Acquisition Announcement Reactions: Are Markets Informationally Efficient?

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Abstract:

This paper seeks to test whether the equity market is informationally efficient before and after the 2008 financial crisis by examining if risk arbitrage opportunities are present due to inefficiencies in the pricing of potential acquisitions. This paper expands upon previous models of acquisition success to incorporate acquisitions in which there are multiple bidders and identifies new factors that appear to be important in determining acquisition success. While the data rejects the use of the proposed model, this paper is able to use parts of the model to construct a regression equation that estimates acquisition success probabilities and concludes that statistically significant arbitrage opportunities cannot be found. While these results should be interpreted with caution due to possible selection bias issues, they indicate that even following the financial crisis the equity market was able to maintain efficiency in acquisition pricing.

Keywords: Information and Market Efficiency, Financial Crisis, Behavioral Finance; Risk Arbitrage, Acquisitions, Probit Model

1 Introduction to the Financial Markets

1.1 Introduction:

As stock markets have grown in size, they have also grown in importance. Large companies that impact everyday life are almost exclusively publicly traded, and managers increasingly consider the price of the company's shares in everyday decision making. In addition, the stock market offers households a liquid investment, helps households diversify risk, and acts as a signaling mechanism to businesses regarding what investments may be profitable. As such, it is important to gauge whether the equity market is informationally efficient (that is, new information is quickly and accurately incorporated into stock prices).

This paper studies whether or not the equity market is informationally efficient by examining evidence from acquisition announcement reactions during two time periods, before and after the 2008 financial crisis. The market is considered informationally efficient if the market-implied probability of acquisition success, determined by changes in the stock of the acquired firm's stock following the announcement, does not systematically overestimate or underestimate the actual probability of success.

The remainder of Section 1 introduces important aspects of the financial markets. Section 2 presents two competing theories of informational efficiency and introduces the concept of risk arbitrage. Section 3 provides an overview of the acquisition process, which is used along with the concept of risk arbitrage to analyze informational efficiency. Section 4 reviews the economic literature on modeling acquisition success. Section 5 expands on previous models to develop a more complete and robust model of acquisition success. Section 6 describes the data used in this paper's empirical analysis, and Section 7 details the results. Section 8 concludes.

1.2 The Financial Markets

"Financial markets" is a broad term that categorizes many markets in which financial products are traded, such as the capital markets, the currency markets, and the insurance markets. This paper will specifically examine the equity market, a subdivision of the capital markets in which investors can buy or sell equity, or ownership in a company. Most of the activity in the equity market in the United States occurs on major exchanges, such as the American Stock Exchange, the NASDAQ, and the New York Stock Exchange[1]. These exchanges facilitate trade by posting bid and ask prices for each listed security as well as announcing trades as they occur.

The equity market can further be subdivided into the primary and secondary markets. In the primary market, the owner or owners of a previously private company can sell shares to the public in an Initial Public Offering (IPO). After an IPO, shares of the company trade on the secondary market, where investors can buy and sell shares that they purchased either on the primary or secondary markets. In addition, investors in the secondary market can borrow shares of a company from other investors and sell those shares on the secondary market in a technique known as short selling. The investor must eventually buy back the original number of shares he has borrowed, allowing him to profit if the price of the shares has decreased during the time after he has sold the shares but before he has repurchased the shares. Because the investor has borrowed a specific number of shares, it is less costly to repurchase the shares if they have decreased in value. Short selling is important because it enables investors to achieve profits even if stock

[1] Each exchange also has requirements that companies must meet in order to be able to trade shares of their company on the exchange. Companies that are unable to meet these requirements or decide not to trade on an exchange can still participate in the equity market by selling shares that trade over the counter. Such shares do not trade on an exchange but rather through a network of dealers.

prices decrease, allowing investors to create portfolios of investments with a more sophisticated payout structure than would be possible if stocks could only be bought or sold. Portfolio construction, enabled by the ability to both buy and short sell assets, plays an important role in risk arbitrage, discussed in Section 2.3.

1.3 Impact of the Equity Market

The equity market significantly impacts the economy as a whole and serves several necessary economic functions. First, movements in the overall price of stocks in the equity market can have a substantial impact on consumption, investment, GDP and unemployment. A change in the overall price of stocks in the equity market can have major effects on consumer behavior, as the secondary equity market acts as a store of wealth: all of the value of the shares of a company ultimately belongs to households. Therefore, as the overall value of the shares in the equity market rises, households become wealthier and are therefore more likely to increase consumption. Knowing this, businesses' investment decisions may reflect movements in the overall price of stocks to take advantage of anticipated increases in consumption.

Further, the average movement in the price of stocks in the equity market has an effect on consumer confidence levels and can affect expectations for all households, even those who do not own stock and are therefore not directly affected by the wealth effect. If the overall price of equities declines, consumer confidence in the economy could fall, leading consumers to expect future poor economic performance. This could then cause consumers to spend less, reducing demand for goods and services. In response, businesses would likely invest and produce less, which could lead to an increase in unemployment and a decrease in GDP.

In addition to their substantial impact on the economy, the financial markets serve several necessary economic functions. First, the equity market provides companies with a way to raise capital. In the primary equity market, a private company can undertake an IPO in which it exchanges shares in the company in return for investor money, enabling the company to gain additional capital without the previous owners having to take on more risk. Also, companies can raise capital in the secondary equity market by undergoing a *secondary* public offering. In this procedure, a company that has already issued shares of the company to the public issues additional shares in order to raise capital. While this dilutes the ownership of those who held shares prior to the secondary offering, it provides companies in financial trouble with an avenue to raise capital other than issuing debt at exorbitant interest rates. Several major banks and automakers used this procedure to raise urgently needed cash following the 2008 financial crisis.

The equity market also provides liquidity, which makes stock ownership an attractive vehicle for savings and therefore increases the amount of capital available to firms for investment. When investing their savings, households often prefer liquid investments so that their savings remain available for consumption without having to plan far in advance. If a household were to use its savings to purchase part of a private business, rather than being able to simply buy shares in that business, it would likely undergo a costly and time-consuming process before it could access those savings, as the household would have to search for another household who wished to buy its exact ownership stake, negotiate a fair price, and finally obtain payment from that buyer. If this were the only way to invest in a company, most households would likely put their savings in some other asset due to the high cost and lack of liquidity available in such an investment. Instead, the equity market enables households to rapidly convert their

ownership in a company to cash, providing a liquid investment. In this way, the equity market allows and encourages more households to invest in companies, thus increasing the overall amount of capital available to companies.

Third, the equity market helps households diversify risk. When deciding what to do with savings, households must balance the desire for returns with their own risk preferences. If a household holds its entire savings in cash, it will earn no returns (and even gain negative returns in the event of inflation) but will also carry no risk. On the other hand, if a household uses its savings to privately purchase part of a business it may gain higher returns but will also take on significant risk as the company could suffer rising costs, an increase in competition, or in some cases even go bankrupt, potentially resulting in the household losing much of its savings. The equity market allows households to take the middle ground by providing the opportunity to purchase small ownership stakes in numerous companies across varying sectors with low transaction costs, thus diversifying their risk and allowing households to fit their portfolio of investments more closely to their risk/return profile. In addition, the equity market allows households that do own a private business the ability to sell shares in their company through the primary market and to purchase shares in other companies, thus diversifying their own savings and reducing risk.

Finally, the equity market can act as a signaling mechanism to a specific company, indicating what investments should and should not be made. For example, suppose there exists a company with 100 workers and machines, 600 shares of stock, and no diminishing returns to production. Further, suppose that the cost to the company of hiring an additional worker and buying a new machine is $120 and that the share price of the company is $30. A simple calculation shows that the value of the company is $18,000

(600 shares * $30 per share), meaning each machine and worker is valued by the market at $180. Thus, the market acts as a signaling mechanism to the company, indicating that it should invest in more workers and machines. The market also enables the company to raise money for this new investment by selling new shares and allows current shareholders of the company to benefit without taking on additional risk. The company can sell more stock to finance the purchase of 100 additional machines by selling additional shares to new investors at $40[2]. With shares of the company now worth $40, original investors of the company have made a profit of 33.33%.

Given the impact the equity market has on the economy and the role it plays in providing companies access to capital, giving households with the ability to maintain immediate access to their savings, and signaling profitable investments to companies, it is clearly critical that the equity market be informationally efficient. While it is also important for the market to be economically efficient (that is, that it efficiently allocates capital and does not create deadweight losses) this paper primarily addresses the informational efficiency of the market.

2 Theories on Market Efficiency

An informationally efficient market is defined as one where the prices of securities accurately reflect all of the publicly available information about a company at that time. In an informationally efficient market, the fundamental or technical analysis of stocks based on publicly available information would not allow an investor to consistently earn excess returns over the market average return, assuming that all

[2] If the company owns 200 machines and workers, it is worth $36,000 (200 machines * $180 per machine). If the company sells 300 new shares at $40 per share it will raise $12,000, which is enough to buy 100 new machines and workers at the market price of $120. In addition, since the company is now worth $36,000 and there are 900 shares, each share is worth $40.

information available to one investor is also equally available to other investors. Sections 2.1 and 2.2 detail two major competing theories on the efficiency of the financial markets.

2.1 Efficient Markets Hypothesis

One of the most widely accepted theories on informational efficiency is the Efficient Markets Hypothesis (EMH), which states that the financial markets, including the equity market, are informationally efficient. The EMH, formalized by Eugene Fama (1970), can further be subdivided into three forms: the weak, the semi-strong, and the strong. This paper will concentrate on examining the semi-strong form, which states that all public information about a security is already incorporated into its current price. If this form of the EMH were to hold, the equity market would efficiently allocate savings and investment.

2.2 Behavioral Finance

The theory of behavioral finance evolved as a response to observed market phenomena that could not easily be explained by the EMH. For instance, on October 19, 1987, the S&P 500 index declined in value by 20.4%, a decrease that many thought could not be justified by a change in the available public information. To explain these perceived inefficiencies in the equity market (and the financial markets as a whole), adherents of behavioral finance look to psychological biases native to humans (Riccardi and Simon (2000)). The idea is based upon the principle that if humans have innate biases and the market is formed by a multitude of human decisions, the equity market should reflect these biases. Examples of biases include anchoring, a psychological phenomenon in which the value that an individual assigns to an item is affected by a number that the individual relates to that item. Tversky and Kahneman (1972) demonstrate anchoring in an experiment in which they spin a wheel with the numbers 1 to 100 and then ask

participants if the number of African nations in the United Nations is above or below the number given. They then ask the participants to estimate the true number of African countries in the United Nations and find that when a lower number is spun on the wheel, the estimates given by participants are significantly lower than the estimates given when a high number is spun on the wheel. While the number on the wheel obviously bears no relation to the number participants are asked to estimate, it nonetheless affects their decision making process. In relation to the equity market, it is theorized that many investors buy stocks that once traded at higher levels because investors' opinion of the valuation of the company is driven in part by anchoring to the previously higher price of the company. If behavioral finance were to hold, it should be possible for an investor to consistently gain excess returns over the market average by taking advantage of these biases.

2.3 Risk Arbitrage

In order to evaluate the efficiency of the equity market, this paper will examine the possibility of risk arbitrage. In general, risk arbitrage occurs when an investor can create a portfolio of investments at no cost[3] through a series of transactions that provides the overall portfolio of investments with positive expected value. In other words, if the investor were to repeat these investments ad infinitum, he would receive some positive payout. Arbitrage is a market mechanism to eliminate temporary mispricing, as it will shift the price of an incorrectly valued asset towards the correct value[4]. Thus, if arbitrage

[3] *No cost* refers to the idea that the value of equity or riskless asset that the investor purchases should be the same as the value of equity or riskless asset that the investor sells, thus causing the overall price or value of the portfolio in the initial state to be zero. This does not imply there are no transaction costs. In addition, it should be noted that short selling of equities or a riskless asset as described in the introduction is necessary to construct such a portfolio.

[4] If a stock price is too low, arbitragers will buy that stock, slowly increasing its price until it is correctly priced.

opportunities have not been exploited and continue to exist, the EMH hypothesis would be weakened as mispricing could exist for extended periods. However, the absence of risk arbitrage would support the EMH and indicate that the market is informationally efficient[5].

In particular, this paper examines if risk arbitrage opportunities are present in the pricing of potential acquisitions. If the market were to systematically over or underestimate the probability of the success of potential acquisitions, risk arbitrage opportunities are likely to be present.

3 Acquisition Basics

In order to understand how to examine the market pricing of potential acquisitions, I first review acquisition process.

3.1 How An Acquisition Occurs:

In an acquisition, one company (the acquirer) makes a formal offer to acquire another company (the target)[6]. This offer is frequently made to the board of directors of the target company, who must decide whether to accept or reject the offer. If the board of directors of the target firm decides to accept the offer, the offer can be considered "agreed upon". Alternatively, if the board of directors rejects the offer or if the acquirer so chooses, the acquirer can commence a tender offer, or an offer directly to the shareholders of the target firm to buy all of the shares of the target firm at a set price, usually well above the given market price. The acquirer is typically forced to pay a premium in order to give shareholders of the target firm an incentive to sell their shares.

[5] It is important to note that the absence of risk arbitrage in the sample I am investigating does not prove that the market is efficient, but instead only lends support to the EMH. There could still be many other possible risk arbitrage strategies available.

[6] While either the acquirer, target, or both firms could be public or private firms, this paper only focuses on circumstances where the target firm is public. This is a necessary condition to calculate the market-implied probability of success of the acquisition.

If a tender offer is made, the board of directors of the target company makes a recommendation to shareholders but each individual shareholder decides independently whether or not to accept the offer. If enough of the shareholders agree to the tender offer[7] the acquisition can be considered "agreed upon". In the United States, once an acquisition is "agreed upon", the Justice Department or Federal Trade Commission has the option to challenge the acquisition if it feels that the combination of the two companies could have anticompetitive effects. If no such challenge occurs or if a challenge is sufficiently addressed by the two firms, the acquisition is completed and the acquirer gains control of the target.

If the board of directors of the target firm has either rejected the initial offer or recommends that shareholders do not accept the tender offer, then the acquisition is considered to be hostile. In a hostile takeover, the acquirer may attempt to negotiate with large shareholders to replace the board of directors with new members who are friendlier to the acquisition. In response to this tactic, the board of the target firm may sometimes solicit takeover bids for the target firm from another company, known as a *white knight*. This response of seeking additional bidders is significant in developing a model of acquisition success.

3.2 Why Acquisitions Occur

An acquisition can occur for many reasons. Frequently, the acquirer wants to purchase the target company for the creation of synergies, or cost advantages arising from the two companies working together that could not be realized if the two companies were owned separately. Additional reasons for an acquisition include obtaining of a technology owned by the target company, creating market power by purchasing competitors,

[7] The term "enough" refers to a certain percentage which is determined by each company individually.

eliminating double marginalization, gaining expertise in new markets, and creating new sales channels for the acquirer's products, among many other reasons.

3.3 Market Reaction and Its Relation to Risk Arbitrage

An acquisition offer is made either in cash, in shares of the acquiring company, or a combination of the two. If the offer is in shares or a combination of cash and shares, one can immediately determine the cash value per share of the acquisition offer, called the offer value per share[8]. Thus, if the acquisition were certain to be agreed to and to not be challenged by the government, the shares of the target company would be worth the offer value per share[9]. However, since there is frequently some uncertainty about whether the acquisition will succeed, either because the target will not agree or because the government may challenge the acquisition, the price of the target company will typically trade below the offer value per share.

From the market reaction, the market-implied probability of success can be inferred. As can be seen in the following example, if this market-implied probability of success differs greatly from the true probability of success, risk arbitrage opportunities are present and the markets are therefore considered informationally inefficient. Suppose that an acquirer has made an offer for target company ABC for $100 per share. Further, suppose that prior to the offer ABC stock sold for $50 per share, and on news of the offer the stock now trades for $75 per share. Additionally suppose that if the acquisition offer failed, ABC stock would decrease to $50 per share. Finally, suppose the true probability

[8] For example, if the acquirer offers 1.55 shares of its stock for every share of the target company and the value of one share of the acquirer is $10, the offer value per share would be $15.50

[9] If one factors in interest, this statement is not correct. Technically the shares of the target company are worth the present value of the value of the stock of the acquirer at the moment the acquisition is announced in addition to any cash payments that would be received by shareholders of the target company at a later date. In addition, because the shares of the acquirer can be short sold a stock or stock/cash offer does not offer any more uncertainty in terms of acquisition price than does an all cash offer.

of the acquisition succeeding is 80%. In this case, an investor who purchases one share of ABC at the market price obtains:

$$E_{Investor} = .8 * 100 + .2 * 50 = 90$$

where $E_{Investor}$ is the expected payoff to the investor of owning 1 share of ABC. Since 1 share of ABC only costs $75, the investor who purchases one share has an expected payoff of $90-$75=$15. In this case, by buying one share of the stock and simultaneously short selling $75 worth of a riskless asset[10], the investor can gain positive expected value at no cost, so there exists the possibility of risk arbitrage[11].

In order for the above scenario to exhibit risk arbitrage opportunities, the investor needed to know the true probability of the acquisition succeeding, which is obviously unrealistic in the real world. However, the investor could form risk arbitrage by only knowing that on average the market probability of success underestimated (or overestimated) the true probability of success.

4 Literature Review

Most studies that focus on acquisitions do so from an ex-post point of view, examining the acquisition after it has been completed or has failed. These studies focus on subjects such as the determinants of returns to the acquirer following an acquisition, if acquisitions are socially optimal, or how acquisitions affect innovation at large firms. My analysis, however, focuses on the acquisition from an ex-ante point of view, examining the market-implied probability at the time the potential acquisition is announced.

[10] A riskless asset can be thought of as an asset such as a treasury bond that is unlikely to experience significant changes in price. This example, as with the rest of this paper, supposes that interest rates are zero.

[11] This scenario assumes that the offer is made in cash. If the offer was made in stock or a combination of stock and cash, the investor would also need to short sell an equal value in shares of the acquiring company in order to capture the spread, and would not need to short sell a riskless asset.

4.1 Previous Models

While their objectives differ slightly, Brown and Raymond (1986) and Samuelson and Rosenthal (1986) both develop models to calculate the market-implied probability of success of an acquisition at the time it is announced. Both models are based on the idea that if the acquisition offer is accepted, the shareholder of the target company receives P_T, or the value per share of the acquisition offer. If the acquisition offer is not successful, the stock price of the target company is assumed to change to P_F, known as the fallback price. The fallback price can be thought of as the initial price of the stock adjusted by any new information revealed about the company by a failed merger attempt[12]. Thus, according to Brown and Raymond (1986) and Samuelson and Rosenthal (1986), the price of the stock of the target company at any point during the offer period (the time in between when the offer has been made and when the offer is completed or rejected) can be given by:

$$P_C = X(P_T) + (1 - X)(P_F) \tag{4.1}$$

where P_C is the current price of the stock and X is the probability that the acquisition offer will be successful. This equation supposes that the current price is equal to the expected value of the stock price: if the acquisition succeeds the stock is worth the offer price while if the acquisition fails the stock moves to the fallback price. From equation (4.1) above, we can solve for X, providing a direct formula for the market-implied probability of success of a potential acquisition:

$$X = \frac{P_C - P_F}{P_T - P_F} \tag{4.2}$$

[12] A failed acquisition could also cause the fallback price to be lower than the initial price, all else equal, if the initial price factored in some probability of an acquisition offer before the offer was officially made.

Equation (4.2) is the model used by both Brown and Raymond (1986) and Samuelson and Rosenthal (1986). Both papers focus on the markets' ability to discern between successful and unsuccessful offers as each acquisition approaches its conclusion date by examining how X changes over the offer period to determine if X moves differently for successful offers than it does for unsuccessful ones. By examining X immediately after an acquisition announcement, I can calculate the initial market-implied probability of success directly after the acquisition announcement.

4.2 Limitations

A quick examination of equation (4.2) reveals that in the case that $P_C > P_T$, the probability of success of the acquisition would be greater than one, which is statistically impossible. This is especially a problem because frequently the stock price does rise above the acquisition offer price once the offer is announced. This may occur for several reasons, including the anticipation of another offer from the same or a different acquiring firm at a higher price than the original offer, or if the original offer revealed new information about the target company that makes it a more desirable company. In addition, if $P_F > P_C$ or $P_F > P_T$ but not both, the probability of the success of the acquisition is negative, which also is not mathematically possible. While this is not likely, it can occur depending on how P_F is estimated.

In order to cope with the possibility that P_C could be greater than P_T, Samuelson and Rosenthal (1986) only consider acquisitions in which there were not competing offers, thus eliminating this difficulty. While this solution forces the probability to be less than one, it limits the usefulness of their results since it cannot be known at the time of the acquisition announcement whether or not there will be competing offers. On the

other hand, Brown and Raymond (1986) put limitations on equation (4.2), replacing it with:

$$X = Min\{ \frac{Max\{P_C - P_F, 0\}}{P_T - P_F}, 1\} \tag{4.3}$$

While calculating the probability of the success of each offer based on equation (4.3) guarantees that the probability is between 0 and 1[13], it fails to take into account that there is a reason that the probability given by equation (4.2) can be below 0 and above 1 at certain points. The ability of the model to yield invalid values indicates that it is either inaccurate or incomplete. Section 5 extends the model to incorporate missing factors.

4.3 Fallback Price Estimation

Since the fallback price can only be directly observed for acquisitions that are unsuccessful, we must find some way to estimate the fallback price for the stock of target companies where the acquisition has been successful.

In calculating the fallback price of a stock, Brown and Raymond use the price of the stock four weeks prior to the announcement of the potential acquisition. Samuelson and Rosenthal (1986) use data from unsuccessful acquisition offers to calculate the coefficients in regression equation (4.4), where P_F is the fallback price, P_I is the price of the stock of the target company before the acquisition announcement, and P_T is the takeover offer price. This equation is then used to estimate what the fallback price would have been for the stock of the target company in the successful offers.

$$P_F = a_0 + a_1 * P_I + a_2 * P_T + \varepsilon \tag{4.4}$$

[13] Since Brown and Raymond select the fallback price as the price of the target company four weeks prior to the announcement offer, they are not likely to encounter the case that $P_T < P_F$. If this did occur, even this revised formula would yield a negative probability.

In calculating the coefficients for equation (4.4), Samuelson and Rosenthal make two key assumptions. First, they assume that because the market does not suffer from money illusion, a_0 should equal zero. That is, because prices are affected by real instead of nominal levels, there should not be a constant affecting the relationship between the fallback price, the initial price, and the offer price. Second, Samuelson and Rosenthal assume that P_F should lie in the interval $[P_I, P_T]$, which would imply that $a_1 + a_2 = 1$.

4.4 Previous Results

As mentioned in the previous sections, both Brown and Raymond (1986) and Samuelson and Rosenthal (1986) examine the market-implied probability of success of the proposed acquisition during the offer period, albeit with different goals. Brown and Raymond (1986) show that the market-implied probabilities of successful and unsuccessful offers are substantially different from one another throughout the offer period, implying that these probabilities can be used to predict the likelihood of the success of an acquisition. Samuelson and Rosenthal (1986) demonstrate that in each period during the offer price, the price of the stock of the target company reflects the expected value of the stock at the conclusion of the acquisition, which indicates the market is efficient.

However, these results should be approached with caution. Due to the limitations in each model as well as the time periods in which these studies were conducted, these results may not hold when expanded to a more complete model in a more recent time period.

5 Model and Theory

5.1 Expanded Model of Acquisition Success

The model used by Brown and Raymond (1986) and Samuelson and Rosenthal (1986) faces significant shortcomings in that it fails to take into account the possibility that for an announced acquisition there may be another competing offer with a different offer value. Thus, I expand equation (4.1) based on the idea that the share price of the target firm following the acquisition should reflect its expected value:

$$P_C = X(P_T) + Y(P_O) + (1 - X - Y)(P_F) \tag{5.1}$$

P_C is the price of the target firm at the close of the trading day of the acquisition announcement, P_T is the offer price per share of the current offer, P_O is the price of another successful offer for the target firm, P_F is the fallback price, X is the probability that the current acquisition offer succeeds, and Y is the probability that there is another successful acquisition offer. After a potential acquisition is announced, a share in the target company should be worth the expected value of a share at the time that the target company is sold or not sold, as this is the price for which the shareholder will be able to sell the share in the future. It is important to note that the point at which the company is sold or not sold is not necessarily the same point at which the current acquisition offer is accepted or rejected. In many cases, an initial acquisition offer is followed by other bids from competitors of the acquiring firm or by an amended bid by the initial acquiring firm. Thus, the potential for a different offer price must be taken into account, which is the purpose of the $Y(P_O)$ term[14].

[14] It is important to note that P_O does not necessarily have to be greater than P_T. In some cases in my data the fundamentals of the target company may deteriorate during the acquisition process triggering provisions in the initial acquisition agreement that allow the acquirer to revise its offer

The addition of the potential for several offer prices does introduce new complications, however. First, this adds one new variable which cannot be directly observed: P_O. In addition, since there are now three probabilities that must be calculated, we must find some way to estimate Y. Thus, to solve equation (5.1) for X, we first must estimate P_F, P_O, and Y.

5.1.1 Determination of Fallback Price

Because the fallback price is only observable for acquisitions that do not succeed, we need a way to estimate what the fallback price would have been for the stock of the target firms which were successfully acquired.

While the method used by Brown and Raymond (1986) to calculate a fallback price is simple, as they pick the price of the stock of the target company four weeks prior to the acquisition announcement, it has several shortcomings. First, it does not take into account that the potential acquisition could have disclosed new information about the target company that would alter its value to a shareholder, thus increasing the fallback price, all else equal. In addition, any large movement in the overall price of the market and thus likely in the price level of the stock of the target company during the four weeks before the acquisition was announced would greatly affect the accuracy of fallback price selected. For example, if the overall market price substantially decreased during this time period, the fallback price selected for the target company would likely be too high. Furthermore, this error in the fallback price would be different for each acquisition

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downward. Since a downwardly revised offer does affect what a shareholder of the target company receives as a final payment, P_O is allowed to be less than the original offer price.

depending on the movement of the market in the four weeks prior to the acquisition announcement, resulting in bias.

Although the method employed by Samuelson and Rosenthal (1986) of using regression equation (4.4) to estimate what the fallback price would have been for target companies with successful acquisitions is promising, it is not without its drawbacks. In equation (4.4), the assumption that a_0 should be zero should hold, as the market should not suffer from money illusion. However, Samuelson and Rosenthal (1986) also assume that P_F should lie in the interval between P_I and P_T, a condition that is frequently violated by my data. While this condition could have held for the data set they used, it remains an unrealistic assumption for the purposes of this paper. Finally, P_I and P_T are likely to exhibit a high degree of correlation, which is likely to lead to problems of multicollinearity.

To calculate the fallback price for each potential acquisition, I test two different equations:

$$LN(P_F) = a_1(LN(P_I)) + a_2(LN(\frac{P_T}{P_I})) + \varepsilon \tag{5.2}$$

$$LN(P_F) = a_1(LN(P_I)) + a_2(LN(P_T)) + a_3(LN(P_C)) + \varepsilon \tag{5.3}$$

where P_F is the fallback price, P_C is the price of the target company directly following the acquisition announcement, P_I is the initial price[15], and $(\frac{P_T}{P_I})$ can be thought of as a type

[15] For most samples, P_I is directly observed as the price of the target company at the close of the trading day before the acquisition is announced. However, for some samples, a rumor of the acquisition is announced prior to the actual acquisition announcement. Because there can be a significant increase in the price of the target company as a result of this rumor (causing an artificially high initial price relative to those samples without rumors) an estimation technique is used to calculate a fair initial price. The initial price of such a sample is the initial price of the

of bid premium factor. Unlike equation (4.4), equation (5.2) is unlikely to suffer from correlation between the independent variables, as the initial price of the target company is unlikely to be correlated with the bid premium that the acquiring company offers. However, it is possible that this bid premium term will fail to incorporate the information that is measured by the tender offer price used in equation (4.4). Thus, I will also test equation (5.3), which is likely to incorporate a large amount of information by including the three observable prices associated with an acquisition offer. While this regression is likely to suffer from multicollinearity, it is possible that the additional information provided by the extra price terms will nevertheless provide a better estimate for the fallback price than equation (5.2).

Both equations (5.2) and (5.3) are run without a constant term to reflect the principle of no money illusion noted by Samuelson and Rosenthal (1986). However, no restrictions are placed on the coefficients because, as discussed above, such constraints are violated by my data. Taking the natural logarithm of each of the terms is necessary in order to measure the effect of the independent variables in terms of percentages rather than levels.

However, similar to equation (4.4), equations (5.2) and (5.3) rely on the key assumption that the fallback behavior of the target firms in failed acquisitions is the same as it would have been for target firms in successful acquisitions. While this may be a strong assumption, it is unavoidable if one is to calculate fallback prices with the available data. If possible, a regression equation that estimated fallback price could take

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stock before the rumor combined with the return of the S&P 500 index over the period between the rumor and the official announcement. For example, if the price of the stock before the rumor was $10 and the S&P 500 index returned 5% over the period between the rumor and official announcement, the estimated initial price would be $10.50.

into account company specific factors that could differ between target firms in successful and failed acquisition attempts. Such factors could include the strength of the management team of the target company, the amount of new information revealed by the acquisition offer, the desire of the management team to resist or accept the acquisition, underlying business fundamentals of the target company, or other factors. While it is true that these factors could change how the stock price of a target company responds to a failed acquisition, collecting and quantifying this information for the firms in my sample space is unrealistic as it is difficult to find information about delisted firms. It is also possible that some of this information about the acquiring company's desire to acquire the target is captured in the bid premium term in equation (5.2) or in the three price terms in equation (5.3). A more eager buyer is likely to offer a higher bid premium in order to intimidate potential rival buyers and ensure that their bid is successful. In addition, it is possible that a firm with more positive information revealed by the acquisition announcement will have a higher P_C, all else equal. [16]

5.1.2 Determination of Other Offer Price

In addition to estimating the fallback price, it is important to estimate P_O, the other offer price used in equation (5.1). P_O presents challenges similar to those of the fallback price estimation, and so a similar estimation procedure is followed.

[16] Instead of estimating fallback prices with a regression, an alternative method for calculating the fallback price would be to take the average percentage change from the initial price of each of the failed acquisitions, to its realized fallback price. While this method still relies on the assumption that the fallback prices for the target firms in successful acquisitions be similar to those in failed acquisitions, it would be much simpler than using a regression. However, since equations (5.2) and (5.3) incorporate more information about each company than this method could, I will use equations (5.2) and (5.3).

$$LN(P_O) = a_1 LN(P_C) + \varepsilon \quad (5.4)$$

where P_O is the price of another successful offer and P_C is the price of the stock of the target company following the acquisition. No constant term is used because of the assumption of no money illusion.

Similar to the estimation of P_F, the estimation of P_O relies on the assumption that the firms that received other offers are similar in nature to those that did not, and the offers these firms received can thus be used to estimate what other offers other firms could have received. In this case, this assumption is again necessary due to data constraints. Ideally, an estimation equation would also include data regarding the fundamental financial data of the target company as well as the level of desire among other firms to acquire the target company. All else equal, deteriorating fundamentals of the target company would likely cause the company to receive a lower P_O (as occurred in a few samples in my data). A high level of desire to own a target company, all else equal, would likely cause a higher P_O, as many firms compete to acquire the target company. However, since obtaining such information is difficult, equation (5.4) uses only the price of the stock of the target company at the close of the trading day of the announcement of the acquisition. While this is not a perfect instrument, a higher current price of the stock should be related to a higher other offer price. If a stock price rises steeply following an acquisition announcement, especially if its price exceeds the current offer price, it can be taken as the market signaling that it expects a higher other offer price. Since the market's expectations are built into the current price and the market's expectations incorporate elements such as the fundamentals of the target company, the current price could serve as a good instrument for measuring P_O. However, the current price cannot capture all of the

useful independent variables, as some factors such as desire among firms to own the target company are not known except to the individuals in other firms.

5.1.3 Determination of the Probability of Another Successful Offer

The final variable that must be estimated in order to be able to use equation (5.1) to estimate the probability that the current acquisition will succeed is Y, the probability that there is another successful offer. The following regression equation is used, where *cash* is a binary variable representing whether the acquisition offer was in cash, *hostile* is a binary variable representing whether the acquisition was hostile, and *google* is the number of Google news hits for the target company in the year before the acquisition announcement, used to represent the amount of available information about the target firm[17].

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[17] *cash* is a 1 if the offer was in cash and a 0 otherwise. *Bid premium* is given by $\left(\frac{P_T - P_I}{P_I}\right)$ and *market premium* is given by $\left(\frac{P_C - P_T}{P_T}\right)$. *hostile* is a 1 if the bid is hostile and a 0 otherwise. The *google* variable is the total number of hits when searching the ticker of the target company along with its associated exchange name on Google news for the period of one year before the announced acquisition, including the day after the acquisition was announced. The day after is used so that articles about the acquisition are included. Since the acquisition may be announced late in the day, the day after the acquisition is announced is used in order to give the press time to write and publish articles about the acquisition. For example, if the target company had ticker ABC and was traded on the New York stock exchange and the acquisition was announced on January 1, 2000, the search term used would have been (NYSE: ABC) for the dates January 1, 1999 to January 2, 2000. The search term needed to be in this format in order to avoid obtaining biased results. For some companies, the official name of the company differed from the colloquial name that is used in the press, such as with Provident Bank which is known colloquially as Provident Bank but is officially Provident Bankshares Corporation. Thus, to use official names would bias the results downward for firms that were often referred to by other names. In addition, it was not possible to find every colloquial name for every company in the sample, since there is no systematic way to find all of the colloquial names of a company; it is therefore possible that some names would be overlooked. Searching solely by ticker would be biased as well, as searches for companies with simple tickers such as T would include many irrelevant results while companies with more complicated tickers such as ABCD would not. Since many financial press articles from well-established sources mention a company in the form of (Exchange Abbreviation: Ticker), such a search term was used to avoid bias. If sources that used the (Exchange Abbreviation: Ticker) format reported specifically on certain types of acquisitions this could also introduce bias. However, sources that use this format are frequently large organizations that

$$Y = a_0 + a_1 cash + a_2 bid\ premium + a_3 market\ premium + a_4 hostile + a_5 google + \varepsilon^{18} \quad (5.5)$$

Fishman (1989) proposes that the form of exchange for the acquisition plays an important role in determining whether there will be multiple offers for the target company. Fishman suggests that if the acquirer offers to pay for the target company with cash rather than stock, the acquirer signals a relatively high private valuation of the target firm. When rival firms see this high valuation, they are less likely to make competitive offers for the target firm because they are not willing to enter into a bidding war and pay a high price for the target company. Thus, if the acquirer pays cash, the probability of another successful offer should decrease.

Similarly, a high *bid premium* often signals that the acquirer has a high valuation of the target firm. This high valuation, for reasons similar to those discussed above, could deter other potential acquirers from bidding, thus reducing the probability of another successful offer. However, the correlation between bid premium and cash is not necessarily high because how a company finances an acquisition is based on many factors other than its valuation of the company such as the acquirer's cash reserves, free cash flow, and the size of the target company. An acquirer with a high valuation of the target may nonetheless decide to finance the acquisition with stock when the acquirer has low cash reserves, low free cash flow, and/or when the target is large (the acquirer is less likely to hold sufficient amounts of cash).

If the board of the target firm is hostile to the acquisition, the probability of another successful offer should increase. In a hostile takeover, management may try to

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report on all kinds of companies and acquisitions and do not appear to favor some companies over others.

[18] This regression will be run using a probit model because the dependent variable, Y, must be between 0 and 1.

find a white knight to purchase the company instead of the initial bidder. While hostility is likely correlated with bid premium, this correlation may not be particularly strong as bid premium has not been found to be one of the main determinants of whether or not a bid is hostile. Morck et al (1988) show that company ownership among officers in the target firm is the most important factor in determining if a bid offer is hostile, with low officer ownership increasing the probability of that a bid would become hostile. Other factors affecting if the bid is hostile are the motivation behind the acquisition (disciplinary or synergetic) and the size, age, growth rate, and Tobin's q of the target. Thus, including both hostility and bid premium as independent variables should not present significant collinearity issues.

In addition, a variable to represent the amount of information available on the target firm is included. Jennings and Mazzeo (1993) show that the amount of available information about the target company will affect whether there are multiple bids - if there is less information available on the target company, potential acquirers should be less likely to make competing bids because the true value of the firm is more uncertain, and firms are less willing to enter into a bidding war to win a prize of uncertain value. I use Google news hits as a proxy for the overall amount of information available about a company as a greater availability of information on a company should be related to the overall number of articles in which the company is mentioned.

Finally, there are other factors that could affect the probability of another successful offer for which data was not available. While these factors may partially be

captured in some of the other terms I am using, their omission could cause imprecise estimates.[19]

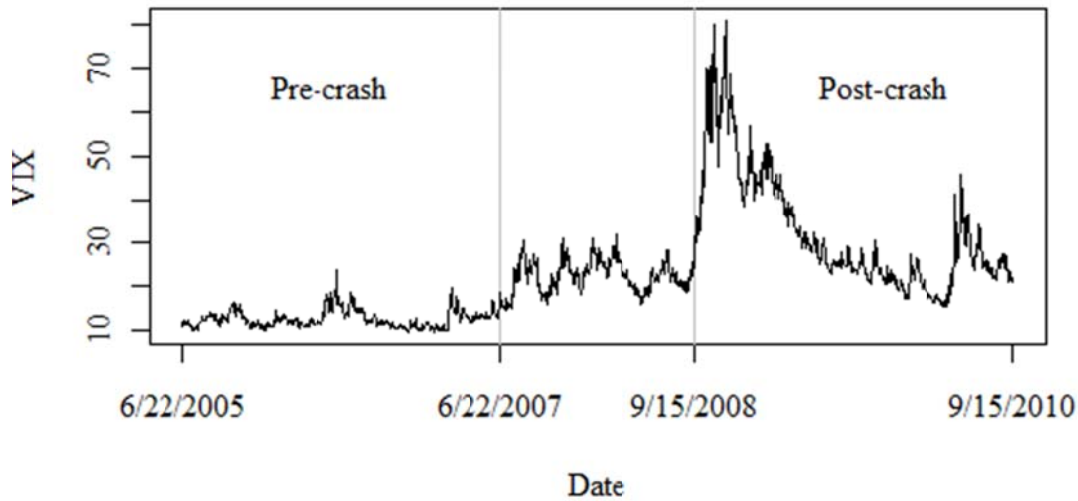
5.2 Time Period

In order to analyze the informational efficiency of the market, two distinct periods surrounding the 2008 financial crisis are examined. The pre-crash period lasts from June 22, 2005 to June 22, 2007, while the post-crash period is from September 15, 2008 to September 15, 2010. On June 22, 2007, two credit derivative hedge funds operated by former investment bank Bear Stearns ceased operations after suffering tremendous losses. The collapse of these funds caused a spike in the S&P Volatility index, or VIX. The VIX measures overall market volatility and is commonly thought of as a "fear index," where higher values indicate an increased sense of fear in the market. As we can see from Figure 6.1, the VIX rose to new highs following the collapse of the two Bear Stearns hedge funds. However, I mark the beginning of the post-crash period with the collapse of the former investment bank Lehman Brothers, which is widely viewed as the event that significantly increased fear in the marketplace. Following the collapse of Lehman Brothers, at the time the fourth largest investment bank in the United States, the VIX increased nearly 300% within one month, an unprecedented change. During the pre-crash period the average value of the VIX was 12.84, compared with 32.28 during the post-

[19] Betton and Eckbo (2000) find that if the acquiring company owns a significant percentage of the target company (known as a toehold) prior to the acquisition offer, the probability of a competing acquisition offer from a rival bidder is reduced. In addition, the greater the size of the toehold owned by the acquiring company, the lower the probability of a competing offer. These findings are supported by Bulow et al (1999). While data on toeholds owned by the acquiring company was not available, Betton and Eckbo (2000) note that the effect of a toehold may also be reflected by a lower bid premium, which is included in my regression equation. In addition, Bradley, Desai and Kim (1988) find that in a sample of 236 acquisitions, 66% of bidders had no toehold. Thus, due to the relatively scare occurrence of toeholds and the likely correlation of toe holds to bid premium, the absence of toeholds in my regression equation is not likely to cause significant problems.

crash period, reaffirming that fear in the pre-crash period was significantly lower than it was in the post-crash period[20].

Figure 6.1: S&P Volatility Index (VIX) June 2005 - September 2010



[21]

5.3: Using the implied probabilities

After estimating P_F, P_O, and Y for each sample, it is possible to use equation (5.1) to calculate the market-implied probability of success, X, for each acquisition. In addition, for each acquisition we know after the fact whether or not the acquisition was successful or unsuccessful. This result can be represented by a success/failure term, where a 1 represents a success and a 0 represents a failure. For each acquisition we can calculate a difference term, given by:

$$difference = success/failure - X \tag{5.6}$$

For example, if the market-implied probability of success was 65% and the acquisition succeeded, the difference term would be 1-.65= .35. If the market-implied probability of each acquisition in a given period was exactly equal to the true

[20] Source: Yahoo Finance data
[21] Source: Yahoo Finance Data

probability[22], then the sum of the difference terms in each period should be 0. For instance, if each market-implied probability was 65% and each true probability was also 65%, then 65% of the samples would have a difference of .35 and 35% of the samples would have a difference of -.65. Thus, the overall sum of the difference terms would be .65*.35 + .35*(-.65) = 0.

However, simply because the sum of the differences is 0 for a given period does not necessarily mean that the market-implied probabilities are equal to the true probabilities. For example, suppose that for the first half of the sample the market-implied probabilities were 25% for each acquisition and the true probabilities were 75% for each acquisition, while for the second half of the sample the market-implied probabilities were 75% for each acquisition and the true probabilities were 25% for each acquisition. In this case, even though the market-implied probability differs from the corresponding true probability for each acquisition, the sum of the difference terms would be zero. What the sum of the difference terms really signifies is, therefore, not whether or not the market-implied probabilities equal the true probabilities, but rather whether the market-implied probabilities overall overestimate or underestimate the true probabilities. If the sum of the difference terms is zero, risk arbitrage would not be possible as the probability that the market-implied probability was higher than the true probability would be equal to the probability that the market-implied probability was lower than the true probability.

On the other hand, if an investor knew that the market-implied probabilities either underestimated or overestimated the true probabilities, then risk arbitrage would be

[22] The true probability can be thought of as the objective probability that the acquisition succeeds. The true probability can also be called the actual probability.

possible.[23] For example, if the investor knew that the market-implied probabilities on average underestimated the true probabilities, the investor could create a portfolio by buying the stock of the target company and short selling an equal value of a riskless asset or shares of the acquiring company if the acquisition offer was to be paid in stock[24]. While the value of the portfolio made up of this series of transactions could decline in value if the acquisition failed, the portfolio would still have zero cost and positive expected value, which is the condition for risk arbitrage.

Even if the market is informationally efficient, the sum of the differences may be nonzero. In fact, it is probable that the sum of the difference terms will not be zero, as it is unlikely that the market could predict the true probabilities as not all of the information required to predict such probabilities is publicly available or even known. However, for the market to be informationally efficient, it must be the case that an investor could not predict whether or not the market-implied probabilities would overestimate or underestimate the true probabilities. If it were possible to make such a prediction, the market could not be considered efficient as risk arbitrage would be possible. Thus, for both the pre-crash and post-crash periods, I will calculate the sum of the difference terms. Behavioral finance would suggest that given a low level of fear in the pre-crash period the implied probabilities may overestimate the true probabilities, causing the sum of the difference terms to be negative, while the high fear level during the post-crash period

[23] The investor would have to know specifically if the implied probabilities underestimated or overestimated the true probabilities. Simply knowing that one of the two was true would not allow for risk arbitrage.

[24] A riskless asset can be thought of as some asset that does not bear a risk premium. Such a riskless asset could be an instrument such as a U.S. Treasury bond. The above scenario also assumes that the spread gained by buying stock in the target company compensates the investor for any interest they must pay on the riskless asset. For simplicity, if we assume the interest rate is 0 then any situation in which the implied probabilities underestimate the true probabilities would allow this kind of risk arbitrage.

could cause the market-implied probabilities to underestimate the true probabilities, causing the sum of the difference terms to be positive. A t-test will be used to determine if either difference is significantly different from zero.

6 Data

6.1 Selection Criteria

My data includes all officially proposed acquisitions that occurred during each of the two periods, the pre-crash and the post-crash[25]. An officially proposed acquisition is defined as one where the acquirer officially offers the target a specific amount, either in stock of the acquiring company or in cash, in exchange for 100% ownership of the target company[26]. Rumors of an offer, even if the rumor included a specific offer amount, were not included in the data. When a rumor about an acquisition exists, the stock price of the target company is affected not only by the possibility that the acquisition will be successful, but also by the probability that the rumor is true. Measuring the probability of the truth of a rumor complicates the analysis and is unnecessary in answering the questions put forth by this paper.

In addition, acquisition offers for majority control or offers of any size for less than a complete acquisition were excluded. While partial acquisitions provide an

[25] The list of acquisitions was obtained from the Zephyr Merger and Acquisition database via the New York Public Library system. The list is complete to the best of my knowledge. Other information such as the rumor dates, announcement dates, offer withdrawal dates, the price per share of the offer, whether or not the acquisition was hostile and the method of payment of the acquisition were also obtained from the Zephyr database. Historical price information for delisted companies was obtained from the Norgate Investor Services database, while historical price information for actively listed stocks was obtained from Google Finance and Yahoo Finance.

[26] The requirement that an official offer be made is a condition for inclusion in the Zephyr Merger and Acquisition database. I further filtered the Zephyr results to include only acquisitions for 100% of the target company.

interesting area of study, the characteristics of a partial acquisition and the effect it has on share prices are significantly different from the complete acquisitions I examine in this paper.

Also, acquisitions that occurred 1) for technical reasons, 2) where the two participants took part in a "merger of equals," and 3) in which the terms of the acquisition were uncertain or highly variable were not included. First, mergers that occur for technical reasons, such as a reverse merger, were not considered. For example, in 2006, American Apparel purchased Endeavor Acquisition Corp, a shell corporation that had been set up with the purpose of eventually merging with American Apparel, thus allowing American Apparel to become a publicly traded company without having to incur the expense of an IPO. While this was technically an acquisition, it does not involve the same considerations as acquisitions where the target firm is a functional and operational company as technical mergers do not fail and the price of the "target" company never rises. A "merger of equals" is defined as when two companies sign a merger agreement in which the two companies join together to form a new company. An example of such a merger is when the Bank of New York merged with Mellon Financial. In this case, neither firm can clearly be considered the acquirer or the target, since both firms were combined to form a new firm. In addition, at the time of the proposed acquisition, the payout to shareholders of each company was in the form of stock in the new company. Because the value of this stock is highly variable, shareholders cannot make the same kind of value decision as can those shareholders considering a cash or stock (in an existing company) offer. For similar reasons, acquisitions in which the terms of the acquisition are highly variable are excluded. In some acquisitions, such as Endo Pharmaceutical's 2009 purchase of Indevus pharmaceutical, the acquiring company

offers a certain guaranteed price, in addition to a bonus payment if the acquirer (once in possession of the target) meets certain revenue, profit, or other targets. In the case of Endo's acquisition offer, Endo agreed to an initial payment of $4.50 a share, with an additional payment of $3 per share if Indevus met specified sales and development targets after being acquired. In such a case, the value of the acquisition offer depends on the probability that a shareholder in the target company would receive such a bonus payment. Since calculating such a probability would be highly subjective if not impossible, such acquisition offers are excluded from the list of acquisitions that are examined.

Finally, to be included in either period, an acquisition must be both proposed and resolved, meaning that it was either completed or failed, within the time period. Acquisitions that are proposed in the pre-crash period but not resolved until after June 22, 2007, or those that are proposed in the post-crash period but not resolved until after September 15, 2010, are not included in either period. The resolution of an acquisition provides important information about a stock's fallback price or the possibility of another offer being made that would affect the calculation of both fallback price and the increased offer price for each sample period. These fallback prices and the prices of another offer are affected by company specific factors, but also by market sentiment. Thus, proposed acquisitions that are not completed within a period cannot be used in an unbiased manner, as examining their conclusions would measure market sentiment at a time other than during the period under examination.

6.2 Summary Statistics

Table 6.1: Summary Statistics

Variables	Pre-Crash	Post-Crash
Observations	214	163
Percentage of Successful Acquisitions	70.56	80.96
Percentage of Acquisitions Paid for With Cash	88.31	67.58
Percentage of Hostile Acquisitions	2.33	9.20
Percentage of Acquisitions with Rumors	20.56	26.38
Average Deal Value (In thousands of USD)	2,881,343.12 (5,385,174.56)	1,009,679.75 (1,216,020.66)
Average google score	11.33 (15.2052)	24.15 (79.2867)
Average Number of Bids per target	1.603 (1.4937)	1.153 (0.4659)
Average Bid Premium (in percent)	20.70 (0.1901)	42.48 (0.5376)
Median Bid Premium (in percent)	17.91	32.60

Table 6.1 presents summary statistics for the pre-crash and post-crash periods. As can be observed from the table, hostile bids were more common in the post-crash period than in the pre-crash period. This is consistent with the idea that in periods of depressed stock prices, firms that have experienced significant declines in market value will resist being taken over at low price. Another important difference in the two periods is bid premium, which is generally higher in the post-crash period, although with a greater variation than in the post-crash period. The bid premium is still higher in the post-crash period when examined by measures more robust to skewed data, such as the median. One potential reason for this could be that since the stock of the target firm had already traded at a low price in the post-crash period, a price that the target firm would agree to was higher when compared with the initial price than it would have been in the pre-crash.

7 Results and Discussion

Table 7.1 reviews all of the variables used in the following section:

Table 7.1:

Variable Name	Definition
P_F	The estimated fallback price, or price that the stock of the target company will move to if the acquisition fails.
P_T	The offer price per share of the current offer
P_O	The estimated price that shareholders of the target company would receive if there was another successful offer
P_C	The price of the target company at the close of the trading day when the acquisition was announced
P_I	The price of the target company before the acquisition was announced
Y	The probability that there is another, successful acquisition offer made for the target company
cash	1 if the offer was made entirely in cash, 0 otherwise
hostile	1 if the offer was hostile, 0 otherwise
google	The number of google news results for the target company during the period of one year before the acquisition announcement until two days following the announcement
bid premium	Calculated as $\left(\frac{P_T - P_I}{P_I}\right)$
market premium	Calculated as $\left(\frac{P_C - P_T}{P_T}\right)$
completed	1 if the acquisition offer succeeded, 0 otherwise

7.1 Fallback Price, Other Offer Price Estimation

Table 7.2: Pre-Crash Estimates for P_F and P_O

	LN(P_F) (1)	LN(P_F) (2)	LN(P_O)
LN(P_I)	.94160*** (.04514)	-.19644 (.48715)	
LN($\frac{P_T}{P_I}$)	.99050 (.83101)		
LN(P_C)		2.49228*** (.71903)	1.02028*** (.00467)
LN(P_T)		-1.33310 (.95631)	
R Squared	.75732	0.91395	.98739
Total Observations	15	15	44

Significance Levels: * 10%, ** 5%, *** 1%, standard errors in parenthesis

Table 7.3: Post-Crash Estimates for P_F and P_O

	$LN(P_F)(1)$	$LN(P_F)(2)$	$LN(P_O)$
$LN(P_I)$	.99002*** (.03935)	.90892 (.65537)	
$LN(\frac{P_T}{P_I})$	.12316 (.72449)		
$LN(P_C)$		1.88644* (.90730)	1.07951*** (.01799)
$LN(P_T)$		-1.77375 (1.11152)	
R Squared	.89776	.92862	.98340
Total Observations	13	13	12

Significance Levels: * 10%, ** 5%, *** 1%, standard errors in parenthesis

Table 7.2 shows the estimated coefficients for equations (5.2), (5.3), and (5.4) for the pre-crash period, while Table 7.3 shows these estimated coefficients for the post-crash period. While each regression was initially run with a constant term, the restriction that the coefficient was zero could not be rejected even at the 10% level. These estimates therefore did not include a constant term in the regression equation.

In Table 7.2 we can see that column 2 appears to have more explanatory power than does column 1, as is evidenced by a higher R squared. While only P_C appears to be significant, this is likely due to the issue of multicollinearity, discussed in section 5.1.1. This does, however, mean that we cannot draw conclusions about the individual effect of each of the variables on the fallback price, as the individual coefficients are not significant. In addition, it appears that P_C is a good indicator of P_O, with an R squared of .987.

In Table 7.3, as in Table 7.2, column 2 appears to have a higher amount of explanatory power than does column 1. However, the difference is far smaller than it was in the pre-crash period. One explanation for this might be that in the post-crash period,

the fallback price is more similar to the initial price because there is less positive new information released by the acquisition announcement. The release of positive new information is likely to be captured by a higher P_C term, which is not included in column 1. However, it is also possible that this difference is simply the result of the small sample size in column 1 and in column 2 in both the pre-crash and post-crash periods. As in Table 7.2, column 2 in Table 7.3 likely suffers from multicollinearity, and thus the coefficients cannot be accurately interpreted. In addition, P_C appears to be a good indicator for predicting P_O, just as it was in the pre-crash period.

To ensure my results are robust, I must determine if the coefficients I estimate are statistically different from one another in the pre-crash and post-crash periods. While a Chow test cannot reject the null hypothesis that the coefficients in column 2 of Table 7.2 are the same as those in column 2 of Table 7.3, I will still use two separate regressions to provide what I hope is the most accurate estimate of P_F in both samples. A Chow test is able to reject the null hypothesis that the coefficients of column 3 in Table 7.2 are the same as those in column 3 of Table 7.3 at the 1% level, indicating that it is correct to use different coefficients to estimate P_O in the pre-crash and post-crash periods.

7.2 Estimation for the Probability of Another successful offer

Tables 7.4 and 7.5 show the results of regression equation (5.5) for both the pre-crash and post-crash periods. The regressions were run using a probit model to ensure that the forecasted values of Y, a probability, were between zero and one. In addition, each column was run with a constant term. While the constant term was significant in every regression, it does not reveal any notable information and so it is not featured in either table.

In Tables 7.4 and 7.5, the results from a total of four regressions are reported. The first column in each table uses all of the explanatory variables detailed in the theory section and is therefore consistent with equation (5.5). Column 2 is used to indicate that some of the variables appear to not be significant, while columns 3 and 4 are used to test whether a subset of the variables are significant.

Table 7.4: Pre-Crash Estimates for Y

	(1)	(2)	(3)	(4)
market premium	12.80366*** (3.86549) [4.71883]	12.58098*** (3.89923) [4.75444]		13.47370*** (3.92517) [5.16521]
bid premium	.00611 (.71058) [.0022]	-.11715 (.70945) [-.04427]	-.85338 (.68268) [-.26457]	
cash	.67703 (.50270) [.26258]	.69854 (.50625) [.27261]	1.00344** (.46092) [.36586]	
google	.00425 (.00571) [.00156]			
hostile	.80922 (.52120) [.23494]			
McFadden R squared	.12248	.11482	.04243	.10362
Obs. With Dep =0	170	170	170	170
Obs. With Dep =1	44	44	44	44
Total Observations	214	214	214	214

Significance Levels: * 10%, ** 5%, *** 1%, standard errors in parenthesis. The square brackets show the partial derivative of the probit function at the point of means for each variable. For the binary independent variables, the square brackets show the change in the dependent variable at the point of means as a result in the change from a 0 to 1.[27]

[27] The partial derivative at the point of means can be found by using: $\frac{\partial \mathbf{P}}{\partial \boldsymbol{x_i}} = \frac{dP}{dY} * \frac{\partial \mathbf{Y}}{\partial \boldsymbol{x_i}} = \varphi(Y) * x_i$ where P is the probit function, and Y = $\sum_{i=0}^{n} a_i x_i$

Table 7.5: Post-Crash Estimates for Y

	(1)	(2)	(3)	(4)
market premium	1.86482 (1.36755) [.73547]	1.97957 (1.35817) [.78915]		2.52662* (1.33042) [1.00660]
bid premium	-.84664 (.51748) [-.33391]	-.76968 (.45675) [-.30683]	-.75515* (.44126) [-.29682]	
cash	.42565 (.42036) [.16753]	.44680 (.41993) [.17664]	.56267 (.42027) [.22095]	
google	-.00126 (.00257) [-.00050]			
hostile	1.25951*** (.42641) [.42627]	1.25716*** (.39420) [.41175]	1.21526*** (.39598) [.37487]	1.29992*** (.38178) [.41811]
McFadden R Squared	.17644	.17512	0.16136	0.14472
Obs. With Dep =0	151	151	151	151
Obs. With Dep =1	12	12	12	12
Total Observations	163	163	163	163

Significance Levels: * 10%, ** 5%, *** 1%, standard errors in parenthesis. The square brackets show the partial derivative of the probit function at the point of means for each variable. For the binary independent variables, the square brackets show the change in the dependent variable at the point of means as a result in the change from a 0 to 1

By examining columns 1 and 2 in Table 7.4, we can see that *google* appears to not be significant and does not seem to add much explanatory power, as the decrease in McFadden R Squared is not very large between column 1, where *google* is included, and in column 2, where *google* is not included. Similarly, in Table 7.5, *google* also appears not to add much explanatory power, as the difference in the McFadden R squared from column 1 to 2 is only .001. One reason that this may be the case in both periods is that *google* may not be an accurate representation of the amount of relevant information available about a target company.

First, *google* may not be highly correlated with the actual amount of public information available about the target company. The *google* term actually measures the amount of public interest in the target company, namely how many articles are written about it. While this should generate a higher score for larger firms (about which presumably, more is written and about which more public information should be available), it could also assign higher scores to firms that are of more interest to the general public. Therefore, even if a large amount of public information is available about a small firm, it is possible that that firm would receive a low *google* score if its product or the news concerning the company were not of interest to the public. In addition, it is likely that when a potential acquirer is deciding whether it should make a competing offer, the acquirer will consider private information as well. The potential acquirer is likely to use internal sales forecasts for the target company, based on information it gathers from surveys and estimates purchased from data companies, or based on conversations with members of the target firm. This information is clearly not captured in the *google* term, as it is not publicly available.

As in Table 7.4, columns 3 and 4 in Table 7.5 test the significance of the *market premium* term separately from that of the *cash* and the *bid premium* terms due to the correlation between the two groups of variables. In column 3, the bid premium term appears to be slightly significant, while the *cash* term is not significant. This differs from Table 7.4, where *cash* is significant while the *bid premium* is not. First, it is important to note that the coefficient of the *cash* term in both tables is positive, indicating that payment in cash increases the likelihood of another successful offer. This is contrary to the theoretical predictions of Fishman (1989), who argued that a cash payment should deter other offers. There are several possible reasons for this. First, it is possible that

while the cash payment signals a higher value of the target company, other potential acquirers may note this high valuation and therefore consider the target company to be more valuable, resulting in these companies making a bid for the target company when they otherwise would not have bid. Alternatively, it is possible that when the target has a high valuation, observed initially by all firms, the first firm to bid will bid in cash because of its high valuation. However, since other firms also have a high valuation of the target independent of the first offer, there may be multiple offers for the target.

The significance of *cash* in the pre-crash period is tenuous at best, as *cash* only becomes significant when the *market premium* term, which is very significant and also has a correlation of .31 with *cash*, is removed. *cash* is not significant under any circumstances in the post-crash period. While unlikely, there are possible reasons that *cash* could be an important factor in the pre-crash period but not the post-crash period. [28]

Third, there appears to be a large change in the significance of *hostile* between the pre-crash and post-crash periods. In both periods the coefficient of *hostile* is positive, indicating that if the acquisition bid is hostile, it is more likely that there will be another

[28] The change in the significance of *cash*, if meaningful, could occur as a result of the changing proportions of cash bids. In the pre-crash period, 88.31% of bids were made in cash, while only 67.58% of bids were cash in the post-crash. It might be the case that because they were relatively rare in the pre-crash period, bids with payment in stock had a higher signaling power to other firms, or alternatively only occurred in circumstances in which all firms viewed the target as not valuable and there were therefore not many firms interested in placing competing bids. However, in the post-crash period, more firms started offering bids with payment in shares. While it is possible that this is because the target firms that were being bid on in the post-crash period were simply less desirable, it is more likely a result of the desire of firms to conserve cash. During difficult economic times, most companies prefer to have a large amount of cash so that they can quickly invest if the economy improves, but also need to have enough money to finance operations if the economy continues to worsen. Thus, it is likely that even with an equal valuation for a target firm, an acquirer would be more likely to pay with cash in the pre-crash period but with stock in the post-crash period, thus reducing the signaling power of cash, or alternatively eliminating the tendency of an acquirer that values a target highly to pay with cash instead of with stock.

successful offer. This agrees with conventional theory in that if there is a hostile takeover, it is possible that management of the target firm will seek a white knight to acquire the company instead of the hostile acquirer. One possible explanation for the change in significance is that in the post-crash period it would likely be significantly harder for target management, if fired by the acquirer, to find new jobs. In a hostile takeover, management at the target firm is much more likely to be replaced by a hostile acquirer than by a white knight. Thus, since the cost to target management of being fired is higher in the post-crash than in the pre-crash period, managers of the target firm may be more likely to try to find a white knight, thus increasing the probability of another offer. While there would still be a cost to target management if they were to lose their jobs in the pre-crash period, it is possible that this cost is not high enough to cause them to seek a white knight to purchase the company.

For the pre-crash period, column 1 seems to have the most explanatory power. However, a Wald test fails to reject the hypothesis that all of the coefficients except for the *market premium* term are zero, reducing confidence in the reliability of the coefficients. While column 4 has slightly less explanatory power than column 1, the *market premium* term is highly significant and is therefore likely to be a good predictor of Y. For robustness, both regressions will be used to estimate Y, one using column 1 and another using column 4 to determine if the end results change as a result of what estimation technique is used. Similarly, for the post-crash period, while column 1 provides the most explanatory power, a Wald test cannot reject the hypothesis that all of the coefficients except that of *hostile* are 0. Thus, even though there is a lower amount of explanatory power, column 4 may provide a better estimate than would column 1. However, for robustness I will use two samples to determine if the choice of the

estimation equation for Y effects my conclusions on market efficiency. Finally, a likelihood ratio test shows that the coefficients used in column 1 in Table 7.4 are statistically different from those in column 1 in Table 7.5 at the 1% level, indicating that it is correct to use these different coefficients for each of the two periods.

7.3 Accuracy of Model

Given the estimations reported above, it is important to first determine if the model of acquisition success developed in Section 5 is accurate before using it to draw conclusions. The model itself could be inaccurate because it may fail to take into account all of the factors that affect the price of a stock or my estimates may not be precise enough. The first possible source of inaccuracy is that in addition to the expected value of the stock of the target company at the time the target is sold or not sold, there may be other factors such as market risk aversion or interest rate factors that affect the current price of a stock. In a more risk averse market, the price of a stock may be less than the expected value as market participants are overall risk averse and therefore are not willing to pay an amount equal to the expected value of the stock price. Further, interest rate factors could be important as market participants really care about the present value of the expected value of the stock at the time it sells or does not sell, something the model does not take into account. When the interest rate is zero, the present value is equal to the expected value in the future, but this is not the case under higher interest rates, when the present value is lower than the expected value in the future. While this is not a large concern in the post-crash period, as the interest rate on a one year U.S. Treasury bond averaged just 0.48%, it could be more of a concern in the pre-crash period, where the yield of a one year US Treasury bond averaged 4.773%[29]. A second source of error could

[29] Source: Federal Reserve Data

be inaccurate estimates that may cause the model to not provide a good calculation of the market-implied probability. For example, if the calculation of P_O was too low, all else equal, my model would consistently overestimate the probability of a successful offer. In order to determine if these potential sources of error make the model too inaccurate to use, I first solve equation (5.1) for X, obtaining:

$$X = \frac{P_C - Y(P_O) + (Y-1)(P_F)}{P_T - P_F}$$

I can then divide the above equation into three parts, where:

$$part1 = \frac{P_C}{P_T - P_F},\ part2 = \frac{-Y(P_O)}{P_T - P_F},\ part3 = \frac{(Y-1)(P_F)}{P_T - P_F}$$

Therefore X can be rewritten as part1+part2+part3.

Using these three parts, I run an OLS regression a constant term and the results are shown in Table 7.6.

Table 7.6:

	Pre-Crash		Post-Crash	
	(1) completed (part variables are using Y estimated by column 1 in Table 7.4)	(2) completed (part variables are using Y estimated by column in Table 7.4)	(1) completed (part variables are using Y estimated by column 1 in Table 7.5)	(2) completed (part variables are using Y estimated by column 4 in Table 7.5)
Constant	.41525*** (.11806)	.33521** (.14199)	.82267*** (.04768)	.82964*** (.04565)
part1	.43849** (.19205)	.50725** (.21773)	-.03478 (.05135)	-.04927 (.06318)
part2	.44296** (.18614)	.52669** (.21544)	-.02724 (.03772)	-.03118 (.03262)
part3	.42824** (.19317)	.48645** (.21642)	-.04180 (.05445)	-.058757 (.04914)
R-squared	.04027	.04303	.06150	.07123

Significance Levels: * 10%, ** 5%, *** 1%, standard errors in parenthesis

In my model, a change in one of the part variables should result in an equal change in the same direction in X, the probability that the offer is successful. Therefore, if my model is accurate, the coefficient for each part variable should be 1. As we can see above, the coefficients for columns 1 and 2 in the pre-crash and post-crash period do not appear to be close to 1. A Wald test rejects the null hypothesis that the coefficients of all of the part variables equal 1 for both columns in the pre-crash and post-crash periods at the 1% level, indicating that my model does not fit the data.

While I therefore cannot use my model to calculate the implied probability of success from each acquisition, I can estimate this probability using a probit regression where *completed* is a binary variable that is a 1 if the acquisition was successful and a 0 if

the acquisition failed or there was another accepted offer. The estimated coefficients for equation (7.1) are shown in Table 7.7.

$$Completed = a_0 + a_1 part1 + a_2 part2 + a_3 part3 + \varepsilon \quad (7.1)$$

Table 7.7:

	Pre-Crash		Post-Crash	
	(1) completed (part variables are using Y estimated by column 1 in Table 7.4)	(2) completed (part variables are using Y estimated by column 4 in Table 7.4)	(1) completed (part variables are using Y estimated by column 1 in Table 7.5)	(2) completed (part variables are using Y estimated by column 4 in Table 7.5)
Constant	-.19157 (.46492)	-.49031 (.55356)	.63688** (.28506)	.48199 (.31782)
part1	1.10370 (.76220)	1.36880 (.84715)	.21006 (.32472)	.41015 (.34618)
part2	1.11956 (.73552)	1.43316 (.83849)	.19914 (.25210)	.40424 (.28323)
part3	1.07440 (.76404)	1.30145 (.83741)	.14967 (.32696)	.33684 (.34001)
McFadden R-squared	.02986	.03452	.10719	.13897
Obs with Dep=0	63	63	31	31
Obs with Dep=1	151	151	132	132
Prob(LR statistic)	0.051552	.029884	. 000707	.000064

Significance Levels: * 10%, ** 5%, *** 1%, standard errors in parenthesis

From Table 7.7, we can see that the coefficients in column 1 in the pre-crash period as a whole do not seem to give a reliable estimate, as we cannot reject the hypothesis that all of the coefficients are 0 at the 5% level. This seems to indicate that using column 1 in Table 7.4 to estimate Y, the probability of another successful offer, may not have been a very reliable method. However, for column 2 in the pre-crash period and for columns 1 and 2 in the post-crash period, we can reject the hypothesis that all of

the coefficients are 0 at the 5% level. While this does not guarantee that these coefficients are individually significant (in fact, very few are, which is likely as a result of multicollinearity), it does at least indicate that the variables taken together provide some explanatory power. Thus, in determining market efficiency I will only examine column 2 in the pre-crash period and columns 1 and 2 in the post-crash period.

By using the coefficients given in Table 7.7 for each of the part variables, I can estimate the implied probability of success for each acquisition. Given these estimates of the market-implied probabilities, I can take the sum of the difference terms given by equation (5.6), where difference = success/failure- market-implied probability. Statistics concerning this sum for each period are given in Table 7.8.

Table 7.8: Results of Difference Term Summation

	Pre-Crash Column 2	Post-Crash Column 1	Post-Crash Column 2
Sum of Difference terms	.170969	-0.08343	-0.33628
Standard Deviation of Difference terms	.444458	0.366434	0.358985
Number of Observations	214	163	163

In Table 7.8, the sum of the difference terms is very close to zero, suggesting that I may not be able to reject the null hypothesis that the market is efficient (the sum of the difference terms is zero). I run a t-test on each of the above sums to determine if they are statistically different from zero and find that I cannot reject the null hypothesis that each of the sums of the difference terms is zero at the 10% level. Thus, these results fail to find statistically significant informational inefficiencies in the acquisition market.

8 Conclusion

This paper has sought to determine if the equity market is informationally efficient by examining the reaction of the stock price of a target company surrounding the period in which its potential acquisition was announced. I created an expanded model of acquisition success, building upon previous models to incorporate acquisitions with competing offers. However, other factors such as overall market risk aversion or interest rate factors, in addition to possibly poor estimations, lead the data to reject my strict model of acquisition success. Using a probit regression on parts of the model to account for these other factors, I was able to estimate the probability of acquisition success for each sample in my two periods and failed to find statistically significant informational inefficiencies in the acquisition market.

In order to improve my model, I could attempt to resolve the potential problem of selection bias by finding more detailed, firm specific information about the companies involved in each acquisition. While my limited data necessitated the assumption that firms in successful acquisitions were similar to those in failed acquisitions in terms of a fallback price[30], it is possible that this assumption does not hold. As stated in Section 5.1.1, it is possible to account for these differences in firm and acquisition characteristics by incorporating more detailed firm- and acquisition-specific information into my regression equation to determine the fallback price. Second, factoring in risk aversion would likely improve my model. Due to diminishing marginal utility, the expected utility that an investor gets from owning a stock is lower than the utility of the expected value of that stock. Thus, by ignoring risk aversion, I have biased my estimates of X downwards. I

[30] Similar selection issues necessitated the same assumptions while estimating P_O and Y

could incorporate this by using a regression on the parts of my model to find a constant term that is appropriate to use.

While there are many improvements that could be made to my model and my study that could alter my results, my results have important implications. While not definitive, my results support the idea of market efficiency, even after the turbulence caused by the financial crisis. This suggests the equity market is still able to effectively signal profitable investments to businesses and enable households to diversify risk even after a substantial increase in market volatility. In addition, this paper finds important and statistically significant elements that predict acquisition success that have been ignored by previous studies. Factors such as whether the acquisition was hostile and the market premium given to the stock of the target company had a significant impact on Y, which greatly affected the final price shareholders of the target company received for their shares.

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