire another company in the US market. And the financial company shares are hardly mispriced in the US market.

Secondly, we come back to the UK market again and apply the similar method. The time period still starts from 2001 and ends to 2016. The test window contains 20 days around the event days. The acquirer stock performances from different industry sectors for cash-financed and stock-financed merger deals are listed in Figure 15 and Figure 16, respectively.

Figure 15a shows all lines having a positive peak on the announcement day except the light green line, which shows the new revealed information indicates the overvaluation of acquiring companies. We could then see in Figure 15c, the green line keeps stable until the deal is announced. It gradually declines later and seems come back to stable at -1%.

Another strange CAAR curve in Figure 15c is the blue one. Unlike the other CAAR curves, the blue curve displays a decrease from the beginning of the window. In total, it has a downward tendency and it is obviously fluctuate in Figure 15a. Therefore, the utilities acquiring firms are



(a) Announcement, AAR

(b) Closing, AAR

(c) Announcement, CAAR

(d) Closing, CAAR

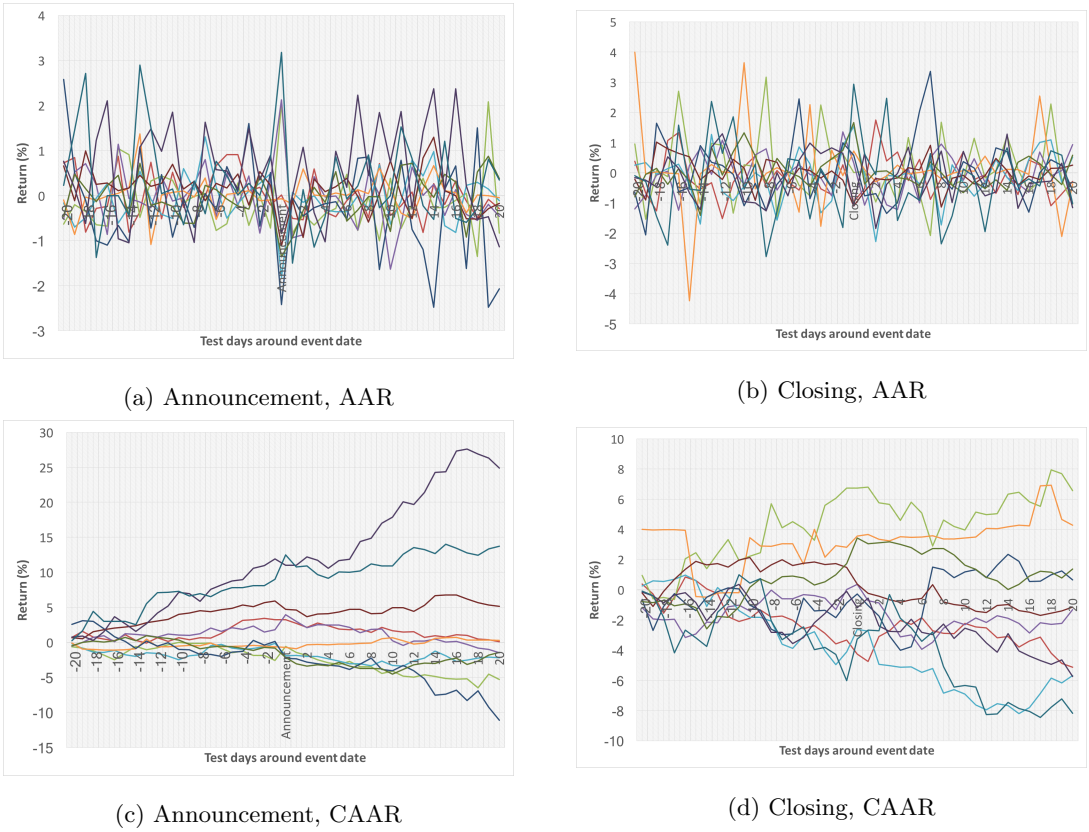
Figure 15: Acquirer stock performance for Cash mergers, Industry sectors, UK

very unstable and its stocks' prices tend to decrease in general. Combined with the behaviors of result in Figure 5, we could understand now why the magnitude of CAAR is so small in the UK market. So the arbitrageurs and traders would better not buy in acquirer stocks in a utility industry in the UK market.

Besides, the red line and the dark purple line exhibit a short ascent after the announcement day. Therefore, it is necessary to find the relationship between acquirer's profitability and its industry sector. Although the CAAR curve in Figure 5 suggests it may be not profitable to buy cash merger acquirer stocks in the UK market, we actually could profit from adding selected acquirer stocks in our trading portfolio.

When it comes to the window around the closing day, we find that only blue line in Figure 15d exhibit a downward tendency after the closing date. For most of the deals, the acquirer stock keeps gently increasing before the deal completion, termination or withdrawal. Subsequently, these stocks tend to be flat. Therefore, it is the utility acquirer in Great Britain that makes the CAAR curve in Figure 5 different from the results in [1, Figure 3, Page 29].

In the following discussion, we see some results for stock merger deals in the UK market. In previous Figure 6, we see the results are quiet comparable with our expectation and the range of



(a) Announcement, AAR

(b) Closing, AAR

(c) Announcement, CAAR

(d) Closing, CAAR

Figure 16: Acquirer stock performance for Stock mergers, Industry sectors, UK

the CAAR is not very large. But the range of abnormal returns in Figure 16 is quiet wide. For example, technology acquirer stocks perform extraordinary after announcement day. The blue line also has a approximately 5% growth. But other acquirer stock performances are in line with our expectation.

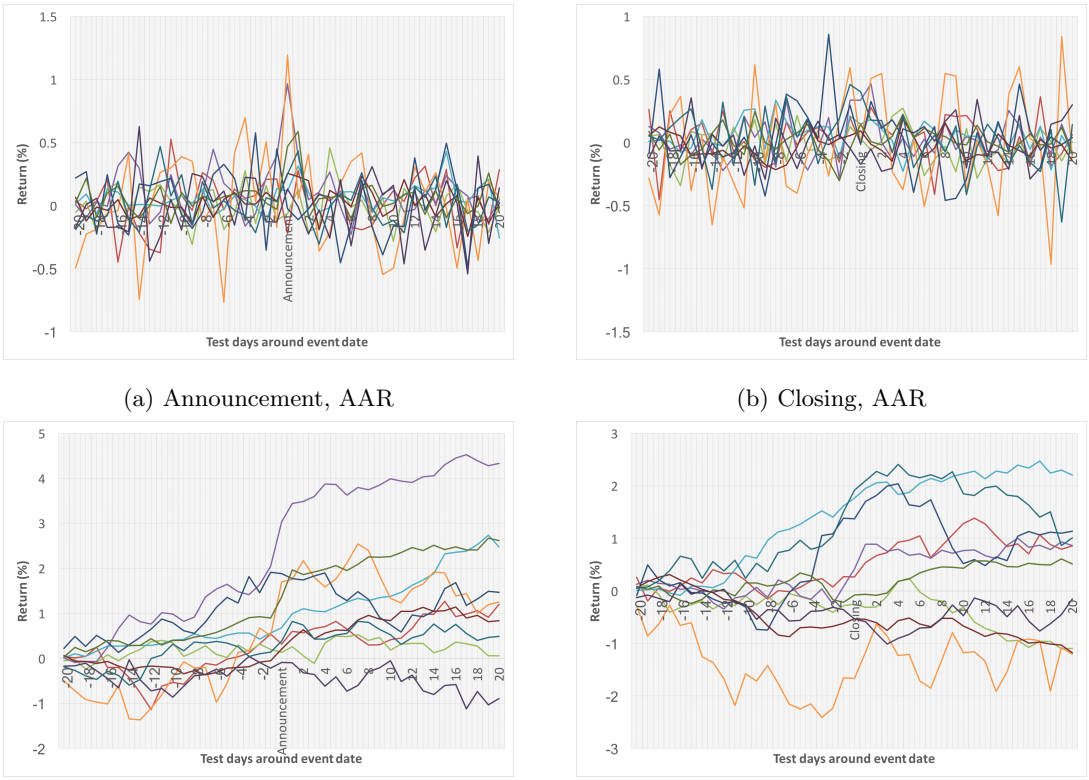
It looks quiet irregular around the closing date. First of all, the dark purple, brown and red lines have a small negative peak on the closing date, which is not in accordance with our expectation. And also the orange and green lines have many large waves in Figure 16b. Those blue lines exhibit several peaks as well. Not like the AAR curves before, almost every industry curve fluctuates a lot here.

Subsequently, it seems like only the red, blue and light blue lines in Figure 16d obviously decline before the closing day. The orange, green and light green lines keep rising up at the meanwhile. Other CAAR curves are hard to say whether increasing or not.

For the AAR curves with more positive peaks, such as the orange and light green lines, their CAAR curves exhibit obviously upward trend. At the meantime, the blue and light blue lines perform oppositely. Generally speaking, only when we find the potential relationship between the profitability of acquirers and the industry sectors shall we construct the trading strategy for stock

merger deals in the UK market.

Thirdly, the same method is applied to the developed European except UK market during the time period from 2001 to 2016. Then the AAR and CAAR curves for acuqirers from different industries are plotted in the following Figure 17 and Figure 18, which exhibit different stock performances for cash and stock mergers respectively.



(a) Announcement, AAR

(b) Closing, AAR

(c) Announcement, CAAR

(d) Closing, CAAR

Figure 17: Acquirer stock performance for Cash mergers, Industry sectors, EU

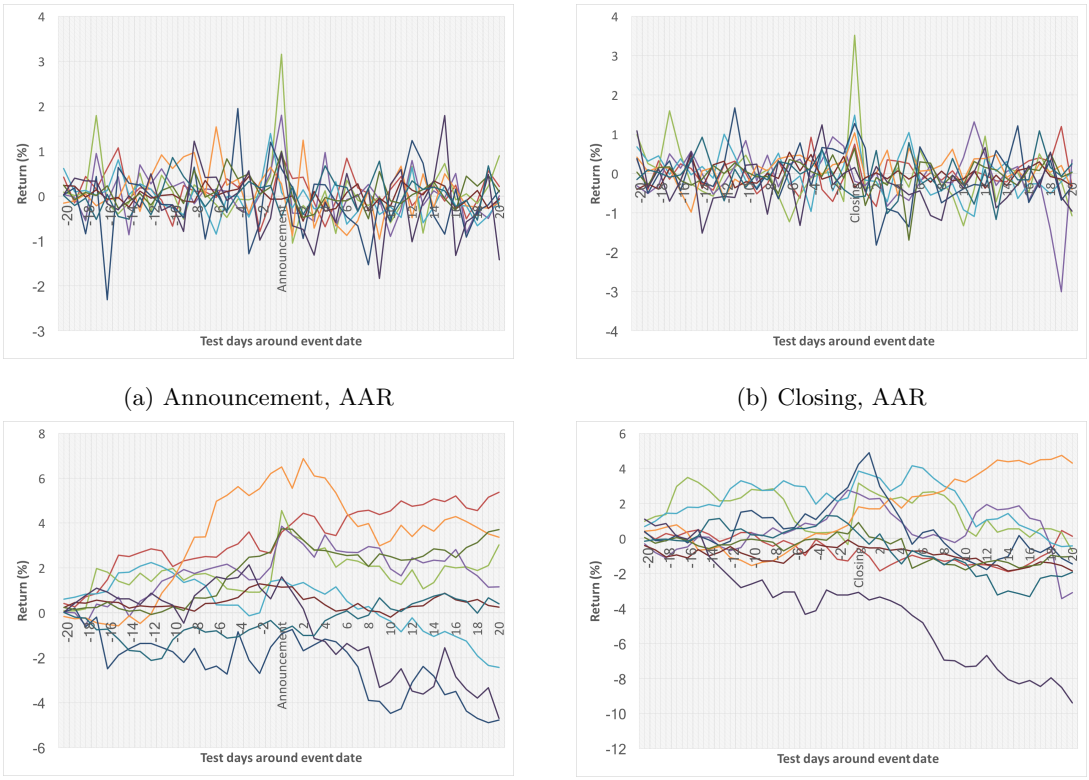
As we can see from the Figure 17a, diversified and cyclical consumer acquiring firms has a peak abnormal return on announcement day in average. Their AAR curves reach at approximately 1%. Only the red line have a negative peak on the announcement day. But it keeps over the zero line on most days later.

In the Figure 17c, the orange line and purple line have a significant higher position owe to their extraordinary performance on announcement day. However the orange line have a downward tendency after the deal is announced. The dark purple CAAR curve also tends to decline at the meantime. What's more, we could see the red line ascending finally even though its stock price have a decrease initially.

The diversified acquiring companies behave unusually again around the closing day. Its AAR curve is very volatile. Then the dark blue line fluctuates a lot and it has a few large peaks as well.

When it comes to the cumulative behaviors of acquirer stocks from different industries, all the lines display totally different trends. The orange line actually has a largely descending trend while the blue line rise up most rapidly before the deal closing. The light blue, darke blue, red and purple lines show varying degrees of increase prior to the closing day.

We could then conclude that the diversified acquirers must not be added into our trading portfolio as it has significant declining tendency during the period between the event dates. Obviously, the non-cyclical acquiring firm stocks are good choices to profit.



(a) Announcement, AAR

(b) Closing, AAR

(c) Announcement, CAAR

(d) Closing, CAAR

Figure 18: Acquirer stock performance for Stock mergers, Industry sectors, EU

It is very interesting that acquirer stock in almost every industry sectors have a positive abnormal return on announcement day. But more amusingly, almost all AAR curves sharply fall below zero one day after the deal announcing. A reasonable guess is short selling activities need one day to complete in most developed European countries.

Subsequently, in Figure 18c, we observe that all lines tens to decrease over the next day after closing day. But the red line and the blue line still grow meanwhile. Actually the two unusual lines in Figure 18a likewise are the red and blue ones. Therefore, it is unfit to add basic material and utility firms in our short portfolio for stock mergers.

There is a peak at 3.5% from the green line in Figure 18b. It may be explained that communi-

cation firms in developed European market are pretty large and included in some important index portfolios. Therefore, many fund managers whose fund tracks these indexes have to buy more these communication firm stocks to rebalance their fund portfolios when these firms acquire other firms successfully and issue new shares. The stock price will then rise up owe to the price pressure in the equity market.

From the perspective of cumulative performance around closing date, Only the dark purple CAAR curve steadily descends in the whole window. Other lines do not exhibit large decreasing trend in Figure 18d. Thus the averaging behavior in Figure 8 after closing day largely results from the lightly regarded technology industry in the developed European market.

Over all, we could draw the conclusion that exploring the difference between the profitabilities of acquirer stocks in diverse industry is quiet meaningful for constructing risk arbitrage trading portfolios in different markets.

5 Relative Size between Market Total Values of Target and Acquiring Firms

The relative size between target firm's and a cquiring firm's market total values is another crucial factor influencing the corresponding acquirer stock's profitability. In previous Section 3.3, we have seen that this kind of outliers could be effectively filtered out if we restrict the relative size of merger deals in a proper scope. On the other hand, taking into account the relative size factor, we may select stocks more effectually to construct our risk arbitrage trading portfolios. In this section we will use RS as the proxy of relative size.

In this section, we will first try to obtain the total market value data for both of targets and acquirers. Then we divide all deal lists into two part, with larger relative size or smaller relative size. The model introduced in Section 2.1 will be constructed for every part and the CAAR curves are plotted in one figure to compare. Finally one trial will be given to show that micro cap acquirer stocks usually behave strangely.

5.1 Data description

Market capitalization represents a company's total market value of all outstanding shares in dollars. Usually it is recognized as market cap and calculated by multiplying the current stock price per share by the number of this company's outstanding shares. The code to obtain a company's Market capitalization data is Market Value Capitalization (MV) in DataStream.

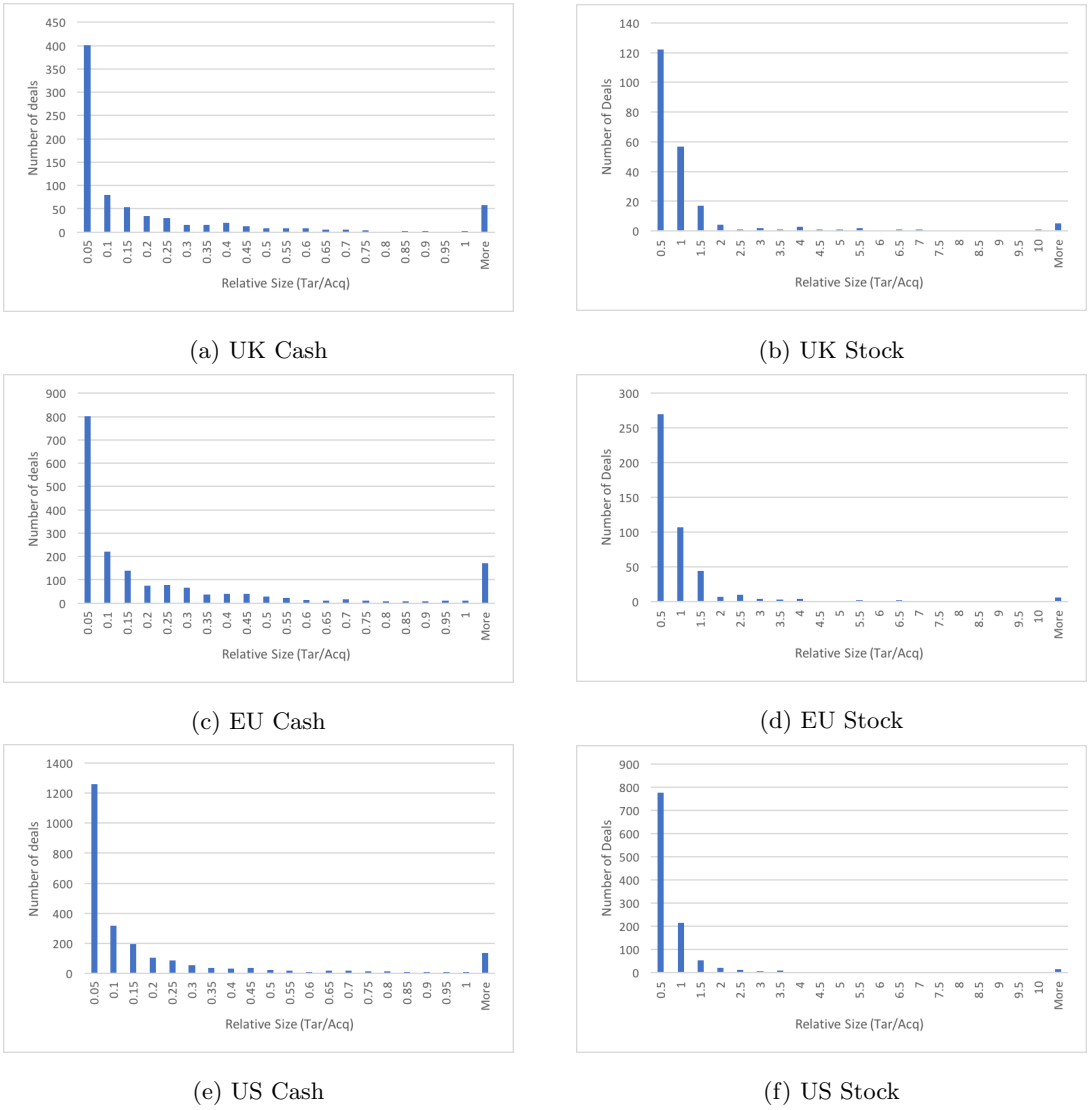
We first download historical MV data using target and acquiring firms' ISIN codes. The deals will be filtered out if ISIN code of its corresponding acquirer or target is not available on Bloomberg. When historical MV data cannot be downloaded successfully by using ISIN code, these deals will be filtered out from our deal list as well.

We only need market values of target and acquiring companies on the day they announced to make a M&A plan. Then we could use these two values to calculate the relative size, which is calculated by:

$$\text{RS} = \frac{MV_{\text{Target}}}{MV_{\text{Acquirer}}} = \frac{Price_{\text{Target}} * Shares_{\text{Target}}}{Price_{\text{Acquirer}} * Shares_{\text{Acquirer}}}.$$

We decide whether add the acquirer stock in our trading portfolio when the deal is announced. Thus the only information we could consider is the relative size on announcing date.

After obtaining all RSs on announcement day, we first plot the histogram for all markets we focused in Figure 19. For all cash-financed mergers, we divide the range of RS into 21 intervals, the length of which is 0.05 and the last interval contains all deals with RS is larger than 1. For all stock-financed mergers, the range of RS is also divided into 21 intervals. The first 20 intervals are 0.5 long, and all deals with RS larger than 10 are included in the final interval. See in Figure 19.



(a) UK Cash (b) UK Stock

(c) EU Cash (d) EU Stock

(e) US Cash (f) US Stock

Figure 19: Relative size histogram

In all figures above, the quantity of deals is sharply declining as the relative size increasing. That is to say, the relative size for majority of cash merger deals is approximately less than 0.1. For stock mergers, the relative sizes mostly are not more than 1. It indicates that company would like to acquire another company using cash if the target company's market size is not too large.

We calculate the mean value of all deals as well, which is listed in Table 4. It is obviously unrealistic to see that the average relative size (target to acquirer) exceed 1. Because a company with finite capital will not be willing to acquire a company bigger than itself. Therefore we compute the median value of all deals, which shows the characteristic of majority data. The median values are also listed in Table 4.

The Median values in every market we focused and for both cash and stock mergers fall into

	RS Median (%)	RS Mean (%)
US Cash	0.042	15.979
US Stock	0.268	1.555
UK Cash	0.045	37.317
UK Stock	0.4212	371.237
EU Cash	0.072	3.058
EU Stock	0.397	5.539

Table 4: Relative size data characteristics

a reasonable scope. We could see that most relative sizes in cash mergers are around 0.05, while relative sizes are nearly all greater than 0.1 for stock-financed mergers. It again demonstrates that acquirer in stock merger deal is relatively larger with respect to its target.

In order to show that relative size is a true factor influencing the profitability of acquirer stocks, we divided all the valid deals into two part. One part contains all deals with relative size larger than the median value listing in Table 4, another part opposites. The quantities of valid deal under every condition are listed in the following Table 5.

Quantity	Large RS Ann.	Large RS Clo.	Small RS Ann.	Small RS Clo.
US Cash	1192	1141	1372	1420
US Stock	556	529	688	718
UK Cash	379	366	420	427
UK Stock	104	98	127	138
EU Cash	900	870	999	1014
EU Stock	228	219	272	295

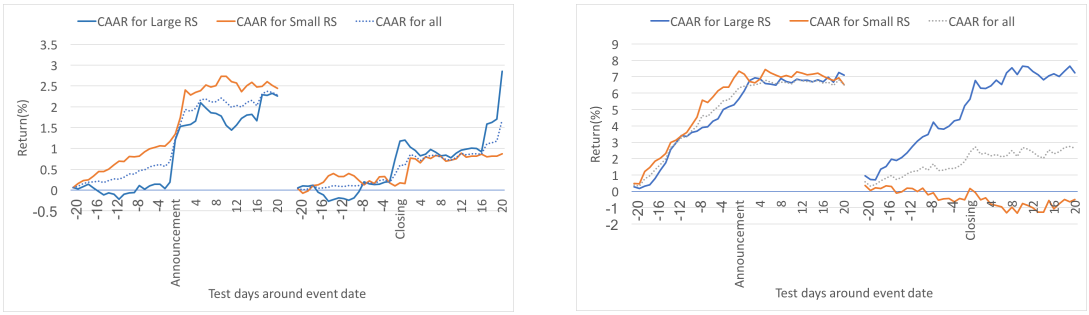
Table 5: Valid deals summary

The valid deals mean those merger deals with announcement and closing dates falling into the time period between 1st Jan. 2001 and 30th June 2017. One deal will be filtered out as well, if the acquirer or target market capitalization data cannot be obtained on DataStream.

All deals are approximately separated into two same size part. Then we could calculate CAAR separately as well and plot the CAAR curves for deals with small relative size or large relative size in one figure. We could then compare the different behaviors of the acquirer stocks in each part. It could be visually judged whether relative size influence acquirer stocks' profitability.

5.2 Results

We calculate CAARs for deals with small or large relative size and plot the curves by method introduced in Section 2.1. All the CAAR curves are plotted in Figure 20, Figure 21 and Figure 22, representing acquirer stock performance in the US market, the UK market and the market containing other developed European countries respectively. The CAAR curves for all deals in every market are added in these figures to compare as well.



(a) Cash mergers

(b) Stock mergers

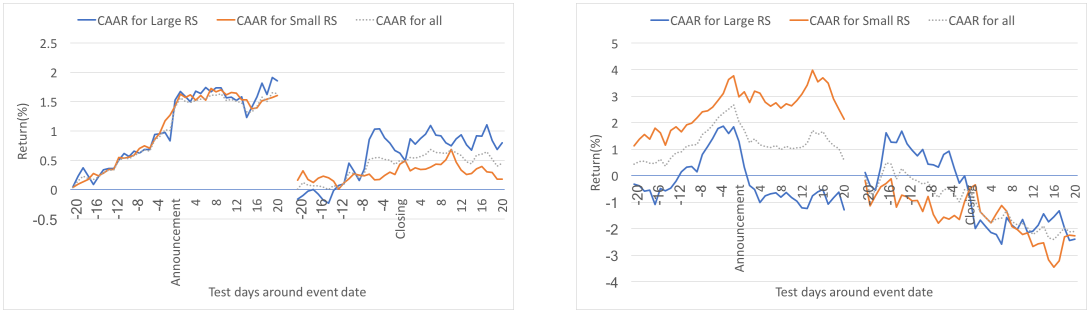
Figure 20: Acquirer stock performance for large and small relative size deals, US

Seeing Figure 20a, CAAR curves for deals with large or small relative size kind of coincide with the CAAR curve for all cash merger deals around the closing date. Only on 20 days after the closing date, it appears a big difference between these two lines. But actually it will tend to be coincided if we filter out the outlier deal stating in Section 3.3.

The cumulative returns rise up to a much the same level before the announcing day. The blue line has a large jump on announcement day while the orange line exhibits a large jump one day later. From the perspective of the whole window around announcement day, the orange line locates over the blue line. But buying more acquirer stocks in cash mergers with large relative size seems more advisable, if we plan to long these stocks on announcement day. Because it approximately has a 2% growth for large relative size deals, and only 1% growth for small relative size deals.

For stock merger deals, three different lines nearly coincide with each other near announcement day. But the difference between the blue and orange line is significantly large around closing day. Then we could find out that the acquier stock performance for stock mergers with relatively small relative size is in line with our forecast. The blue line has a steadily ascending tendency before the deal is completed, terminated or withdrawn, which proves that there are quiet a lot exceptional stock merger deals in US market. Therefore, trading on stock merger acquiring company stocks could be at a profit if we select deals with smaller relative size to short.

When it comes to UK market, results become totally different with what we find in the US market. As we can see in Figure 21a, the orange CAAR curve nearly keeps in line with the blue CAAR curve in the vicinity of announcing date. On the closing date, the two curves approximately

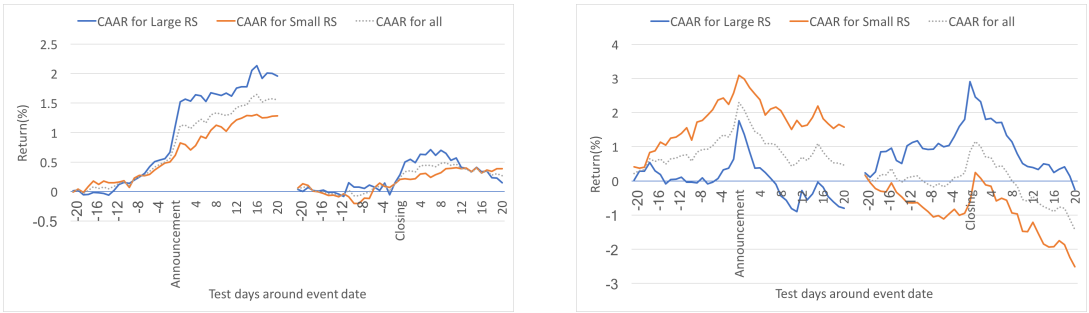


(a) Cash mergers (b) Stock mergers

Figure 21: Acquirer stock performance for large and small relative size deals, UK

reach at one point. But for those deals with large relative size, the abnormal return is negative in average while the averaging abnormal return for small relative size deals is positive. But we could discover the blue line beneath the orange one at the start of the window around closing date. Hence, stocks of acquiring firms in cash merger deals with large relative size are the better choice for us to long prior to the closing day.

In Figure 21b, the orange line and blue line have the same trend as the gray dashed line. However the blue CAAR curve ascends or descends more rapidly than the orange curve during the time period from announcement day to closing day. Thus we could earn more if the acquirer stocks in stock mergers with large relative size are shorted during this time period. From the above discussion for merger deals in the UK market, the deals with larger relative size perform better than those with smaller relative size for both of cash-financed and stock-financed mergers.



(a) Cash mergers (b) Stock mergers

Figure 22: Acquirer stock performance for large and small relative size deals, EU

Now we move to other developed countries in Europe and see the results in Figure 22. Similar to the results in the US market, the CAAR curves for cash mergers with large relative size and small relative size are anastomotic with each other before the closing date. Although the blue curve keeps in line with the orange CAAR curve before the announcement day, the blue line has a great jump near the announcement day. Therefore, longing the stocks of acquiring firms in cash

mergers with large relative size is more profitable.

For stock mergers, CAAR curves for large and small relative size are quite varying. Start from the similar position the the figure, the orange line keeps above the blue line around the announcement day while it stays beneath the blue line near the closing day. In the left part of Figure 22b, there is approximately 1.5% drop after the announcement day for smaller relative size stock mergers. Oppositely, the blue line falls approximately from 1.5% to -0.5%. It seems like stock mergers with large relative size are better choice for our trading strategy. However in the right side, the blue line has a upward tendency while the orange line keeps declining prior to the closing day. Hence a contradiction appears and we have to explore further with more mathematical methods, which will be given in Section 6.

6 Merger Arbitrage Trading Strategy

After exploring the profitability of acquirer stocks in many different aspects, we now try to construct a merger arbitrage strategy to profit from trading stocks of acquiring firms in cash-financed or stock-financed merger deals. A merger arbitrage trading strategy means that we need select the potential highly profitable acquiring firms to buy or short its stocks on the announcement day.

Hence in this section, we first use the logistic regression, introduced in Section 2.3, to find the potential relationship between the acquirer industry sector, the relative market size of acquiree to acquirer and the profitability of acquirer stocks. Subsequently, six portfolios will be constructed in the way introduced in Section 2.4. Two of these portfolios only contain the acquirer stocks that are classified as profitable stocks by the logistic regression results.

6.1 Logistic regression

First of all, the feature variable is defined as $x^i = (1,\ x_1^i,\ x_2^i,\ \ldots,\ x_{12}^i),\ i = 1,\ \ldots,\ n$, where n is the quantity of deals and the element x_1^n represents the relative size of n-th deal. The other 11 elements of vector x^i are dummy variables represents the industry sectors of acquiring firm in the i-th deal.

The target variable y^i represents whether the acquirer stock in the i-th deal is profitable. Here, we calculate the cumulative abnormal returns (CAR) of every deal in the our learning sets. CAR is defined as:

$$\mathrm{AR}_t^i = r_t^i - \hat{\beta} * r_{\mathrm{market},t},$$

$$\mathrm{CAR}^i = \prod_{s=0}^{T^i}(1 + \mathrm{AR}_t^i) - 1.$$

where t represents the number of days between the test day and the announcement. The final test day is the closing day. Thus the length of the merger period, T^i, is varying for deals. All the other symbols are the same as previous assumptions. CAR could stand for the profitability of acquirer stocks because it has been benchmark with market portfolio returns.

%	CAR Median	CAR Mean
US Cash	0	1.864
UK Cash	0.124	1.277
EU Cash	0.165	1.252
US Stock	-2.560	0.003
UK Stock	-4.048	16.418
EU Stock	-1.090	-2.453

Table 6: CAR data summery

We calculate CARs for cash and stock mergers in the US, UK and EU markets. Similarly to the previous sections, we use the CRSP or FTSE Indexes as the market portfolios in the market model. Then the median value and mean value of CARs in every deal list are computed and summarized in Table 6.

It is more in line with our expectations that most stocks of acquiring company in cash mergers appreciate in the merger period. Although the mean values of CAR for stock mergers in the US and UK markets are positive, the negative median values mean the majority of acquirer stocks will depreciate in the merger period. As previous discussions, we know that the return of acquirer stock is likely to increase highly when a micro cap acquirer announces to acquire a relative large cap company. It is a number of outliers in stock mergers that the positive CAR mean values become positive. Generally speaking, we can construct trading strategy to long the acquirer stock in cash mergers or to short the acquirer stock in stock mergers.

Coming back to the target variable y^i, we denote it to be 1 if CAR$>$ 0. In other words, we aim to trading on those stocks behaving better than the market portfolio. Our training sets under every condition include all merger deals announcing during the period between 01/01/2001 and 31/12/2011. Then the other deals in our valid deal list will be put in a testing set, the data of which we will use in the next part to test the profitability of our strategy. The data is summarized in the following Table 7.

Quantity	Training	Testing	Specific value
US Cash	1746	587	2.97
UK Cash	620	140	4.43
EU Cash	1427	348	4.10
US Stock	864	216	4.00
UK Stock	169	45	3.76
EU Stock	372	80	4.65

Table 7: Training and testing sets summary

As we can see from the specific value of training data number to testing date number, testing data approximately accounts for 20%. Actually it is because there are more mergers and acquisitions appearing after the financial crisis in 2008 that quantity of valid deals in the former 11 years is more than in the later five years.

What's more, we try different learning rate γ and tolerance ϵ many times until the regression result hardly changing for every training set. We run both of Batch Gradient Descent algorithm 1 and Stochastic Gradient Descent algorithm 2. As a result of using a lot of dummy variables, the result of Stochastic Gradient Descent algorithm does not keep in line with our expectation,

although it runs faster than Batch Gradient Descent algorithm. Therefore, we only use the result of Batch Gradient Descent in the following part.

6.2 Constructing portfolios

We would like to construct three different trading strategies tracking mergers and acquisitions. One trading strategy is constructed basing on the logistic regression results (θ). That is to say, we use the feature variable of deals in testing set to calculate the value of $h_\theta(x)$. Reminding of assumption in Equation 2.2, the target value of y can be then given. If $y^i = 1$, i.e. $h_\theta(x^i) > 0$, we add the i^th acquirer stock into the first trading portfolio.

The second trading strategy does not distinguish the merger deals. All the merger deals announcing during the period from 2012 to 2016 will be added into the second portfolio. On the other hand, the third merger arbitrage strategy suggests selecting the merger deals randomly. All acquirer stocks will be randomly added into the third portfolio.

All kinds of portfolio will be constructed by equal-weighted and value-weighted ways. The returns of portfolio are computed by the method introduced in Section 2.4. Then the cumulative returns of portfolios will be calculated and then compared to evaluate the effectiveness of the logistic regression results.

6.3 Comparing the returns of trading portfolios

We plot the cumulative return curves for every trading portfolio in every market. To begin with cash mergers, all portfolio performance could be checked in Figure 23, Figure 24 and Figure 25.

Figure 23: Merger arbitrage trading portfolio cumulative returns for Cash mergers, US

Req and Rva mean cumulative returns for equal-weighted and value-weighted trading portfolios following the logistic results respectively. The cumulative returns for equal-weighted and value-weighted trading portfolios containing all acquirer stocks are marked as ReqX and RavX. The rest

two lines represent the cumulative returns for portfolios randomly selecting acquirer stocks.

In Figure 23, the red line locates above all the other lines, which demonstrates our logistic regression result performs well. But the green line is quiet lower than other lines and its ending cumulative returns are the lowest over all portfolios. What's more, the dashed purple line is below the dashed yellow line. The blue line is under the orange line as well. Therefore, the value-weighted portfolios behave worse than the equal-weighted portfolios in general.

Although the equal-weighted trading portfolio considering the regression result exceeds more than 100% returns than other portfolios, it is hardly achieved in reality because there may be not enough liquidity of small acquiring firm stocks in the equity market. So we may find anther better weight distribution method to keep the high returns and operability at the same time.

Figure 24: Merger arbitrage trading portfolio cumulative returns for Cash mergers, UK

In the UK market, we can see the results in Figure 24. On the one hand, the red line is nearly above the other two lines for portfolios with the same weight distribution. On the other hand, the green line behave better than the orange line and the dashed purple line as well. Thus, the merger arbitrageurs can profit from the trading strategy basing on the logistic regression results.

Figure 25: Merger arbitrage trading portfolio cumulative returns for Cash mergers, EU

Our trading strategy behave even better in the developed Europe excluding UK market. We could discover that the equal-weighted random selecting trading portfolio performs better than the value-weighted logistic regression trading portfolio in the UK market. But in the EU market, the red and green cumulative return curves are over other curves in the last half window in Figure 25.

To sum up, it is quiet profitable to apply our trading strategy basing on logistic regression results in the European market (including the United Kingdom). For the US market, we would better only construct a equal-weighted trading portfolio if there is enough liquidity in the equity market.

For stock mergers, we try to construct these six trading portfolios as well. But we choose to short the acquirer stocks during the merger period as the discovery in Table 6. It may be because there are a large amount of outliers in the US market, the logistic regression algorithm keeps running for a very long time. Thus we do not have the results for stock mergers in the US market. Finally only the portfolio cumulative return curves in the UK and EU markets are plotted in Figure 26 and Figure 27 respectively.

Figure 26: Merger arbitrage trading portfolio cumulative returns for Stock mergers, UK

Interestingly, the logistic regression trading portfolio return curves quiet coincide with the all-stock trading portfolios' curves in the UK market. However, the red and green return curves are still a little higher above the dashed lines.

Both of equal-weighted and value-weighted random selecting trading portfolio return curves locate below the corresponding curves, which implies that the logistic regression trading strategy is the best merger arbitrage trading strategy among these three strategies.

Another interesting observation is that the blue portfolio return curve exceeds the green one around the middle of 2015 in both of Figure 24 and Figure 26. Therefore it is reasonable to guess that equal-weighted trading strategy is better than value-weighted trading strategy.

In Figure 27, the red and green lines are blow three other lines initially. But it continues growing later and keeps the returns stable at a level. During the time period from the end of

Figure 27: Merger arbitrage trading portfolio cumulative returns for Stock mergers, EU

2013 to start of 2014, these two lines stay flat. It shows that there is no trading in the logistic regression trading strategy. But other lines tend to descend during the same period. Hence the logistic regression successfully filters out some bad-to-short stocks.

We also could discover the similar phenomenon appearing at the beginning of 2016. It helps the red and green lines exceeding other lines in the end. Therefore, a long term investment in a merger arbitrage trading portfolio is quiet profitable.

In general, the performance of logistic regression trading strategy for stock mergers is not so good as the performance of cash mergers. Therefore, our strategy is better fitted to cash mergers in the markets we researched.

7 Further Exploration

In Section 5, we have explored market total value of target and acquiring firms. But we only use it to calculate the relative size between targets and acquirers, then explore the underlying relation among relative size and profitability of acquirer stock in Section 6. Now we would like to consider the market size of targets and acquirers separately.

In Section 3.3, we discuss an odd case that its abnormal returns exceed normal range. Actually, the target market size is a little lager than the acquirer market size in this deal. So the relative size is not very large. But both of these two companies belong to micro cap company, which represents company with market total value no more than 100 million dollars. Due to limit liquidity in equity market, micro cap companies are usually not considered in asset management firms real trading strategy. Hence the results for M&A deals with micro cap target or acquirer may be extremely out of our expectation.

Next in this section we would like to filter out the deals with micro cap target or acquirer, and then observe averaging acquirer stock behavior. First, the quantity of micro cap deals and valid deals are summarized in the following Table 8.

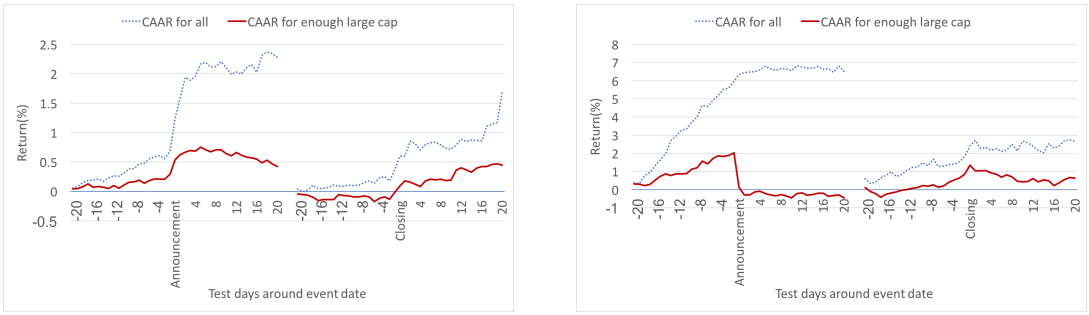
Quantity	Micro cap deals	Valid deals Ann. (relative value)	Valid deals Clo. (relative value)
US Cash	869	1521(0.57)	1462(0.59)
US Stock	607	520(1.17)	496(1.22)
UK Cash	338	425(0.80)	413(0.82)
UK Stock	146	71(2.06)	68(2.15)
EU Cash	510	1292(0.39)	1264(0.40)
EU Stock	165	295(0.56)	284(0.58)

Table 8: Data summary

In the table above, the valid deal numbers are obtained by filtering out deals with announcement or closing date out of time period from Jan. 2001 to June 2017 as well. If the market value of its acquirer or target cannot find on DataStream, the deal is still removed from our valid deal list. Therefore, we just give the quantity of micro cap deals and valid deals in this section. In the following discussion, we use bigger cap as proxy of those companies larger than 100 million dollars.

We also calculate the relative value of micro cap deal quantity to valid deal quantity in the table. It is easy to observe that more stock merger deals have micro cap acquiring or target firms than cash-financed mergers in every market. Because the size of the UK market is quiet smaller than the US and EU market, there are relatively more micro companies involved in M&A in the UK market.

The method introduced in Section 2.1 is then used here to plot the CAAR curves. The time window and test days are the same as before. Figure 28, Figure 29 and Figure 30 show the acquirer stock performance for cash or stock mergers without micro cap target or acquiring firms in the US market, the UK market and the market containing other developed European countries respectively.



(a) Cash mergers (b) Stock mergers

Figure 28: Acquirer stock performance without micro cap deals, US

In Figure 28, we could see obviously that the behaviors for those deals filtering out micro cap acquirer or target keep in line with our expectations. More detailedly, the stock of bigger cap acquirer who acquires bigger cap company does not increase too much on announcement or closing day in cash-financed mergers. The red CAAR curve in Figure 28a only jumps near the event days and has a steadily descending tendency between the event days. But it still looks like profitable to long stocks of acquiring companies in cash mergers.

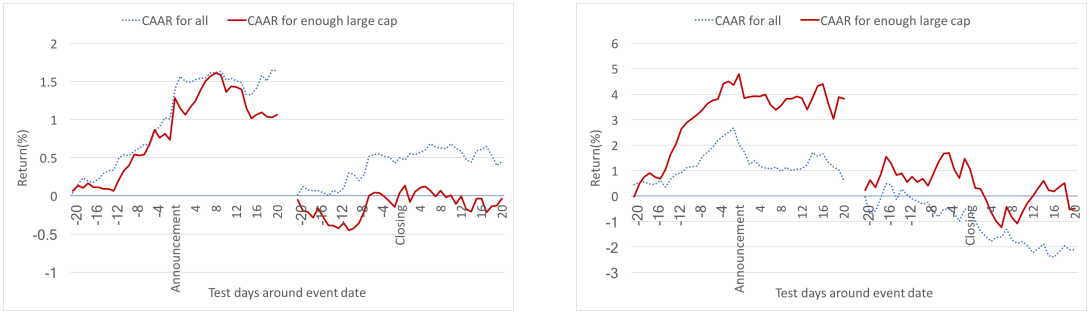
Interestingly, we discussed the cash merger outlier in the US market at the beginning of this section. It is not included in our bigger cap deal list. compared to the dashed line, there is no jump at the end of the red line in Figure 28a.

As we can see in Table 8, there are more micro cap deals than bigger cap deals for stock mergers in the US market. Thus micro cap deal performance influences the general behavior of acquirer stocks quiet a lot. It might be the reason for which CAAR curve for all deals climbs up to the level above 6% before the announcement day and keeps high cumulative returns for a long time period later.

In Figure 28b, the red CAAR curve grows gently prior to announcing date. It sharply falls below 0% on announcement day and keeps the same level later. The stock behavior of acquiring firms for stock mergers is quiet comparable with the results in [1, Figure 3, Page 29], which shows the consistency of acquirer stock performance during the period from 1994 to 2016 in the US market.

Around the closing date, the tendency of the red CAAR curve is similar to the blue line. A peak on closing day means price pressure triggered by rebalancing demand of portfolio managers

and also the completion risk vanished. Before the deal is completed, terminated or withdrawn, the red CAAR curve exhibits a increasing trend. However, the rough 1% growth is smaller than the degree of declining after announcement day. Therefore, it is still quiet a good choice to short for stock mergers in the US market.



(a) Cash mergers (b) Stock mergers

Figure 29: Acquirer stock performance without micro cap deals, UK

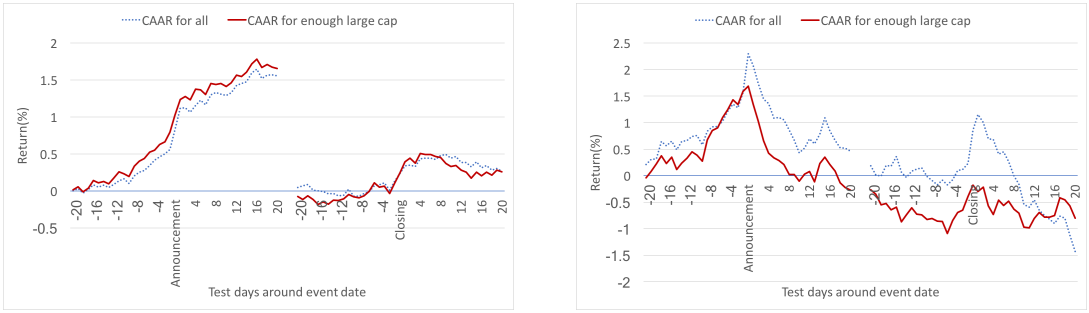
Now we move to the UK market. In figure 29a, the red line has a drop approximately 12 days after announcing date. At the same time, the drop appeared in the blue dashed line is smaller. The jump of this line on announcement day is larger than the red line as well. Thus the acquirer stocks in bigger cap deals perform worse than those in micro cap deals.

Again for the window around the closing date, the declining trend of the red CAAR curve continues in the first 12 days. It grows up later to a level slightly higher than the initial level. Thus we would better trade all the acquirer stocks to benefit from our trading portfolio more. Because the UK market total size is not bigger than the other two markets, the companies participating in M&A are not so large as those companies in the US or EU market.

Subsequently, in Figure 29b, the drop of blue CAAR curve on announcing day is large than the red one, although it grows softly before the event day. Thus the acquirer stock price for all merger deals descends more largely. The similar phenomenon appears in the window around closing day as well. Therefore, we do not need to select micro cap acquiring and target firms when we seek the arbitrage opportunities in M&A in the UK market.

When it comes to European market, we have known that the micro cap deal is relatively less than in other two markets. The CAAR curve for all cash merger deals fairly coincides with the CAAR curve for bigger cap in Figure 30a. Thus there is no difference to trade on bigger caps or micro caps for cash mergers in the EU market. Because these deals with micro cap acquirer or target do not influence the general behaviors of acquirer stocks.

The general characters of the CAAR curves in Figure 30b are similar. The red line starts lower in the window around the closing day but the trend coincides with the blue line. However, the blue dashed line grows up more on both of announcement day and closing day than the red line.



(a) Cash mergers

(b) Stock mergers

Figure 30: Acquirer stock performance without micro cap deals, EU

Thus we could observe that the declining degree of the blue CAAR curve is one quarter percent larger than the CAAR curve for only bigger cap deals after announcing date. But it also grows up more before the closing date. In the end, it is hard to say the acquirer stocks in bigger cap deal behave better.

In summary, the market total value of acquirer or target is quiet necessary to be taken into account when we construct the trading portfolio tracking M&A deals in the US market. We may could improve our regression results in Section 6 by regarding acquirer market total value as another key factor influencing the stock profitability of acquiring firm.

Conclusion

This paper studies the price pressure effects triggered by mergers and acquisitions through examining the trading behaviors of risk arbitrageurs. We find the evidence for the existence of arbitrage opportunities around M&A deals and also find the support for some key factors influencing the profitability of acquirer stocks. All results demonstrates that arbitrage opportunities truly exist in acquirer stocks and varies in different industry sectors and diverse relative size deals.

Subsequently, a merger arbitrage trading strategy is developed. Some concepts in machine learning are used to determine the trading strategy. To be more detailed, we construct a Logistic Regression model to help select potential profitable acquirer stocks on announcement days. Several different kinds of trading portfolios are then constructed to test the effectiveness and profitability of this trading strategy.

Although the test results of trading portfolios indicate our trading strategy is profitable, its earning performance is not well enough. Especially for stock-financed mergers, the short-selling strategy cannot promise absolute benefit during a short term trading period. The regression result in the US market even cannot be carried out smoothly. However, we could improve our model by replacing $z(x;\theta) = \theta^T x$ as a nonlinear model or adding penalty terms in the utility function. For example, add first-order norm or second-order norm of the coefficient vector variable θ in the utility function, which are known as Lasso Regression or Ridge Regression. We may also apply the deep neural network machine to develop the trading strategy.

A further discussion about the stock behavior of micro cap acquiring firms is shown in the final section. We find a lot of extreme high excess returns on acquirer stocks in our merger deal lists and these outlier deals are nearly all accompanied with a micro cap acquirer or acquiree. The result after filtering those deals involving with micro cap firms shows regular stock price changes. Many financial companies do not trade on micro cap companies as well. Therefore, our trading strategy may be further improved by considering the market size of target or acquiring firms separately.

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