Predicting Successful Takeovers and Risk Arbitrage

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In this paper, we explore the probability of merger completion/success for the 1991 to 2001 period. We construct a prediction model for merger completion and, among other issues, test how payment methods/merger types can influence success for three basic types of takeover offers: cash tender, stock swap, and collar. Our multivariate test reveals that takeover attempts offering cash are more likely to succeed than those which offer payment in the form of stock. We argue that the uncertain equity values implicit in the stock payment method accounts for the reduced success rate. A range of exchange ratios (collar offers) tends to improve the chance of success as compared with a fixed exchange ratio. We find that our prediction model, based on both historical and new findings, can be used to improve the risk-adjusted returns of risk arbitrage and related strategies.

Introduction

Mergers and acquisitions long have been a major research area in finance. Most academic researchers have focused on the wealth effects and their economic/financial reasons around merger attempt periods. Wall Street professionals, in contrast, have wanted to take advantage of the merger process to set up a potentially profitable trading strategy known as risk/merger arbitrage.

Risk/merger arbitrage is a strategy that seeks to extract the offer premium that almost always persists after a takeover offer is announced. This premium is reflected in the difference between the offered consideration and the target stock price. Generally, risk arbitrage involves establishing a long position in target stocks and an offsetting short position in acquirer stocks. The short position is generally set up to reflect and mirror the consideration of the offered price. Therefore, the long/short (i.e., risk arbitrage) positions reflect the spreads between the offered consideration and the market price of target stock throughout the merger period. If a merger attempt is successful, the target stock price will converge to the offered consideration

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and the spread will close to zero as the consummation date approaches. In this case, the initial spreads on a day when the long/short positions are set up will be earned by the risk arbitrageurs on the consummation dates. If the merger attempt fails, however, spreads will not close to zero, and the performance of each long and short position will determine the return (positive or negative) of the risk arbitrage position. In failed merger attempts, risk arbitrageurs usually end up with losses whereas risk arbitrage is almost always profitable when the merger offer succeeds. Therefore, predicting which announced merger efforts will be successful and which will fail is an important task for arbitrageurs. In the literature, Baker and Savasoglu (2002) show merger completion risk to be one major risk factor determining the returns of risk arbitrage. Mitchell and Pulvino (2001) find that risk arbitrage losses in a down market are positively related to the probability of merger failure. The probability of merger completion/success is an important topic in the risk arbitrage literature.

The previous merger literature has explored three principal types of information in its efforts to estimate the probability of merger completion/success: firm/deal information, market price information, and risk arbitrageur information. Herein, we extend the previous literature by exploring the impacts of merger types and payment methods on the probability of merger completion/success. Then we examine the implication of our finding for risk arbitrage and related strategies.

The wealth effects literature finds that the roles of payment methods are significant in explaining abnormal returns of targets' or acquirers' stocks (Travlos, 1987; Huang and Walkling, 1987). The asymmetric information hypothesis (Myers and Majiluf, 1984) is one commonly quoted hypothesis used to explain the role of payment methods in wealth effects. According to the asymmetric information hypothesis, an acquirer whose stock is overvalued prefers to finance mergers and acquisitions with equity rather than cash. Also, Hansen (1987) demonstrates theoretically that if an acquirer has less information about the value of the target than the target itself, the acquirer would want to use equity financing in order to share risk with target shareholders in the post merger period. Fishman (1989) shows theoretically that cash payment signals a high value for the target in a situation involving competing bids. These hypotheses imply that in a merger with stock payment, the uncertainty about stock values of the acquirer and target may lead to conflict over the reasonable exchange ratio, thereby reducing the probability of merger success/completion. A merger attempt with cash payment, however, reduces the impact of uncertainty in stock values for the acquirer and target and thereby enhances the probability of merger completion/success. Moreover, consistent with the information asymmetry hypothesis, the pecking order hypothesis (Mayer, 1984) implies that the cash financing tends to signal the strong financial capability and stability of the acquirer to handle the unexpected costs of a merger deal such as an increase in the offer premium etc, thereby improving the probability of merger completion/success. Surprisingly, however, Mitchell and Pulvino (2002) find that a deal with cash pay-

ment increases the probability of failure by 4.65 percent, compared to other deals with non-cash payment.

Merger types may impact the probability of merger completion/success. For example, in collar offers, an acquiring company sets up a range for the exchange ratio based on the average stock price for the acquirer over a short period (e.g., 30 days) prior to the merger's implementation. Typically, the exchange ratio is structured to rise as the acquirer's stock price declines, fall as its price increases, and remain stable over a middle range. This type of approach provides an automatic stabilizer for the value of the deal to the target shareholders. Thus, unless the price of the acquirer's stock moves beyond the pre-set range, the merger offer is unlikely to need to be renegotiated. In stock swap mergers, however, a fixed exchange rate is introduced and then the rate may need to be renegotiated if the stock value of either the target or acquirer changes dramatically. Therefore, by reducing the need for renegotiation, a collar merger offer (with a range of exchange rates) may have a higher probability of merger completion/success than a stock swap merger (with a fixed exchange rate). In tender offers, the offers can proceed directly to the shareholders, bypassing the target company's management and board of directors. Stock swap merger offers, in contrast, require approvals from both target and acquirer's shareholders. Hostile offers must overpower the opposition of management and the board of directors. Therefore, tender offers may have a higher probability of completion/success than stock swap mergers. These considerations imply that payment methods and merger types may impact the probability of merger completion and success.

Our tests explore the impact of payment methods and merger types on the probability of merger completion/success. Unlike Mitchell and Pulvino, we find that cash payment tends to increase the probability of merger completion/success relative to stock payment. A range of (collar offers) exchange ratios tends to improve the chance of success as compared with a fixed exchange ratio. Moreover, our results suggest that our prediction model can be used to improve the risk-adjusted returns of risk arbitrage and related strategies.

Literature Review

The literature on predicting takeover attempt success can be classified into three lines, depending upon the type of information tested: firm/deal information, market price information, and risk arbitrageur information. The first line seeks to use the information such as the size of the bid-premium, the target firm's managerial ownership, leverage, size, and merger experience of the acquirer, etc to predict the success or failure of takeover efforts. The second line of research explores whether the post-announcement date price movement or trading volume of the target firm's shares can be used to predict merger success effectively. The third line focuses on the relation-

ship between the arbitrageurs' purchasing behavior (informed traders) and the predictability of offer success.

Target Size

Hoffmeister and Dyl (1981) find that firm size is an important factor in predicting the success of a takeover attempt. They contend that the larger the target (absolute market value), the lower the merger success rate. Cotter, Shivdasani, and Zenner (1997) and Schwert (2000), however, do not find a significant relationship between log (market values) of targets and takeover success.

Leverage

In 1988, Stultz (1988) and Harris and Raviv (1988) explore the theoretical relationship between target ownership structure, bid premium, payment method, price changes and success. They find the probability of success for a takeover to be negatively related to the targets' leverage. Stultz (1988) contends that increasing leverage (debt-to-equity ratio) indicates increasing substitution of debt for equity, reducing α (fraction of voting right controlled by management) and the bidder' gain. Therefore, the higher the debt-to-equity ratio, the lower the likelihood of both takeover attempt success and the probability of a hostile takeover effort. Harris and Raviv (1988) contend that capital structure change, when used as an antitakeover device, usually increases the bargaining power of targets in control contests. Leverage increases tend to be smaller for targets of successful tender offers than for firms involved in proxy contests and targets of unsuccessful tender offers.

Empirically, Raad and Ryan (1995), Assem and Titman (1999), and Schwert (2000) find that the target's leverage tends to be negatively related to the probability of takeover attempt success. Various specifications such as debt-to-asset (Raad and Ryan, 1995), debt-to-equity (Schwert, 2000), or changes of these ratios have been explored.

Bid Premium

Walkling (1985) finds that the size of the bid premium is positively related to the success of tender offers, noting that the previous findings of insignificance for the bid premium (Pelligrino, 1972; Hoffmeister and Dyl, 1981) resulted from an incorrect premium specification. Also, Jennings and Mazeo (1993) find that a high bid premium tends to deter competing offers and reduce the likelihood of resistance. Mitchell and Pulvino (2002) and Baker and Savasoglu (2002), however, can not find a significant role for bid premium in estimating a probability of merger completion/success.

Resistance of Targets/Friendly Merger

Hoffmeister and Dyl (1981) find that the resistance of targets is one of several major factors affecting the success of merger attempts. Walkling and Long (1984),

Mikkelson and Partch (1989) and Cotter and Zenner (1994) find that this resistance is negatively related to the wealth/cash flow changes of managers. Recently, Schwert (2000) finds that unnegotiated hostile offers have the lowest success rates

Post Announcement Target Stock Price Behavior

Samuelson and Rosenthal (1986), Brown and Raymond (1986), and Huston (2000) find that in both cash tender offers and stock swap mergers, target stock price movements are helpful in predicting the success or failure of merger attempts. The more positive the target stock price movement, the higher is the chance of success. The market's accuracy improves monotonically over time (merger period). Also the target stock price during the offer period reflects the expected price at the consummation date.

The relevant literature also explores other factors. Specifically, Schwert (2000) finds a positive relationship between the book-to-market ratios and the success of takeover efforts. Moreover, the probability of success tends to be higher when the bidder contacts the target in advance. In terms of risk arbitrageurs' behavior, Laker and Lys (1987) and Cornelli and Li (1999) suggest that purchase by the informed arbitrageurs may be positively related to the high success rate for takeover efforts. That is, the more risk arbitragers like the prospects for the deal, the more likely it is to succeed.

In the prediction literature, however, little attention has been given to understanding how payment methods/merger types are related to the success of merger attempts, especially the success rate after a merger announcement. Therefore, using a sample of cash tender, stock swap, and collar merger attempts from 1991 to 2000, we test such an impact of merger types/payment methods on the success of takeover attempts. At the same time, we develop a multivariate prediction model designed to enhance portfolio construction for risk arbitrage and related strategies. The effectiveness of the prediction model is tested using our of sample data for 2001.

Data and Historical Success Rates

We utilize five data/information sources in our study to collect merger price and firm information: SDC (Security Data Corporation), Data Stream, CompuStat, Form 8-K files in SEC, and Lexis-Nexis. First, we download raw merger information from SDC. We use Lexis-Nexis to check the information's accuracy. Only merger attempts having a complete set of needed information are retained.

We collect information on 1,097 completed (successful or unsuccessful) stock, cash tender, and collar merger offers for the 1991 to 2000 period. Table 1 sum-

Table 1—Transaction Size Distribution

Range of Transaction ($million)	Cash Tender	Stock Swap	Collar	Total	%
Less Than 1	0	0	0	0	0.0%
1-100	63	190	37	290	26.4%
101-200	47	89	35	171	15.6%
201-300	26	73	16	115	10.5%
301-400	13	51	11	75	6.8%
401-500	15	32	8	55	5.0%
501-600	5	33	3	41	3.7%
601-700	2	19	6	27	2.5%
701-800	9	13	5	27	2.5%
801-900	5	18	8	31	2.8%
901-1000	6	16	2	24	2.2%
1001-1500	11	32	7	50	4.6%
1501-2000	11	36	1	48	4.4%
2001-2500	2	18	4	24	2.2%
2501-3000	4	10	3	17	1.5%
3001-3500	3	7	1	11	1.0%
3501-4000	2	5	3	10	0.9%
4001-4500	0	5	2	7	0.6%
4501-5000	0	4	0	4	0.4%
5001-10000	9	28	1	38	3.5%
More than 10000	1	28	3	32	2.9%
Total	234	707	156	1097	100.0%

Table 2—Merger Duration (Period) Distribution

Range of Merger Duration	Cash Tender	Stock Swap	Collar	Total	%
0-20	1	9	0	10	0.9%
21-40	54	22	2	78	7.1%
41-60	60	27	8	95	8.7%
61-80	40	78	18	136	12.4%
81-100	30	102	20	152	13.9%
101-120	17	109	24	150	13.7%
121-140	10	88	26	124	11.3%
141-160	4	69	15	88	8.0%
161-180	6	48	6	60	5.5%
181-200	4	44	9	57	5.2%
201-220	2	30	9	41	3.7%
221-240	0	28	4	32	2.9%
More than 240	6	53	15	74	6.7%
Total	234	707	156	1097	100.0%

marizes transaction size information for our sample while Table 2 reports merger duration. Approximately 22 percent, 64 percent, and 14 percent of our sample are cash tender, stock swap, and collar mergers, respectively. Overall, 42 percent of our sample involves mergers with transaction sizes between $1 million and $200 million. The average transaction size tends to increase over time. Cash tender offers tend to have a smaller transaction size than other types of mergers. Mergers with durations

(periods) of less than 100 business days comprise 43 percent of our sample. Successful merger efforts tend to have shorter durations than unsuccessful merger attempts.

We employ simple equal weighted average of SDC raw merger data to calculate the annual merger completion/success rates (Table 3) for each year. Each merger type has high and stable historical success rates—an average of 89 percent or greater for the three types for 1991 to 2000. Collar mergers have the highest overall average success rate, but more recently cash tender offers tend to show the highest success rates. More specifically, the collar merger's success rate is above 90 percent for each year examined (average: 93 percent) except for year 2000. For stock swap mergers the average success rate is almost 88 percent and more recently closer to 90 percent. Cash tender offers have an overall 87 percent success rate which increases to more than 90 percent (higher than others) for the more recent years. With one exception (1993 for cash tender mergers where the success rate was only 51 percent), the success rate for each type for each year exceeds 80 percent and averages close to 90 percent for the 1993-2000 period. Clearly a high percentage of announced takeover attempts has been successfully completed.

Table 3—Historical Merger Completion/Success Rates During 1991 through 2000

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Total
Cash Tender Offers											
Success	16	12	58	50	66	55	75	82	133	181	728
Failure	3	1	55	8	5	4	7	5	0	18	106
Success Rate	0.84	0.92	0.51	0.86	0.93	0.93	0.91	0.94	1.00	0.91	0.87
Stock Swap Mergers											
Success	287	413	474	586	604	712	797	826	780	915	6394
Failure	57	68	86	95	87	89	84	90	78	109	843
Success Rate	0.83	0.86	0.85	0.86	0.87	0.89	0.89	0.90	0.91	0.89	0.88
Collar Mergers											
Success	1	19	43	79	54	42	70	67	72	54	501
Failure	0	1	4	6	1	2	5	7	7	7	40
Success Rate	1.00	0.95	0.91	0.93	0.98	0.95	0.93	0.91	0.91	0.89	0.93
Total											
Success	304	444	575	715	724	809	942	975	985	1150	7623
Failure	60	70	145	109	93	95	96	102	85	134	989
Success Rate	0.84	0.86	0.80	0.87	0.89	0.89	0.91	0.91	0.92	0.90	0.89

Prediction Model

To investigate the impacts of various factors that were found significant in literature and merger types and payment methods on the probability of completion/success, we estimate a prediction model using a stepwise logistic regression. We begin with the following equation (1):

$$y = \alpha + \beta_1 S + \beta_2 L + \beta_3 BP + \beta_4 F + \beta_5 PS + \beta_6 MT1 + \beta_7 MT2 + \beta_8 T + \beta_9 Int + \varepsilon \qquad (1)$$

y = Dummy variable for merger success;
S = Relative size, Ln(target asset size/acquirer asset size);
L = Debt ratio, target's ratio of total debts to assets;
BP = Bid premium, absolute value of (offered price/target price - 1)
F = Dummy variable for friendly mergers (friendly = 1; unfriendly = 0);
PS = Post announcement price reaction, absolute value of (target price/offered price - 1);
α = Intercept, a dummy variable for cash tender offers;
MT1 = Dummy variable for stock swap mergers;
MT2 = Dummy variable for collar mergers;
T = Transaction size, percentage of outstanding equities sought by an acquirer; and
Int = An interaction variable between F and ln(PS).

Interpreting the impact of an independent variable on the dependent variable in a logistic regression relates to understanding the difference of two logits $g(x_i)$ and $g(x_i + \Delta)$ [equation (2) and equation (3)].

$$g(x_i) = \ln\{\pi(x_i)/[1-\pi(x_i)]\} = \beta_0 + \beta_i x_i \quad (2)$$

$$\pi(x_i) = \frac{\exp(\beta_0 + \beta_i x_i)}{1 + \exp(\beta_0 + \beta_i x_i)} \quad (3)$$

$$OR = \exp[g(x_i + \Delta) - g(x_i)] = \frac{\pi(x_i + \Delta)/[1-\pi(x_i + \Delta)]}{\pi(x_i)/[1-\pi(x_i)]} \quad (4)$$

$g(x_i)$ = logits function;
$\pi(x_i)$ = Probability of merger success;
OR = Odd ratio; and
x_i = Independent variables.

The difference of logits is formulated into an odds ratio [OR, equation (4)], defined as the ratio of outcome with $x_i + \Delta$ to outcome with x_i. For example, in our multivariate test, if an independent variable is coded as 0 or 1, the odds ratio estimates a ratio of the likelihood of merger success when $x_i = 1$ to the likelihood when $x_i = 0$. Therefore, the higher the odds ratio, the more positive are the impacts of the independent variable on the probability of merger success.

Test Results

The test results (Table 4) reveal that among the variables, the attitude (friendly or not) of the target company to takeover attempts and the relative size of the target (to the would-be acquirer) are the most significant variables in predicting merger completion/success. Except for the dummy variable for collar mergers, bid premium, and post price movement, all of the remaining variables are found to be significant at the level of $\alpha = 0.1$. As the odds ratio (OR = 20.48) for the attitude variable in the

table shows, a merger attempt in which the target company has a friendly attitude is 20.48 times as likely to succeed as one without a friendly attitude. This result supports the historical finding that the attitude of the target company (board of directors) to the merger attempt is a major determinant in predicting a merger success (Walkling and Long, 1984; Mikkelson and Partch, 1989; and Cotter and Zenner, 1994).

Table 4—Multivariate Test Results from a Stepwise Logistic Regression

	Total Samples			Stock Swap		
	Coefficient	St Error	Odd Ratios	Coefficient	St Error	Odd Ratios
Size	-0.534*	0.091	0.586	-0.493*	0.105	0.611
Debt to Asset	0.827**	0.465	2.286	0.884**	0.501	2.420
Attitude	3.019*	0.458	20.478	2.856*	0.493	17.398
Transaction Size	-6.754*	2.977	0.001	-4.085	2.564	0.017
Attitude × Post Price	-0.426*	0.125	0.650	-0.376*	0.136	0.687
Stock Swap	-1.045*	0.403	0.352			
Collar	-0.802	0.516	0.448			
Intercept	5.116**	2.932		2.539		
Adjusted R-Square	0.482			0.418		
Goodness of Fit Test						
Ch-Square	9.227			10.067		
P-value	0.323			0.260		

Note: 1) * and ** indicate statistical significance at the level of 95 percent and 90 percent confidence interval

2) The entry of p-value is 0.15 in this stepwise logistic regression

The relative size variable is significantly (negative) related to takeover success. Assuming that the logit is linear in the continuous size variable, for every increase of one unit, the success of a merger attempt tends to increase 0.59 times (OR = 0.59). Thus, the greater the relative size of the target company to the acquirer company, the lower the likelihood that the merger attempt succeeds.

The transaction size variable (percentage of equities sought by the acquirer) is also found to have a significantly negative relationship to the success of merger attempts. The OR indicates that for every increase of one unit, the probability of success of a merger attempt tends to increase 0.001 times. That is, the greater the percentage of the shares outstanding an acquirer seeks, the less likely the attempt is to succeed.

Unlike the relative size and transaction size variables, the debt ratio variable tends to have a positive impact on the success of an attempted merger. For every increase of one unit, the success of the merger attempt tends to increase 2.29 times. This result implies that the more debt a target company originally has, the better is chance for takeover success. It does not support the hypothesis, however, that the greater the amount of target debt, the less the chance that the merger attempts will succeed (Stultz, 1988; Harris and Raviv, 1988).

Merger type/payment dummy variables except for collar mergers are found to be statistically significant in predicting merger success at the level of $\alpha = 0.05$. The variable for cash tender offers is used as a reference group. Coefficients of dummy variables for merger types indicate the log difference between stock swap/collar mergers and cash tender offers. The test results reveal that, compared to the cash tender offer, collar (β_7: -0.802) and stock swap (β_6: -1.045) mergers are found to have a negative impact on the success of merger attempts. A collar or stock swap merger increases only 0.45 (OR) or 0.35 (OR) times individually, decreasing the likelihood of merger success. A collar merger attempt, however, tends to have a higher chance of success than a stock swap merger effort. These results suggest that a cash payment is likely to improve the probability of merger completion/success, as compared with a stock payment offer. A range of exchange ratios (a collar merger) also tends to improve the probability of merger completion/success compared to a fixed exchange ratio (a stock swap merger).

We do not find the bid premium and post price variables to be statistically significant at the level of $\alpha = 0.1$ in the prediction model. Interestingly, however, an interaction variable between attitude and the post price variable is found to have a significantly negative impact on takeover attempt success. That is, if the target stock price two days after the merger announcement date fails to converge to the offered price in a friendly merger, the merger tends to have a reduced chance of success. It indicates that somehow the target stock price movement after a merger announcement has information about the probability of merger completion/success.

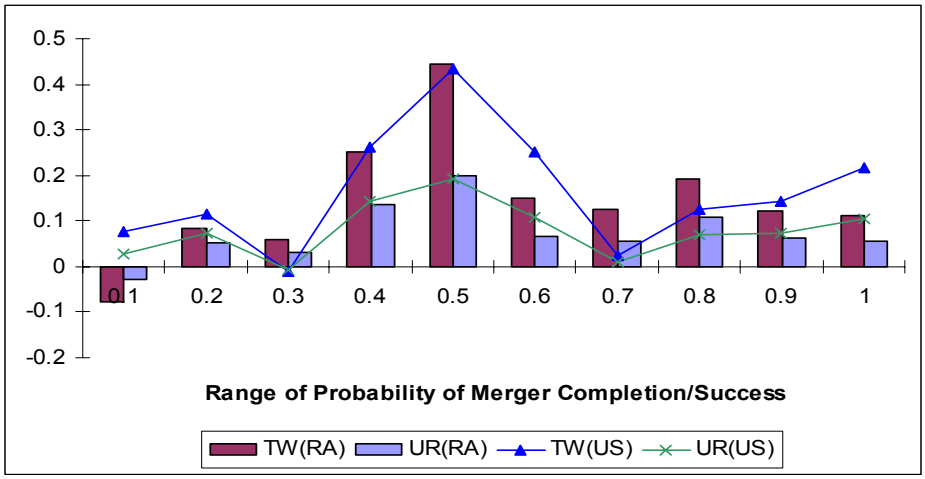
Though only stock swap merger attempts are tested again in the reduced multivariate model, our findings for the full sample except for the transaction size variable are supported at the significant level of $\alpha = 0.1$.

To assess the fit of the prediction model statistically, we use the Hosmer-Lemeshow (HL) test. As shown in Table 4, the chi-square value of the Hosmer-Lemeshow goodness of fit statistic is 9.227. Corresponding p-value with 8 degrees of freedom is 0.32. This indicates that, even at the level of $\alpha = 0.3$, the goodness of fit test can't reject the null hypothesis that the prediction model fits well with samples.

Empirical Application: Risk Arbitrage Returns and Prediction

Next, we explore how the prediction model can improve the performance of risk arbitrage and other (unhedged) strategies such as a simple long position in target or acquirer stocks. As the first step, we investigate the relationship between the returns of risk arbitrage and unhedged strategies and probabilities of merger completion/success from the prediction model.

Figure 1—Returns of Risk Arbitrage and Unhedged Strategy for Target Stocks Over the Ranges of Estimated Probabilities of Merger Completion/Success



RA indicates risk arbitrage taking a long position in target stocks and a short position in acquirer stocks. US indicates an unhedged strategy (long position) for target stocks. TW and UR indicate time-weighted annualized returns and equal weighted returns of portfolios composed of merger attempts which are selected basing on the range of probability of merger completion. We calculate TW to deal with various merger periods for each merger attempt and to weight more a merger attempt with a longer period. TW=UR*252/merger period*merger period/total merger periods in samples

As Figure 1 shows, the returns (UR) and time weighted annualized return (WR)[1] of risk arbitrage (RA) and unhedged strategies for target stocks (US) tend to have a roughly convex shape over the range of estimated probabilities of completion/success. This shape may be attributed to the potential of obtaining arbitrage during the merger period. If a merger is clearly expected to be successful, many risk arbitrageurs will set up a position (risk arbitrage or unhedged strategy) in the stocks related to the merger attempt. The position may reduce the spread (arbitrage) between an offer price and a market price for a target stock, decreasing arbitrage in a merger attempt. In the mid range of probabilities, due to the uncertainty of merger success, the potential of achieving arbitrage from the position may stay on the table, thereby tending to generate attractive returns. For unlikely-to-succeed risk arbitrage opportunities, there may be no position set up. At the same time, the risk of loss from failure may dominate profit opportunities, producing lower returns.

[1] To deal with various merger periods and weight more merger attempts with longer periods, we calculate the time weighted annualized return. It may not represent the actual performance of risk arbitrage and unhedged strategies. The time-weighted annualized return is an equal weighted return * 252/merger period * merger period/sum of total merger periods.

Table 5—The Performance of Risk Arbitrage, Reverse Risk Arbitrage, and Unhedged Strategies Over the Range of Estimated Probabilities of Merger Completion/Success

Panel 1: Risk Arbitrage and Unhedged Strategy for Target Stocks

	Risk Arbitrage				Unhedged Strategy for Target Stocks			
Predicted Value	Time Weighted Annualized Return	Equal Weighted Return	Std. Dev.	Equal Weighted Return/ Standard Dev.	Time Weighted Annualized Return	Equal Weighted Return	Std. Dev.	Equal Weighted Return/Std. Dev.
0.9-1	0.112	0.055	0.145	0.377	0.215	0.106	0.278	0.380
0.8-1	0.114	0.056	0.155	0.364	0.202	0.100	0.312	0.320
0.7-1	0.117	0.058	0.158	0.368	0.198	0.099	0.324	0.305
0.6-1	0.117	0.058	0.157	0.369	0.196	0.098	0.323	0.303
0.5-1	0.117	0.058	0.157	0.370	0.197	0.098	0.321	0.305
0-1	0.116	0.058	0.166	0.349	0.191	0.095	0.322	0.296

Panel 2: Reverse Risk Arbitrage and Unhedged Strategy for Acquirer Stocks

	Reverse Risk Arbitrage				Unhedged Strategy for Acquirer Stocks			
Predicted Value	Time Weighted Annualized Return	Equal Weighted Return	Std. Dev.	Equal Weighted Return/ Standard Dev.	Time Weighted Annualized Return	Equal Weighted Return	Std. Dev.	Equal Weighted Return/Std. Dev.
0-0.1	0.001	0.000	0.234	0.001	0.219	0.077	0.344	0.225
0-0.2	-0.073	-0.039	0.246	-0.157	0.027	0.014	0.279	0.051
0-0.3	-0.059	-0.031	0.276	-0.114	-0.025	-0.013	0.261	-0.051
0-0.4	-0.082	-0.044	0.263	-0.167	-0.033	-0.018	0.250	-0.071
0-0.5	-0.100	-0.053	0.260	-0.203	-0.018	-0.010	0.245	-0.040

Risk arbitrage is a strategy taking a long position in target stocks and a short position in acquirer stocks. Reverse risk arbitrage is a strategy taking a long position in acquirer stocks and a short position in target stocks. Unhedged strategy means simply taking a long position in target or acquirer stocks. We calculate time-weighted annualized returns (TW) to deal with various merger periods for each merger attempt and to weight more a merger attempt with a longer period. TW = UR*252/merger period*merger period/total merger periods in samples

In-Sample Test

In this section we report our tests of the effectiveness of using our model in various investment strategies. To deal with it, we calculate the returns for risk arbitrage, reverse risk arbitrage, and unhedged strategy (long position) portfolios based on probabilities of merger completion/success from our prediction model. Specifically, if a merger attempt generates more than 0.5 probability of merger completion/success, we apply both risk arbitrage and an unhedged strategy (long position) for target stocks to the merger attempt. Otherwise reverse risk arbitrage and an unhedged strategy (long position) for acquirer stocks are applied. The reverse risk arbitrage strategy takes a long position in the acquirer stocks and a short position in the target stocks to benefit from the expected up (down) price movement of acquirer (target) stocks in failed merger cases.

In Table 5, "predicted value 0.9-1" reflects the average performance for a portfolio composed of merger attempts in a range of probability 0.9 to 1 from the prediction model. The range of probabilities of merger completion/success increases

to maximize the potential benefits of using the prediction model. It is based on the convex patterns of arbitrage over the probability of merger completion/success as discussed before. We notice that risk arbitrage and unhedged strategies for target stocks, based on those selected portfolios, tend to generate equal weighted returns of more than 5 percent (time-weighted annualized return of more than 10 percent) and 9.5 percent (time-weighted annualized return of more than 20 percent) individually. Their risk-adjusted returns, the ratio of the equal weighted return to standard deviation (total risk), of the selected portfolios show superior performance, compared to the portfolios based on all merger attempts.

In the lowest probability of merger completion/success, both reverse risk arbitrage and the unhedged strategy for acquirer stocks generate the highest equal weighted return. Moreover, the more merger attempts unlikely to succeed are included in a portfolio, the greater the losses that the reverse risk arbitrage and unhedged strategies for acquirer stocks are likely to be. These test results suggest that the simple prediction model for merger success may be used to enhance the profitability of various investment strategies based on merger attempts.

Out-of-Sample Test

As a check on our findings, we also perform an out-of-sample test using 99 randomly selected merger attempts in 2001. Panel 1 of Table 6 shows the accuracy test result. In the test, a merger attempt with less than 0.5 probability is classified as "unlikely to be successful." Otherwise, a merger attempt is classified as "likely to be successful." Our prediction model correctly classifies 91 percent of merger attempts likely to be successful and 62 percent of merger attempts unlikely to be successful.

Panel 2 reveals that the performance patterns of risk arbitrage, reverse risk arbitrage, and unhedged strategy portfolios support the proposition that the estimated probabilities of merger completion/success tend to assist in the implementation of those strategies. Risk arbitrage exhibit the best risk-adjusted returns when the portfolio includes merger attempts with greater than 0.5 probability of merger completion/success. Unhedged strategies and reverse risk arbitrage show the best performance in the portfolios selected by the highest or lowest probabilities of merger completion/success. These out-of-sample-test results support the effectiveness of our prediction model.

Conclusion and Comments

In this paper, we have explored the probability of merger completion/success, using deal/firm/equity price information. Our multivariate analysis reveals that payments in the form of cash tend to enhance the likelihood of a successful takeover attempt, compared with the use of stock in payment. In stock swap mer-

Table 6—Out-of-Sample Test Results with 99 M&A Attempts in 2001

Panel 1: Accuracy Test of the Prediction Model with Cutoff Probability of 0.5

	Likely to Succeed	Likely to Fail	Total
Success	83(91%)	3(38%)	86
Failure	8(9%)	5(62%)	13
Total	91	8	99

Note: If a predicted value is more than 0.5, the merger attempt is classified as "Likely to Succeed" and otherwise as "Likely to Fail"

Panel 2: The Performance of Risk Arbitrage and Unhedged Strategies for Target Stocks

	Risk Arbitrage				Unhedged Strategy for Target Stocks			
Predicted Value	Time Weighted Annualized Return	Equal Weighted Return	Std. Dev.	Equal Weighted Return/ Std. Dev.	Time Weighted Annualized Return	Equal Weighted Return	Std. Dev.	Equal Weighted Return/Std. Dev.
0.9-1	0.11	0.04	0.19	0.23	-0.02	-0.01	0.29	-0.02
0.8-1	0.13	0.05	0.20	0.24	-0.03	-0.01	0.31	-0.04
0.7-1	0.14	0.05	0.21	0.26	-0.04	-0.02	0.31	-0.06
0.5-1	0.15	0.06	0.21	0.28	-0.03	-0.01	0.31	-0.04
0-1	0.14	0.06	0.21	0.27	-0.05	-0.02	0.31	-0.06

Panel 3: Reverse Risk Arbitrage and Unhedged Strategy for Acquirer Stocks

	Reverse Risk Arbitrage				Unhedged Strategy for Acquirer Stocks			
Predicted Value	Time Weighted Annualized Return	Equal Weighted Return	Std. Dev.	Equal Weighted Return/ Std. Dev.	Time Weighted Annualized Return	Equal Weighted Return	Std. Dev.	Equal Weighted Return/Std. Dev.
0-0.1	0.25	0.14	0.04	3.67	0.46	0.26	0.23	1.13
0-0.2	0.13	0.06	0.14	0.44	0.11	0.05	0.39	0.14
0-0.3	0.10	0.06	0.10	0.65	0.07	0.05	0.23	0.20
0-0.5	0.06	0.04	0.12	0.30	0.09	0.05	0.21	0.25

Risk arbitrage is a strategy taking a long position in target stocks and a short position in acquirer stocks. Reverse risk arbitrage is a strategy taking a long position in acquirer stocks and a short position in target stocks. Unhedged strategy means simply taking a long position in target or acquirer stocks. We calculate time weighted annualized returns (TW) to deal with various merger periods for each merger attempt and to weight more a merger attempt with a longer period. TW=UR*252/merger period*merger period/total merger periods in samples

ger attempts, a range of exchange ratios (collar) tends to improve the chance of success as compared with a fixed exchange ratio. These findings suggest that the payment method may signal something about the uncertainty of both target and acquirer stock values as well as their financial soundness. In addition to accounting and firm information, the merger type is also one of major factors influencing the probability of merger completion and success.

Both our in-sample and out-of-sample tests support the significance of the prediction model based on the historical and new finings. Our prediction model is likely to facilitate improved risk-adjusted returns of risk arbitrage, reverse risk arbitrage, and unhedged strategies (long positions) by assisting in the portfolio

construction, increasing the likelihood of identifying correctly successful versus unsuccessful takeovers.

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