Financial risk and acquirers' stockholder wealth in mergers and acquisitions

An-Sing Chen[a], Hsiang-Hui Chu[b], Pi-Hsia Hung[b,*], Miao-Sih Cheng[c]

[a] Department of Finance, National Chung Cheng University, Taiwan, ROC
[b] Department of Banking and Finance, National Chi Nan University, Taiwan, ROC
[c] Department of Financial Management, E.SUN Commercial Bank, Taiwan, ROC

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ABSTRACT

This study examines the relationship between financial risk and acquirer's stockholder wealth in mergers and acquisitions. Under this detailed methodological framework, our results reveal several new findings which were not observed in extant studies: (1) Acquirers as a group have low financial risk when measured with Altman's Z-score or default risk derived from Black-Scholes-Merton framework. (2) Default risk provides a more powerful measure on the acquirer's successful takeover probabilities than the Z-score valuation. (3) The lower default risk the acquirer has, the higher successful takeover probabilities. (4) Takeovers create value for acquirers with higher default risk.

1. Introduction

This study investigates the relationship between financial risk and acquirer's stockholder wealth in mergers and acquisitions (M&As). Although takeover activity has been examined extensively in the finance and strategy research and the reasons for mergers and acquisitions are generally known, the relationship between firm's financial risk and takeover is still little explored. Empirical studies investigating the risk to takeovers generally focus on leverage, but they fail to detect the firm's full financial risk. The contribution of this study is to investigate how financial risk of the acquirers in its entirety rather than just debt may be linked in the context of takeovers. There are several reasons to look at the overall risk or probability of bankruptcy of the acquiring firm. First, the market-based probability of bankruptcy is designed to measure the likelihood of future events instead of the past accounting performance.[1] The stock market offers a superior source of aggregate information surpassing financial statements. Second, the probability of bankruptcy incorporates a measure of asset volatility that is a crucial measure in bankruptcy prediction. Moreover, volatility is an important omitted factor in accounting-based bankruptcy measures. Lastly, according to Hillegeist, Keating, Cram, and Lunstedt (2004a,b), the overall risk of the acquiring firm can provide better insights than other accounting-based measures. The Black-Scholes-Merton (BSM) default probability provides significantly more information than accounting-based measures. Taking the above reasons into account, this paper looks at the overall risk of the acquiring firm.

Potential acquirers have an incentive to take over the targets with valuable assets or technology but poor managerial skills. Empirical evidence demonstrates that acquirers do better when they target poorly managed targets (Berger & Ofek, 1996). A

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* Corresponding author at: No. 1, University Rd., Puli, Nantou 54561, Taiwan, ROC.
  E-mail address: phhung@ncnu.edu.tw (P.-H. Hung).
[1] Our default risk measure is derived from Black and Scholes (1973) and Merton (1974). The default risk is the risk that a corporation will fail to make payments that they have promised.

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company's financial risk may be linked to a managerial strategies and internal control mechanisms. Poor control systems, for example, are not able to prevent managers from destroying essential amounts of firm value. Suboptimal management creates incentives for outsiders to acquire the targets and improve operations. Existing studies show that acquirers earn greater profits when their targets' managers have destroyed more value (Lang, Stulz, & Walking, 1989; Servaes, 1991).

In this paper, we employ two models to estimate financial risk (Z-score and BSM default risk) and examine the risk around takeovers activities. We then compute the excess returns of targets and acquirers over the pre- and post-takeover period, respectively, and examine the differences in excess returns around takeovers. We also examine whether takeovers create value for acquirers and which acquirers are most likely to be winners. Finally, we investigate the impact of financial risk on acquirer's stockholder wealth in takeover activities.

This paper examines both the acquirer and target in the takeover in the primary analysis. However, the focus is on acquirers and to provide a deeper understanding of the firm's financial risk and takeover activities. There are some reasons why we mainly concentrate on the acquirer's side, although we explore returns and default risk of both acquirers and targets for the sake of contrast and comparison in the primary analysis. First, we have a larger sample of acquiring firms than targets. The sample size is an essential feature of our empirical study. Second, whether acquirers can earn abnormal returns or create value is a long-standing issue in financial markets. Lastly, whether acquirers own sufficient financial resources to complete the deal has attracted much attention worldwide in the last decades. This paper examines the determinants of successful takeovers from the perspective of acquirers. Given the reasons mentioned above, this study focuses on acquirers' stockholder wealth in M&A activities.

The paper is organized as five sections. Section 1 is the introduction that explains the research background, motivation, and objectives. Section 2 describes literature on financial risk, wealth effects of takeover activities for both targets and acquirers, and the link between financial risk and takeover activities. Section 3 presents data and measurements, including the data sources, sample selection and related variables, followed by the discussion of empirical results in Sections 4. Finally, Section 5 concludes the paper and provides suggestions for future research.

2. Literature review

2.1. Literature on financial risk

Modeling of the financial risks can be roughly classified into three main categories: (1) accounting-based models, (2) structure-form models, and (3) reduced-form models. Examples of accounting-based approaches include the two widely used models suggested by Altman (1968) and Ohlson (1980). Under this framework, financial risk can be evaluated by the composite measures that statistically combine several different accounting variables. The Altman model consists of five variables with the highest predictive power, while Ohlson uses of nine accounting-based variables. After the publication of Altman' Z-score model, additional studies have done further works on the Z-score model (Agarwal & Taffler, 2007; Altman, Iwanicz-Drozdowska, Laitinen, & Suvas, 2017; Boritz, Kennedy, & Sun, 2007; Deakin, 1972; Edmister, 1972; Goudie, 1987; Grice & Ingram, 2001; Sandin & Porporato, 2007; Taffler, 1982, 1983). Other research also has been done related to the Ohlson model (Beneda, 2007; Boritz et al., 2007; Das, Hanouna, & Sarin, 2009; Lau, 1987; Muller, Steyn-Bruwer, & Hamman, 2009).

Structural-form modeling of financial risks originated from Black and Scholes (1973) and Merton (1974). Under the Black-Scholes-Merton framework, the company is in default when the company's assets are no longer sufficient to cover the debt obligations at maturity of the debt. Other examples of structural models include Anderson and Sundaresan (1996), Black and Cox (1976), Collin-Dufresne and Goldstein (2001), Duffie and Lando (2001), Geske (1977), Huang and Huang (2012), Kim, Ramaswamy, and Sundaresan (1993), Leland (1998), Longstaff and Schwartz (1995), Titman and Torous (1989), and Vasicek (1984). Each of these models extends Merton's framework by eliminating some unrealistic assumptions. For example, Black and Cox (1976) consider the subordinated debt in the option pricing model; Longstaff and Schwartz (1995) assume stochastic interest rates as described by the Vasicek (1977) model; and Collin-Dufresne and Goldstein (2001) introduce a stationary leverage ratio. In addition, reduced-form models assume that the bankruptcy process is specified exogenously and does not depend on the firm's underlying assets (Duffie & Singleton, 1999; Fons, 1994; Jarrow, Lando, & Turnbull, 1997; Jarrow & Turnbull, 1995; Litterman & Iben, 1991).

2.2. Literature on takeover activities

2.2.1. Takeover and wealth effects of targets

Berger and Ofek (1996) examine whether the diversification's value effect influences takeover probabilities and show that firms with greater value losses are more probable to be taken over. Schwert (2000) supports both target management entrenchment and bargaining strategy in the hostile takeover contests. Gains from hostile takeovers come from replacing incumbent managers, while gains from friendly takeovers generally result from strategic synergies. Jayaraman, Khorana and Nelling (2002) investigate the wealth impact on shareholders of target and acquiring funds and find significant improvements in post-merger performance for target fund shareholders. Greenwood and Schor (2009) also show that announcement returns and long-term abnormal returns are high for targets that are ultimately acquired. In brief, wealth effects of targets broadly show a positive association.

2.2.2. Takeover and wealth Effects of acquirers

Many studies have mentioned the post-M&A performance; however, compared to research on the wealth effects of target shareholders, the wealth effects of acquirers are inconclusive. Related papers include André, Kooli, and L'Her (2004), Dutta and Jog

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(2009), Mantravadi and Reddy (2008), Martynova, Oosting, and Renneboog (2007), Papadakis and Thanos (2010), Pazarskis, Vogiatzogloy, Christodoulou, and Drogalas (2006), Rahman and Limmack (2018), Rao-Nicholson, Salaber, and Cao (2016), and Sharma and Ho (2002). Existing research reports improvements in long-run operating performance of corporate acquisitions (see, for example, Kumar & Bansal, 2008; Lin & Piesse, 2003; Rahman & Limmack, 2018), while some papers document a deterioration of post-M&A performance (Agrawal, Jaffe and Mandelker, 1992; André et al., 2004; Jayaraman et al., 2002; Mantravadi & Reddy, 2008; Pazarskis et al., 2006; Rau & Vermaelen, 1998). On the contrary, several papers show no significant changes between pre- and post-M&A profitability (Dutta & Jog, 2009; Martynova et al., 2007; Papadakis & Thanos, 2010; Sharma & Ho, 2002). Other related papers include Banerjee and Homroy (2018), Becht, Polo, and Rossi (2016), Bhagwat, Dam, and Harford (2016), Brooks, Chen, and Zeng (2018), Dimopoulos and Sacchetto (2014), Gorbenko and Malenko (2014), Jiang and Yuan (2018), Lel and Miller (2015), Offenberg, Straska, and Waller (2014), Roosenboom, Schlingemann, and Vasconcelos (2014), and Ward, Yin, and Zeng (2018).

2.3. Financial risk and takeover activities

Extant literature on the relationship between risk and takeover mainly focuses on how leverage affects how acquirers choose to finance takeovers and how they adjust their capital structure following the takeovers. For example, Safieddine and Titman (1999) show that firms that increase leverage following an unsuccessful takeover are subsequently less likely to be taken over than those that do not increase leverage. The evidence suggests that leverage-increasing targets tend to act in the interests of shareholders and decrease the probability of being taken over. Novaes (2002) document that increasing leverage carries a positive signal resulting from management's ability to enhance value, but it conveys a negative signal if inefficient managers are pressured into levering up. In addition, the dynamic model provided by Morellec and Zhdanov (2008) predicts that the acquirers with the lower leverage are likely to be winners in takeovers and that the premium paid to the target should decrease with the leverage of the winning bidder. Their model also predicts that the winner of the takeover contest should lever up after the takeover consummation.

3. Data and measurements

3.1. Data sources and sample selection

The primary data for this study comes from three sources. We collect the data of takeover announcements from Securities Data Corporation's (SDC) Mergers and Acquisitions Database during the period from the beginning of 2006 to the end of 2010. The announcement day refers to the day of the first bid by the bidder who obtained control right of the target. The simple acquisitions of assets and buy back cases are excluded. The announcement data of mergers and acquisitions is matched with related data from the Center for Research in Security Prices (CRSP) and Standard and Poors' Compustat databases. Daily stock prices are obtained from the CRSP daily files. Financial information is from the Compustat database. We require all related data for the takeover from CRSP and Compustat database to be available during the year prior to the M&A announcements. We also require both the target and acquiring firms to be publicly traded companies with non-missing relevant information in the NYSE, National Association of Securities Dealers Automated Quotation (NASDAQ), or AMEX. Finally, we require the acquiring firms to have complete information available for computing the financial risk and the probabilities of successful takeovers.

3.2. Measurements

This section provides details on the variable construction, including financial risk modeling, firm characteristics, firm performance and macroeconomic variables.

3.2.1. Financial risk modeling
To model financial risk, recent research has tended to use either accounting based measures such as the Altman's Z-score or the market based measure by estimating the BSM probability of bankruptcy implied by the structural model.

(1) Z-score, *ZScore*, is evaluated by Altman's (1968) approach, which involves a combination of five distinctive financial ratios, including the ratios of working capital to total assets, retained earnings to total assets, earnings before interest and taxes (EBIT) to total assets, market value of equity to total liabilities, and sales to total assets.
(2) Default risk, *Default*, is estimated according to the default probability from Black-Scholes-Merton (Black & Scholes, 1973; Merton, 1974) option pricing model (see the Appendix A).

3.2.2. Firm characteristics
Firm characteristics comprise various accounting data and financial market information. The related accounting data is measured at the fiscal year-end preceding the M&A announcements, including liquidity measures, long-term solvency, asset management capability, profitability measures, and market value ratios. Liquidity is measured by quick ratio (acid-test). Long-term solvency is characterized by interest coverage (times interest earned ratio) and debt ratio. Asset management capability is measured by total assets turnover. Profitability is measured by return on total equity (ROE). Market value ratios are measured with price to earnings ratio and price to cash flow ratio. Additional variables include firm size, stock volatility (firm risk), and the degree of diversification (measured by the number of total segments in a firm).

The following variables are constructed from accounting and financial market data.

(1) Firm size, *Size*, is defined as the natural logarithm of the market capitalization measured at the end of the previous year.
(2) Firm risk, *StdRet*, is computed by the standard deviation of returns of individual stock over the period of one-year prior the M&A announcement.
(3) Quick ratio, *QuickRatio*, relates the most liquid assets to current liabilities. The quick ratio is the ratio of the sum of cash equivalents, marketable securities, and net receivables to current liabilities.
(4) Interest coverage ratio, *IntCov*, is computed as earnings before interest and taxes divided by the interest.
(5) Debt ratio, *DebtRatio*, indicates the proportion of the debt a company has relative to its assets.
(6) Total assets turnover, *TAT*, is computed by the net sales over total assets, measuring the ability of total assets to generate sales dollars.
(7) Return on total equity, *ROE*, is calculated by the ratio of net income divided by the total assets.
(8) Price to earnings ratio, *PE*, is defined as the ratio of price per share to earnings per share.
(9) Price to cash flow ratio, *PCF*, is calculated as the ratio of share price to cash flow per share, measuring the market's expectations of a firm's future financial health.
(10) The number of firm segments, *NSegment*, is defined as how many segments the firm has, obtained from the Compustat Industry Segment (CIS) database.

3.2.3. Firm performance

The abnormal returns associated with market reaction are measured by market adjusted abnormal returns and market model adjusted abnormal returns. The market adjusted abnormal returns are constructed by subtracting the equal- and value-weighted returns of market portfolios from the individual raw returns. The market model adjusted abnormal return is the risk adjusted return

Table 1
Descriptive statistics of M&A announcements.

Statistics	Number of events	Number of firms	Market value (million)	Std. dev. of returns (%)	Market to book ratio	Quick ratio	Interest coverage	Debt ratio	Total assets turnover	Return on total equity (%)	Number of segments
Panel A: Basic statistics											
Acquirers											
Mean	1024	298	15,642	0.70	3.87	1.94	156.40	0.47	1.16	7.80	2.73
Std. Dev.	1024	298	35,265	2.33	3.30	1.73	801.75	0.20	0.82	30.24	1.83
Max	1024	298	165,967	16.01	22.25	10.51	15866.00	0.95	4.42	59.68	10.00
Min	1024	298	12	0.01	0.43	0.26	−138.60	0.08	0.06	−211.2	1.00
Targets											
Mean	9	8	2635	0.05	3.70	2.36	121.02	0.39	0.81	−18.27	1.22
Std. Dev.	9	8	3265	0.02	5.60	1.83	322.28	0.18	0.65	34.92	0.67
Max	9	8	8186	0.09	18.45	4.97	973.50	0.70	1.87	9.25	3.00
Min	9	8	20	0.02	0.40	0.51	−39.46	0.17	0.23	−95.02	1.00
Difference	1015	290	13,007	0.65	0.17	−0.42	35.38	0.08	0.35	26.07	1.51
P-value	–	–	0.00	0.00	0.93	0.51	0.76	0.21	0.15	0.06	0.00
Panel B: Descriptive statistics sorted by years											
Acquirers											
2006	195	107	14,943	1.03	4.55	1.83	257.02	0.46	1.25	9.91	3.09
2007	289	124	23,180	0.56	4.66	2.06	151.70	0.47	1.07	9.73	2.81
2008	242	138	14,955	1.15	3.91	1.99	122.99	0.48	1.24	6.84	2.71
2009	174	110	8046	0.43	2.25	1.91	78.83	0.47	1.23	6.09	2.51
2010	124	74	10,540	0.03	3.07	1.76	177.41	0.46	0.96	4.26	2.35
Total	1024	553	15,642	0.70	3.87	1.94	156.40	0.47	1.16	7.80	2.73
Targets											
2007	1	1	233	0.03	2.51	4.97	−39.46	0.18	0.23	−47.51	1.00
2008	4	3	3914	0.05	5.40	1.04	255.59	0.43	1.18	−20.79	1.50
2009	2	2	1663	0.05	2.57	4.64	49.36	0.22	0.34	−13.32	1.00
2010	2	2	2250	0.04	2.02	1.44	3.80	0.57	0.81	−3.57	1.00
Total	9	8	2635	0.05	3.70	2.36	121.02	0.39	0.81	−18.27	1.22

Number of events refers to as the number of M&A announcements over the period from beginning of 2006 to the end of 2010. Number of firms is the number of acquirers/targets. Market value is defined as the market capitalization (million) measured at the previous end of the year. Std. dev. of returns is the standard deviation of returns of individual stock over the period of one-year prior M&A announcements. The market to book ratio is a firm's market value of common equity over book equity. The quick ratio relates the most liquid assets to current liabilities, calculated as the ratio of sum of cash equivalents, marketable securities, and net receivables to current liabilities. The interest coverage is computed as EBIT divided by interest; the debt ratio indicates the proportion of debt a company has relative to its assets; total assets turnover is computed as net sales over total assets, measuring the ability of total assets to generate sales dollars. Return on total equity is calculated by the ratio of net income divided by the total assets.

Table 2
Descriptive statistics of acquirers sorted by industries.

Industries	Number of events	Number of firms	Market value (million)	Std. dev. of returns (%)	Debt ratio	Return on total equity (%)	Trade value (million)	Trade shares (%)	Post-event ownership (%)	Cash (%)	Stock (%)
Panel A: Descriptive statistics of acquirers sorted by industry sectors											
Mining	67	15	7673	1.52	0.57	5.49	1306	87.57	90.16	95.47	65.79
Manufacturing	328	111	19,676	0.29	0.46	7.90	198	98.80	99.28	83.24	64.66
Transportation & public utilities	116	35	19,145	0.37	0.55	2.51	258	97.64	99.32	83.83	47.99
Wholesale trade	40	9	5873	0.13	0.60	17.16	410	96.61	96.61	78.01	–
Retail trade	53	15	1693	3.12	0.51	6.75	39	94.15	95.39	98.76	13.64
Finance, insurance, & real estate	46	17	21,117	0.47	0.52	17.21	902	96.41	98.59	80.77	48.96
Services	371	96	14,955	0.74	0.41	7.76	139	98.61	99.09	81.58	57.07
Others	15	5	9317	1.73	0.34	13.60	63	60.00	60.00	53.54	–
Total	1024	298	15,642	0.70	0.47	7.80	302	97.45	98.28	83.80	58.64
Panel B: Descriptive statistics of acquirers sorted by 2-digit SIC industries											
Mining											
Oil & gas extraction	54	12	8399	1.66	0.53	0.86	1381	88.31	89.60	52.60	42.99
Coal mining	12	2	4721	1.13	0.75	26.07	1030	83.23	91.58	95.84	100.00
Metal mining	1	1	6037	0.06	0.45	8.07	757	100.00	100.00	93.55	–
Manufacturing											
Industrial machinery & equipment	81	15	56,844	0.18	0.55	20.97	374	100.00	100.00	71.64	80.48
Instruments & related products	72	15	18,431	0.02	0.43	19.21	127	96.71	97.43	–	77.75
Electronic & other electric equipment	56	27	2143	0.11	0.38	0.43	130	100.00	100.00	63.23	53.53
Chemicals & allied products	53	27	2297	0.21	0.45	–14.73	146	100.00	100.00	100.00	76.83
Printing & publishing	13	3	571	3.12	0.33	4.89	12	90.85	97.90	76.62	24.88
Rubber & misc. plastics products	10	3	835	0.60	0.47	6.52	82	100.00	100.00	–	–
Primary metal industries	9	2	1711	0.03	0.50	16.78	20	100.00	100.00	100.00	–
Apparel & other textile products	7	3	219	0.04	0.37	3.77	15	100.00	100.00	–	47.90
Food & kindred products	6	2	666	1.95	0.35	–7.11	210	100.00	100.00	100.00	71.91
Petroleum & coal products	6	4	11,532	0.05	0.50	–17.61	124	100.00	100.00	88.87	100.00
Transportation equipment	5	3	939	0.06	0.57	–8.59	20	100.00	100.00	89.53	–
Paper & allied products	3	1	5041	0.01	0.68	17.17	–	100.00	100.00	76.96	–
Fabricated metal products	3	2	406	0.04	0.44	7.79	12	100.00	100.00	93.90	–
Miscellaneous manufacturing industries	2	2	815	0.05	0.59	1.48	13	–	–	48.78	–
Tobacco products	1	1	–	–	0.59	30.34	2900	100.00	100.00	66.39	–
Transportation & public utilities											
Electric, gas & sanitary services	50	14	5941	0.34	0.62	5.95	335	96.92	99.71	75.31	56.18
Communication	47	12	43,845	0.24	0.52	–5.26	188	97.29	98.41	75.12	39.80
Trucking & warehousing	12	5	260	1.13	0.39	10.92	41	100.00	100.00	–	–
Transportation services	4	2	6076	0.03	0.45	8.14	197	100.00	100.00	90.54	–
Water transportation	2	1	908	0.02	0.78	34.74	–	100.00	100.00	100.00	–
Transportation by air	1	1	31,418	0.01	0.49	15.69	780	100.00	100.00	100.00	–
Wholesale trade											

Table 2 (*continued*)

Industries	Number of events	Number of firms	Market value (million)	Std. dev. of returns (%)	Debt ratio	Return on total equity (%)	Trade value (million)	Trade shares (%)	Post-event ownership (%)	Cash (%)	Stock (%)
Wholesale trade-durable goods	38	7	6153	0.02	0.60	17.86	456	96.35	96.35	86.11	–
Wholesale trade-nondurable goods	2	2	551	2.22	0.57	3.99	36	100.00	100.00	100.00	–
Retail trade											
Miscellaneous retail	28	6	2278	5.17	0.52	1.17	44	97.77	97.77	–	13.64
Eating & drinking places	11	3	1254	0.02	0.35	14.18	22	85.71	93.00	96.59	–
Automotive dealers & service stations	9	3	998	0.99	0.59	7.24	219	87.00	87.00	–	–
Building materials & garden supplies	3	1	672	3.81	0.73	27.88	27	100.00	100.00	100.00	–
General merchandise stores	1	1	271	0.03	0.47	8.91	22	100.00	100.00	100.00	–
Apparel & accessory stores	1	1	1460	0.04	0.67	11.24	–	100.00	100.00	100.00	–
Finance, insurance & real estate											
Insurance carriers	21	7	37,047	0.23	0.58	15.34	230	100.00	100.00	85.28	.
Security & commodity brokers	11	5	5463	1.50	0.37	18.94	2763	83.67	93.56	100.00	60.69
Real estate	8	2	3628	0.02	0.62	25.13	906	100.00	100.00	–	13.76
Non-depository institutions	2	1	736	0.03	0.44	13.04	35	100.00	100.00	39.32	–
Holding & other investment offices	2	1	1577	0.02	0.62	0.19	16	100.00	100.00	22.31	–
Services											
Business services	224	60	23,505	0.47	0.40	4.59	149	99.12	99.55	88.33	63.82
Health services	83	15	2046	1.16	0.37	15.39	173	97.81	97.81	87.83	18.63
Engineering & management services	49	13	1114	1.35	0.45	10.39	29	100.00	100.00	72.77	17.96
Amusement & recreation services	9	4	1384	0.04	0.48	1.66	139	91.25	100.00	92.62	–
Educational services	2	2	1881	0.04	0.49	8.44	13	100.00	100.00	72.77	7.28
Personal services	1	1	551	0.03	0.67	4.41	45	44.40	44.40	80.40	77.69
Others	15	5	9317	1.73	0.34	13.60	63	60.00	60.00	53.54	–
Total	1024	298	15,642	0.70	0.47	7.80	302	97.45	98.28	83.80	58.64

Number of events refers to as the number of M&A announcements over the period from beginning of 2006 to the end of 2010. Number of firms is the number of acquirers. Market value is defined as the market capitalization (million) measured at the previous end of the year. Std. dev. of returns is the standard deviation of returns of individual stock over the period of one-year prior M&A announcements. The market to book ratio is a firm's market value of common equity over book equity. Trade value and trade shares are the M&A's transaction value (million) and target's stock shares, respectively. Post-event ownership is the acquirers' shareholdings of targets after M&A events. Cash and stock indicate the percent of payment composed by cash and stock, respectively.

using the market model $R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$, where R_{it} is individual return for stock i on day t, R_{mt} is concurrent return for CRSP value-weighted market portfolio on day t, and β_i is the systematic risk for stock i, computed over the period from $t = -200$ to -20.

3.2.4. Macroeconomic variables

(1) Bond yield, *BondYield*, is the market yield on U.S. Treasury securities at 1-year constant maturity, quoted on investment basis.
(2) Industrial production growth rate, *IPGrowth*, is the percentage change of real output of the manufacturing, mining, and electric and gas utilities industries.
(3) The change rate of capacity index, *CIChange*, is measured by the percentage change of capacity index. The capacity index is constructed for 89 detailed industries (71 in manufacturing, 16 in mining, and 2 in utilities), which mostly correspond to industries at the three- and four-digit North American Industry Classification System (NAICS) level.

4. Empirical results

4.1. Basic descriptive statistics

Table 1 reports descriptive statistics of M&A announcements. The sample includes 1024 M&A announcements from January 2006 to December 2010, a total of 298 acquirers and 9 targets listed in NYSE, NASDAQ or AMEX. Panel A shows basic statistics for acquirers and targets. The market value of an acquirer in each M&A event averages approximately 15.64 billion dollars. Firms' market values spread widely, ranging from a minimum of 12 million to a maximum of 165.97 billion dollars. Each M&A event of acquirers has an average standard deviation of prior-year daily returns of 0.70%, and market to book ratio of 3.87. On average, the acquirers tend to be glamour-oriented firms. In addition, the sample firms have an average quick ratio of 1.94, debt ratio of 0.47, total assets turnover of 1.16, return on total equity of 7.80%, and an average number of segments of 2.73. In brief, acquirers have a larger market value, higher stock volatility, higher profits and are more diversified than targets. Panel B of Table 1 shows the firm characteristics sorted by years. The most events happen in 2007 with a total of 289 events in 124 firms, the least in 2010 only with 124 events in 74 firms. On average, acquirers show similar standard deviation of returns and various financial ratios across sample periods.

Table 2 shows the descriptive statistics of acquirers sorted by industries. Trade value and trade shares are the M&A's transaction value (million) and targets' stock shares, respectively. Post-event ownership is the acquirers' shareholdings of targets after M&A events. Cash and stock indicate the percent of payment composed by cash and stock, respectively.

Panel A of Table 2 presents the descriptive statistics of acquirers sorted by industry sectors. In our sample, the most M&A events

Table 3
Descriptive statistics of acquirers sorted by fund sources, merger attitude, and exchange markets.

Categories	Number of events	Number of firms	Market value (million)	Std. dev. of returns (%)	Debt ratio	Return on total equity (%)	Trade value (million)	Trade shares (%)	Post-event ownership (%)	Cash (%)	Stock (%)
Panel A: Descriptive statistics sorted by merger attitude											
Friendly	1008	298	14,979	0.70	0.47	7.67	277.00	97.73	98.50	83.94	57.40
Not application	9	6	80,947	0.02	0.43	13.04	–	100.00	100.00	–	–
Neutral	4	4	35,486	2.60	0.40	17.15	579.77	33.71	55.60	100.00	100.00
Unsolicited offer	2	2	9587	0.03	0.43	26.79	6105.1	–	80.90	22.20	88.90
Hostile	1	1	13,896	0.03	0.32	13.47	429.80	–	–	–	–
Panel B: Descriptive statistics sorted by fund sources											
Mixed	39	34	4425	0.29	0.48	14.54	788.00	96.60	98.72	90.65	25.75
Corporate funds	31	20	2802	0.55	0.51	11.79	254.02	100.00	100.00	90.57	32.69
Borrowings	16	13	1553	0.73	0.48	15.72	154.56	97.08	97.08	74.08	26.73
Line of credit	13	9	895	1.04	0.58	11.22	113.10	100.00	100.00	91.44	–
Common stock issue	3	2	305	3.69	0.29	12.86	454.00	83.50	83.50	87.89	12.12
Unavailable	922	279	17,053	0.71	0.46	7.17	271.17	97.39	98.23	82.57	61.48
Panel C: Descriptive statistics sorted by exchange markets											
NASDAQ	615	181	16,616	0.79	0.41	4.15	145.68	98.42	98.64	80.74	57.46
NYSE	395	107	14,412	0.56	0.57	15.00	576.07	95.84	97.68	89.42	55.20
AMEX	14	10	90	0.52	0.34	−39.44	13.98	100.00	100.00	91.53	100.00
Total	1024	298	15,642	0.70	0.47	7.80	302.18	97.45	98.28	83.80	58.64

Number of events refers to as the number of M&A announcements over the period from beginning of 2006 to the end of 2010. Number of firms is the number of acquirers. Market value is defined as the market capitalization (million) measured at the previous end of the year. Std. dev. of returns is the standard deviation of returns of individual stock over the period of one-year prior M&A announcements. The market to book ratio is a firm's market value of common equity over book equity. Trade value and trade shares are the M&A's transaction value (million) and target's stock shares, respectively. Post-event ownership is the acquirers' shareholdings of targets after M&A events. Cash and stock indicate the percent of payment composed by cash and stock, respectively.

Table 4
Returns for acquirers and targets around M&A announcements.

Relative day	Panel A: Cumulative raw return			Panel B: Equally weighted adjusted abnormal return		
	Acquirers	Targets	Difference	Acquirers	Targets	Difference
Prior 1 month	−0.18	0.04	0.22	−0.19*	0.02	0.21
Prior 2 weeks	0.01*	0.05**	0.04*	0.00	0.04**	0.04*
Prior 1 week	−0.00	0.03**	0.03	−0.00	0.03**	0.03
Announced date	0.01***	0.13***	0.12***	0.00***	0.13***	0.13***
After 1 week	0.01***	0.14***	0.13***	0.01***	0.14***	0.13***
After 2 weeks	0.01***	0.15***	0.14***	0.01***	0.16***	0.15***
After 1 month	−0.18	0.04	0.22***	−0.19*	0.02	0.21***
After 3 months	0.02***	0.19***	0.17***	0.01	0.15***	0.14***
After 6 months	0.03***	0.17***	0.14**	0.00	0.14**	0.14***
After 1 year	−0.02	−2.56	−2.54	−0.09	−2.61	−2.52
After 2 years	0.02	−2.52	−2.54	−0.19	−2.61	−2.42
After 3 years	0.22*	−2.44	−2.66	−0.19	−2.57	−2.38
After 5 years	0.36***	−2.42	−2.78	−0.18	−2.55	−2.37
Difference						
After 1 – Prior 1 week	0.01*	0.11**	0.10**	0.01*	0.11**	0.10**
After 2 – Prior 2 weeks	0.00	0.10**	0.10**	0.01	0.12**	0.11**
After 1 – Prior 1 month	0.00***	0.00***	0.00**	0.00***	0.00**	0.00**

Relative day	Panel C: Value weighted adjusted abnormal return			Panel D: Market model adjusted abnormal return		
	Acquirers	Targets	Difference	Acquirers	Targets	Difference
Prior 1 month	-0.18*	0.03	0.21	0.74***	0.02	−0.72
Prior 2 weeks	0.01	0.05**	0.04*	0.33***	0.04**	−0.29*
Prior 1 week	−0.00	0.03***	0.03	0.16***	0.03**	−0.13*
Announced date	0.00***	0.13***	0.13***	0.04***	0.13***	0.09***
After 1 week	0.01***	0.14***	0.13***	0.19***	0.14***	−0.05***
After 2 weeks	0.01***	0.16***	0.15***	0.36***	0.15***	−0.21***
After 1 month	−0.18*	0.03	0.21***	0.74***	0.02	−0.72***
After 3 months	0.02***	0.16***	0.14***	2.22***	0.13**	−2.09***
After 6 months	0.02**	0.15***	0.13***	4.36***	0.11*	−4.25***
After 1 year	−0.03	−2.58	−2.55	8.85***	−2.64	−11.49
After 2 years	−0.03	−2.56	−2.53	17.51***	−2.65	−20.16
After 3 years	0.07	−2.51	−2.58	24.62***	−2.61	−27.23
After 5 years	0.11	−2.49	−2.60	31.89**	−2.58	−34.47
Difference						
After 1 – Prior 1 week	0.01*	0.11**	0.10**	0.03	0.11**	0.08**
After 2 – Prior 2 weeks	0.00	0.11**	0.11**	0.03	0.11**	0.08**
After 1 – Prior 1 month	0.00***	0.00**	0.00**	0.00**	0.00**	0.00**

Statistics of return for acquirers and targets are reported for cumulative raw return, equal- and value-weighted adjusted abnormal return, and market model adjusted abnormal return around M&A announcements in NYSE, NASDAQ or AMEX. The market model adjusted abnormal return is the risk adjusted return using the market model $R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$, where R_{it} is individual return for stock i on day t, R_{mt} is concurrent return for CRSP value-weighted market portfolio on day t, and β_i is the systematic risk for stock i, computed using firm's daily returns for CRSP value-weighted market portfolio over the period from $t = -200$ to -20. Statistical significance for the differences between acquirers and targets is obtained from t-test, so are the differences between after and prior event period. *, ** and *** indicate statistical significance at the 1, 5 and 10 percent level, respectively.

occur in the service sector (371 events in 96 firms), the next in manufacturing (328 events in 111 firms), and then in transportation and public utilities (116 events in 35 firms). The largest market value of industry sectors for acquirers happens in finance, insurance, and real estate (21.12 billion), the next is manufacturing (19.68 billion), and then transportation and public utilities (19.15 billion).

The average standard deviation of prior-year daily returns varies between 0.13% in wholesale trade and 3.12% in retail trade. Higher return on total equity is associated with finance, insurance, and real estate (17.21%) and wholesale trade (17.16%). Transportation and public utilities show the lowest profit (only 2.15%), and it is nearly one-seventh of the maximum ROE. The trade value varies widely, ranging from 1.31 billion in mining sectors to only 39 million dollars in retail trade.

Panel B of Table 2 shows the descriptive statistics of acquirers sorted by 2-digit Standard Industrial Classification (SIC). The top 5 acquirers' industries are business services (224 events in 60 firms), health services (83 events in 15 firms), industrial machinery and equipment (81 events in 15 firms), instruments and related products (72 events in 15 firms), and electronic and other electric equipment (56 events in 27 firms). The largest market value of 2-digit SIC industries for acquirers occurs in industrial machinery and equipment (56.84 billion), the next is communication (43.85 billion), and then insurance carriers (37.05 billion). The standard deviation of returns, ROE, and trade value vary widely across industries. In brief, our event sample includes many industries and their industry characteristics deviate extensively.

Table 5
Z-score and default risk for acquirers and targets around M&A announcements.

Relative year	Z-Score			Default risk		
	Acquirers	Targets	Difference	Acquirers	Targets	Difference
−5	6.72***	−9.00	−15.72	0.07***	0.20	0.13
−4	5.89***	−12.85	−18.74	0.06***	0.16	0.10
−3	5.51***	6.50**	0.99	0.07***	0.21	0.14
−2	5.71***	5.84***	0.13	0.09***	–	–
−1	5.71***	10.32**	4.61	0.07***	0.07	0.00
0	5.18***	5.85	0.67	0.04***	0.31	0.27**
1	4.32***	6.26**	1.94	0.01***	0.09	0.08
2	3.86***	5.19**	1.33	0.02***	0.18	0.16
3	3.53***	7.64*	4.11	0.02***	–	–
4	3.43***	9.19*	5.76	0.03***	–	–
5	3.44***	2.22	−1.22	0.07***	–	–
Average (−5, +5)	4.85	3.38	−1.47***	0.05	0.17	0.13***
Average (−5, −1)	5.91	0.16	−5.75***	0.07	0.16	0.09
Average (+1, +5)	3.72	6.10	2.38	0.03	0.14	0.12*
(+1, +5) − (−5, −1)	−2.19	5.94	8.13	−0.04	−0.03	0.03

We compute two measures to evaluate financial risk around M&A announcements. This table presents Z-Score and default risk for acquirers and targets around M&A announcements in NYSE, NASDAQ or AMEX. Z-score is evaluated as Altman's (1968) approach and default risk is estimated according to the default probability from Black-Scholes-Merton (Black & Scholes, 1973; Merton, 1974) option pricing model. Statistical significance for the difference between acquirers and targets is obtained from *t*-test. *, ** and *** indicate statistical significance at the 1, 5 and 10 percent level, respectively.

Table 3 presents the descriptive statistics of acquirers sorted by fund sources, merger attitude, and exchange markets. In our sample, most of the M&A events are friendly. The M&A acquirers tend to more frequently use mixed fund sources, followed by corporate funds and then borrowings. These results are in line with the pecking order theory (Myers and Majluf, 1984). In our sample, acquirers and M&A events mainly come from NASDAQ (615 events in 181 firms), and the next is NYSE (395 events in 107 firms). Only 14 events of 10 acquirers happen in AMEX.

4.2. Returns for acquirers and targets around M&A announcements

Table 4 exhibits returns for acquirers and targets around M&A announcements. Panels A to D present the cumulative raw return, equally weighted adjusted abnormal return, value weighted adjusted abnormal return, and market model adjusted abnormal return, respectively. Both acquirers and targets tend to show positive returns around M&A announcements, regardless of return measures. Targets outperform acquirers around M&A announcements in terms of cumulative raw return, equally and value weighted adjusted abnormal return. However, they do the opposite under the market model adjusted return.

4.3. Financial risk valuation around M&A announcements

This section adopts the Z-score and default risk to measure financial risk and examines the risk around M&A announcements. The Z-score formula for predicting bankruptcy was suggested by Altman (1968). It is an easy-to-calculate control measure for the financial distress status of companies in academic studies, which can be used to predict the probability that a firm will go into bankruptcy. Z-score is a statistical method of quantifying the distance (measured in standard deviations) a data point is from the mean of a data set. It measures the number of standard deviations an observation is away from the mean of all observations. A positive Z-score indicates the observed value is above the mean of all values, while a negative Z-score denotes the observed value is below the mean of all values. The higher a company's Altman Z-score, the lower the possibility the company will go bankrupt.

Alternatively, we compute default risk by using Black-Scholes-Merton model (Black & Scholes, 1973; Merton, 1974). The default risk measures the degree of uncertainty surrounding a firm's capability to service its debts and obligations. It is a probabilistic assessment of the default likelihood and offers a way to discriminate unambiguously between firms that will default and those that will not. As a result, firms tend to pay a spread over the default-free rate of interest that is proportional to their default likelihood to compensate creditors for this uncertainty. Typically, there is substantial variation in default probabilities across firms. In brief, the lower the default risk, the lower the possibility of bankruptcy.

Table 5 reports the Z-score and default risk for acquirers and targets around M&A announcements. Relative year refers to the year relative to the M&A announcement year. In terms of Z-score measures, acquirers show positive Z-scores for all of the relative years around the M&A announcements, while targets show negative Z-scores in the 4th and 5th relative year prior to the M&A announcements. The Z-scores of acquirers display more stable pattern than these of targets.

The results show that, on average, acquirers have higher Z-scores than targets and the differences are significant at the 1% level over the period from relative year −5 to +5 and from −5 to −1, even though there is no significant difference between acquirers and targets in each relative year. It implies that acquirers have extremely low probability of going into bankruptcy.

Table 6

The determinants of successful takeover.

Independent variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Panel A: Full sample including event firms and matching firms							
Intercept	4.04***	3.84***	3.81***	3.78***	3.63***	2.68***	−106.30
ZScore	−0.01		−0.04				
Default		−0.52***	−0.54***		−0.37*	−0.36*	−0.36*
Size				−0.19***	−0.18***	−0.18***	−0.18***
StdRet				−0.13***	−0.14***	−0.13***	−0.14***
QuickRatio				−0.05***	−0.05***	−0.07***	−0.05***
IntCov				0.00	0.00	0.00	0.00
DebtRatio				0.00	0.00	0.00	0.00
TAT				−0.18***	−0.17***	−0.11***	−0.17***
ROE				0.98***	0.96***	0.93***	0.98***
PE				−0.17***	−0.16**	−0.20***	−0.15**
PCF				−0.19**	−0.18*	−0.30***	−0.16
LnSegment				0.13	0.13	0.16**	0.14*
BondYield						0.33**	−23.33
IPGrowth						−0.52***	109.00
CUChange						0.52***	−71.99
Fixed industry effects	Yes	Yes	Yes	Yes	Yes	No	Yes
Fixed year effects	Yes	Yes	Yes	Yes	Yes	No	Yes
Likelihood ratio	717.25	639.53	629.13	389.56	416.74	275.18	437.36
Number of obs.	32,697	26,911	26,296	7,282	6,969	6,969	6,969
Panel B: Sample excluding firm with zero default risk							
Intercept	4.04***	3.84***	3.90***	4.04***	3.67***	0.36	−91.25
ZScore	−0.01		0.02				
Default		−1.07***	−1.09***		−1.84***	−1.42**	−1.22**
Size				−0.19**	−0.14	−0.21**	−0.14
StdRet				−0.21***	−0.16***	−0.15***	−0.15***
QuickRatio				−0.02	0.00	−0.02	−0.06
IntCov				0.01	0.02	0.00	0.07
DebtRatio				0.22	0.64	0.02	0.04
TAT				−0.44***	−0.41***	−0.44***	−0.50***
ROE				2.89***	3.02***	3.55***	3.28***
PE				−0.11	0.02	0.09	0.08
PCF				−0.29*	−0.21	−0.11	−0.05
LnSegment				0.42	0.41	0.17	0.21
BondYield						2.13***	−16.78
IPGrowth						−3.27***	86.01
CUChange						3.26***	−55.68
Fixed industry effects	Yes	Yes	Yes	Yes	Yes	No	Yes
Fixed year effects	Yes	Yes	Yes	Yes	Yes	No	Yes
Likelihood ratio	146.29	110.79	113.70	188.82	187.48	177.22	211.14
Number of obs.	9,214	2,878	2,813	882	569	569	569

The table shows the results of logistic regression analyses. Panel A presents logistic regressions for full sample including M&A event firms and matching firms. Panel B shows results related with sample excluding firms with zero default risk. The dependent variable is a binary variable that takes the value of one if M&A status is complete in SDC database, and zero otherwise. Z-score, *ZScore*, is evaluated as Altman's (1968) approach and default risk, *Default*, is estimated according to the default probability from Black-Scholes-Merton (Black & Scholes, 1973; Merton, 1974) option pricing model. The firm size, *Size*, is defined as the natural logarithm of the market capitalization measured at the previous end of the year. Firm risk, *StdRet*, is the standard deviation of returns of individual stock over the period of one-year prior M&A announcements. The quick ratio, *QuickRatio*, is the ratio of sum of cash equivalents, marketable securities and net receivables to current liabilities. The interest coverage, *IntCov*, is computed as earnings before interest, tax and depreciation divided by interest. The debt ratio, *DebtRatio*, indicates the proportion of debt a company has relative to its assets. Total assets turnover, *TAT*, is computed as net sales over total assets, measuring the ability of total assets to generate sales dollars. Return on total equity, *ROE*, is calculated by the ratio of net income divided by the total assets. Price to earnings ratio, *PE*, is defined as the ratio of price per share to earnings per share. Price to cash flow ratio, *PCF*, is calculated as the ratio of share price to cash flow per share. Firm segments, *NSegment*, are defined as how many segments the firm has. Market yield on U.S. Treasury securities, *BondYield*, at 1-year constant maturity is quoted on investment basis. Industrial production growth rate, *IPGrowth*, measures the percentage change of real output of the manufacturing, mining, and electric and gas utilities industries. The change rate of capacity index, *CIChange*, is measured by the percentage change of capacity index. The capacity index is constructed for 89 detailed industries (71 in manufacturing, 16 in mining, and 2 in utilities), which mostly correspond to industries at the three- and four-digit North American Industry Classification System (NAICS) level. *, ** and *** indicate statistical significance at the 1, 5 and 10 percent level, respectively.

As to the default risk measure, the default risk of acquirers lies between 0.01 and 0.09, lower than that of targets, but are not significantly different from them. Overall, the table shows that acquirers have a low financial risk, regardless of Z-score or BSM's default risk. Our empirical results, on average, do not experience a merger-related increase in the default risk of the acquiring firm

Table 7
The determinants of successful takeover sorted by default risk.

Independent variables	Low default risk		High default risk	
Intercept	7.70**	53.99**	−16.06	−33.16**
Default	−5.14***	−8.32**	6.91	18.91
Size	−0.33*	−0.50	−0.23	−0.15
StdRet	−0.29***	−0.81***	−0.22***	−0.26***
QuickRatio	0.15	0.34	−0.09	−0.12
IntCov	0.01	−0.07	0.10	0.15
DebtRatio	1.14	1.67	0.00	−0.02
TAT	−0.51**	−0.58	−0.54***	−0.74***
ROE	4.80***	6.08***	3.49***	3.82**
PE	0.06	−0.69	0.35	0.38
PCF	1.26	4.10	−0.14	−0.04
LnSegment	0.39	1.28	0.07	−0.15
BondYield	−0.61	−22.30**	7.47***	10.60***
IPGrowth	1.30	31.93**	−11.69***	−16.25***
CUChange	−1.37	−29.83**	11.81***	16.35***
Fixed industry effects	No	Yes	No	Yes
Fixed year effects	No	Yes	No	Yes
Likelihood ratio	82.21	136.60	125.30	148.70
Number of obs.	284	284	285	285

The table shows the results of logistic regression analyses. Sample is sorted by low and high default risk. The dependent variable is a binary variable that takes the value of one if M&A status is complete in SDC database, and zero otherwise. Default risk, *Default*, is estimated according to the default probability from Black-Scholes-Merton (Black & Scholes, 1973; Merton, 1974) option pricing model. All observations are decomposed into low and high default risk groups, based on the median of non-zero default probabilities. The firm size, *Size*, is defined as the natural logarithm of the market capitalization measured at the previous end of the year. Firm risk, *StdRet*, is the standard deviation of returns of individual stock over the period of one-year prior M&A announcements. The quick ratio, *QuickRatio*, is the ratio of sum of cash equivalents, marketable securities and net receivables to current liabilities. The interest coverage, *IntCov*, is computed as earnings before interest, tax and depreciation divided by interest. The debt ratio, *DebtRatio*, indicates the proportion of debt a company has relative to its assets. Total assets turnover, *TAT*, is computed as net sales over total assets, measuring the ability of total assets to generate sales dollars. Return on total equity, *ROE*, is calculated by the ratio of net income divided by the total assets. Price to earnings ratio, *PE*, is defined as the ratio of price per share to earnings per share. Price to cash flow ratio, *PCF*, is calculated as the ratio of share price to cash flow per share. Firm segments, *NSegment*, are defined as how many segments the firm has. Market yield on U.S. Treasury securities, *BondYield*, at 1-year constant maturity is quoted on investment basis. Industrial production growth rate, *IPGrowth*, measures the percentage change of real output of the manufacturing, mining, and electric and gas utilities industries. The change rate of capacity index, *CIChange*, is measured by the percentage change of capacity index. The capacity index is constructed for 89 detailed industries (71 in manufacturing, 16 in mining, and 2 in utilities), which mostly correspond to industries at the three- and four-digit North American Industry Classification System (NAICS) level. *, ** and *** indicate statistical significance at the 1, 5 and 10 percent level, respectively.

(Furfine & Rosen, 2011; Vallascas & Hagendorff, 2011). The five-year differences in financial risk between pre- and post-M&A announcements are not significantly different, irrespective of acquirers and targets.

4.4. The determinants of the successful takeover

To examine whether the firm's financial risk plays an important role in successful takeover, we perform the binomial logistic regression as follows:

$$Pr(Success_{it} = 1) = Pr(\alpha + \beta_1 Zscore_{it} + \beta_2 Default_{it} + \beta_3 Size + \beta_4 StdRet_{it} + \beta_5 QuickRatio_{it} + \beta_6 IntCov_{it} + \beta_7 DebtRatio_{it}$$
$$+ \beta_8 TAT_{it} + \beta_9 ROE_{it} + \beta_{10} PE_{it} + \beta_{11} PCF_{it} + \beta_{12} LnSegment_{it} + \beta_{13} BondYield_{it} + \beta_{14} IPGrowth_{it} + \beta_{15} CUChange_{it}$$
$$+ Fixed\ Industry\ Effects + Fixed\ Year\ Effects + \varepsilon_{it} > 0),$$

(1)

where S*uccess_{it}* equals one if the M&A event is successful, and zero otherwise. Other variables are defined above.

Table 6 shows the determinants of successful takeover described by the logistic models relating successful takeover probabilities to default risk and other firm characteristics. A positive (negative) coefficient corresponding to a given explanatory variable indicates that the explanatory variable will increase (decrease) the probability of a successful takeover. Panel A of Table 6 presents the determinants of successful takeover using the full sample, and Panel B excludes firms with zero default risk.

The results in Panel A of Table 6 show that the coefficients of the Z-Score (*ZScore*) variable in Model 1 and 3 are not significant while these of the default risk (*Default*) are negatively significant at the 1% level in both Model 2 and 3. The results show that default risk plays a more important role than Z-score when evaluating acquirers' financial risk in takeover activities. The negative and significant coefficients of default risk show that the probability of successfully taking over a target will decrease with the acquirer's default risk. This finding is consistent with Safieddine and Titman (1999), showing that acquirers with lower default risk have a higher probability of a successful takeover. The results are also in support of Hillegeist et al. (2004a,b). The BSM default risk provides more explanatory power than the popular Z-Score does. We can improve the power of the tests by incorporating default risk derived

Table 8

Regression results of acquirers' post-event abnormal returns.

Independent variables	1 Week	2 Weeks	1 Month	3 Months	6 Months	1 Year	2 Years	3 Years	5 Years
Intercept	−7.53	−16.26*	−31.01*	−98.06*	−195.13*	−412.33**	−782.56*	−1070.30*	−1212.59
ZScore	−1.97	2.15	4.71	18.83	31.69	39.41	160.71	236.51	245.18
Default	3.39	7.77**	16.46*	46.06*	95.03**	191.82**	358.94*	466.65*	667.52*
Size	0.13	0.05	0.24	0.13	0.44	0.71	−2.88	−7.65	−5.20
StdRet	0.16***	0.27***	0.56***	1.78***	3.48***	7.68***	15.25***	20.88***	25.35***
QuickRatio	−0.02	−0.48	−1.05	−3.12	−6.44	−12.55	−27.92	−35.86	−48.94
IntCov	0.18**	0.25*	0.60*	1.67*	3.67**	8.39**	14.82**	22.66**	25.59*
DebtRatio	0.68	1.20	2.05	10.26	21.25	42.02	105.66	183.75	102.04
TAT	−0.24	−0.85**	−2.08**	−6.40**	−13.68***	−25.37**	−52.50**	−81.54***	−92.71**
ROE	−1.22	−3.83	−6.06	−22.46	−42.58	−93.02	−190.82	−239.63	−256.33
PE	−0.32	−0.77*	−1.66*	−4.60*	−9.48*	−19.70*	−37.89*	−56.80*	−85.24**
PCF	0.02	−0.07	−0.71	−1.98	−4.10	−6.23	−12.94	−15.71	−6.77
LnSegment	−1.20*	−2.09*	−3.81	−12.04	−23.02	−49.57*	−98.33*	−130.58	−137.51
BondYield	2.82	7.37**	13.60*	45.72*	89.72**	188.96**	376.80**	530.66**	573.35
IPGrowth	−3.92	−10.46**	−19.41*	−65.15*	−128.52**	−270.28**	−538.24**	−749.78**	−790.44
CUChange	3.91	10.12**	18.93*	62.75*	123.91**	260.32**	515.85**	716.33**	765.45
Fixed industry effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-Value	2.80	3.39	3.29	3.62	3.95	3.39	3.87	4.06	3.39
Adj. *R*-square	0.24	0.30	0.28	0.32	0.34	0.34	0.34	0.35	0.30
Number of obs.	114	114	114	114	114	114	114	114	114

The table demonstrates regression results of acquirers' post-event abnormal returns. The dependent variables are market model adjusted cumulative abnormal return over the period from 1 week to 5 years immediately after M&A announcement. Z-score, *ZScore*, is evaluated as Altman's (1968) approach and default risk, *Default*, is estimated according to the default probability from Black-Scholes-Merton (Black & Scholes, 1973; Merton, 1974) option pricing model. The firm size, *Size*, is defined as the natural logarithm of the market capitalization measured at the previous end of the year. Firm risk, *StdRet*, is the standard deviation of returns of individual stock over the period of one-year prior M&A announcements. The quick ratio, *QuickRatio*, is the ratio of sum of cash equivalents, marketable securities and net receivables to current liabilities. The interest coverage, *IntCov*, is computed as earnings before interest, tax and depreciation divided by interest. The debt ratio, *DebtRatio*, indicates the proportion of debt a company has relative to its assets. Total assets turnover, *TAT*, is computed as net sales over total assets, measuring the ability of total assets to generate sales dollars. Return on total equity, *ROE*, is calculated by the ratio of net income divided by the total assets. Price to earnings ratio, *PE*, is defined as the ratio of price per share to earnings per share. Price to cash flow ratio, *PCF*, is calculated as the ratio of share price to cash flow per share. Firm segments, *NSegment*, are defined as how many segments the firm has. Market yield on U.S. Treasury securities, *BondYield*, at 1-year constant maturity is quoted on investment basis. Industrial production growth rate, *IPGrowth*, measures the percentage change of real output of the manufacturing, mining, and electric and gas utilities industries. The change rate of capacity index, *CIChange*, is measured by the percentage change of capacity index. The capacity index is constructed for 89 detailed industries (71 in manufacturing, 16 in mining, and 2 in utilities), which mostly correspond to industries at the three- and four-digit North American Industry Classification System (NAICS) level. *, ** and *** indicate statistical significance at the 1, 5 and 10 percent level, respectively.

from market data instead of accounting base measures.

Model 4 of Panel A shows that the acquirer's size (*Size*), firm risk (*StdRet*), Quick ratio (*QuickRatio*), total assets turnover rate (*TAT*), price to earnings ratio (*PE*) and price to cash flow ratio (*PCF*) negatively affects the probability of successfully taking over a target, while its return on total equity (*ROE*) positively affects the successful takeover probability. Models 5, 6, and 7 of Panel A show that even after controlling for firm characteristics, the probability of an acquirer's successful takeover still decreases with default risk (but only at a significance level of 10%).

Panel B of Table 6 presents the corresponding results excluding firms with zero default risk. The coefficients corresponding to Z-Score (*ZScore*) variables in Models 1 and 3 remain insignificant while those corresponding to the default risk (*Default*) are negatively significant. As a whole, the main results of Panel B of Table 6 are similar with those of Panel A. The coefficients corresponding to default risk are now, however, more significant.

We furthermore decompose the observations into low and high default risk groups, based on the median of non-zero default probabilities. Table 7 depicts the determinants of successful takeover sorted by default risk. The results show that the negative relation between acquirers' default risk and successful takeover probabilities only exists in firms with low default risk. For high default risk firms, the relation between acquirers' default risk and successful takeover probabilities show a positive relation but are not statistically significant.

In brief, our results show that an acquirer's default risk is more strongly associated with the probability of successful takeover activities than the Z-score values. Additionally, the negative relation between acquirers' default risk and successful takeover probabilities mainly come from firms with low default risk.

4.5. Acquirers' financial risk and the post-event abnormal return

To examine the impact of acquirers' default risk on wealth effects of their stockholders, this section investigates whether the

Table 9
Regression results of acquirers' post-event abnormal returns sorted by default risk.

Independent variables	1 Month		6 Months		1 Year		3 Years		5 Years	
	Low risk	High risk	Low risk	High risk	Low risk	High risk	Low risk	High risk	Low risk	high risk
Intercept	4.31	−506.69	24.15	−3892.99*	65.27	−8575.67**	59.43	−23953**	−160.55	−26208
ZScore	0.49	0.34	3.07*	2.15	6.04	4.01	16.56*	12.02	17.62	12.18
Default	−10.80	452.67	−65.12*	3571.62*	−144.79	7932.84*	−298.76	22015*	−257.39	23,490
Size	−1.28	0.60	−7.42	5.47	−14.94	9.31	−40.92	17.70	−36.67	4.63
StdRet	3.87**	−0.21	23.54**	−1.29	47.65**	−2.05	122.98**	−6.76	146.32*	−7.23
QuickRatio	−1.10	−2.95	−4.78	−14.76	−11.78	−27.08	−25.24	−66.56	−37.70	−68.81
IntCov	0.59**	0.38	3.52***	−0.94	7.77***	−1.37	19.26***	−2.48	18.23*	14.29
DebtRatio	0.19	22.55	8.73	145.17*	6.43	303.58*	42.73	987.93**	−155.36	1260.73*
TAT	−0.65	−2.31	−5.66	−12.78	−8.08	−22.92	−31.32	−69.46	−25.21	−86.22
ROE	−0.49	−1.32	−3.41	−43.32	−6.30	−107.40	−10.39	−324.06	91.73	−456.42
PE	−2.29	0.75	−12.36	0.74	−27.26	4.43	−64.93	13.95	−65.27	39.66
PCF	−9.90	−1.84	−82.42	−7.01	−128.98	−10.79	−538.89	−31.01	−646.99	−36.63
LnSegment	1.26	−6.42	6.71	−34.57	19.99	−72.09	11.85	−186.40	36.24	−244.63
BondYield	0.28	32.31	0.63	187.71	−5.66	374.68	44.89	1107.88	131.07	1620.46
IPGrowth	−0.69	−41.82	−2.76	−249.62	4.56	−497.85	−64.98	−1477.46	−172.65	−2184.48
CUChange	0.83	42.20	3.72	252.65	−2.67	503.72	69.27	1499.02	180.61	2228.75
Fixed industry effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-Value	2.72	1.90	2.92	2.60	2.89	2.67	3.17	2.74	2.86	1.96
Adj. *R*-square	0.40	0.20	0.43	0.30	0.42	0.31	0.46	0.32	0.42	0.21
Number of obs.	47	67	47	67	47	67	47	67	47	67

The table shows regression results of acquirers' post-event abnormal return sorted by default risk. Sample is sorted by low and high default risk. The dependent variables are market model adjusted cumulative abnormal return over the period from 1 month to 5 years immediately after M&A announcement. Z-score, *ZScore*, is evaluated as Altman's (1968) approach and default risk, *Default*, is estimated according to the default probability from Black-Scholes-Merton (Black & Scholes, 1973; Merton, 1974) option pricing model. The firm size, *Size*, is defined as the natural logarithm of the market capitalization measured at the previous end of the year. Firm risk, *StdRet*, is the standard deviation of returns of individual stock over the period of one-year prior M&A announcements. The quick ratio, *QuickRatio*, is the ratio of sum of cash equivalents, marketable securities and net receivables to current liabilities. The interest coverage, *IntCov*, is computed as earnings before interest, tax and depreciation divided by interest. The debt ratio, *DebtRatio*, indicates the proportion of debt a company has relative to its assets. Total assets turnover, *TAT*, is computed as net sales over total assets, measuring the ability of total assets to generate sales dollars. Return on total equity, *ROE*, is calculated by the ratio of net income divided by the total assets. Price to earnings ratio, *PE*, is defined as the ratio of price per share to earnings per share. Price to cash flow ratio, *PCF*, is calculated as the ratio of share price to cash flow per share. Firm segments, *NSegment*, are defined as how many segments the firm has. Market yield on U.S. Treasury securities, *BondYield*, at 1-year constant maturity is quoted on investment basis. Industrial production growth rate, *IPGrowth*, measures the percentage change of real output of the manufacturing, mining, and electric and gas utilities industries. The change rate of capacity index, *CIChange*, is measured by the percentage change of capacity index. The capacity index is constructed for 89 detailed industries (71 in manufacturing, 16 in mining, and 2 in utilities), which mostly correspond to industries at the three- and four-digit North American Industry Classification System (NAICS) level. *, ** and *** indicate statistical significance at the 1, 5 and 10 percent level, respectively.

degree of default risk is significantly related to the post-event abnormal returns. We estimate the following equation:

$$AR_{it} = \alpha + \beta_1 Zscore_{it} + \beta_2 Default_{it} + \beta_3 Size_{it} + \beta_4 StdRet_{it} + \beta_5 QuickRatio_{it} + \beta_6 IntCov_{it} + \beta_7 DebtRatio_{it} + \beta_8 TAT_{it} + \beta_9 ROE_{it}$$
$$+ \beta_{10} PE_{it} + \beta_{11} PCF_{it} + \beta_{12} LnSegment_{it} + \beta_{13} BondYield_{it} + \beta_{14} IPGrowth_{it} + \beta_{15} CUChange_{it} + Fixed\ Industry\ Effects$$
$$+ Fixed\ Year\ Effects + \varepsilon_{it}, \tag{2}$$

where AR_{it} is the market model adjusted cumulative abnormal return over the periods from one week to five years immediately after M&A announcements. The explanatory variables of the equation are defined in the previous section.

Table 8 presents the regression results of acquirers' post-event abnormal return. We find that the coefficients of the Z-Score (*ZScore*) are not significant, regardless of how long for the return period. However, the coefficients corresponding to default risk (*Default*) are positively significant for all return measurement periods, except for the one-week abnormal return immediately after M&A announcements. The findings show that acquirers' default risk is positively related to their stockholders' wealth. In addition, acquirers' firm risk (*StdRet*) and interest coverage (*IntCov*) are also positively related with the abnormal return immediately after M&A announcements for both short- and long-term. In contract, acquirers' total assets turnover (*TAT*) and price to earnings ratio (*PE*) are negatively related with their abnormal returns. On average, our results confirm Markowitz's (1952) trade-off relationship between risk and return. That is, the results show the greater the risk associated with acquirers, the greater the return expected from takeover activities.

Table 9 shows the regression results of acquirers' post-event abnormal return sorted by default risk. The sample firms are separated into low and high default risk groups according to the median of non-zero default risk. We find the positive relation between acquirers' default risk and post-event abnormal returns mainly comes from firms with high default risk. On the contrary, positive coefficients corresponding with firm risk (*StdRet*) only occur in the low default risk group. Our evidences imply that default risk and

Table 10

Acquirers' default risk, successful takeover probabilities, and post-event abnormal returns.

Variables	Full sample	Subsamples		
		Low default risk	High default risk	High – low
Default risk	0.06***	0.03***	0.97***	0.94***
Successful takeover probabilities	0.79***	0.82***	0.38***	− 0.44***
Post-event abnormal returns				
1 Week	0.19***	0.04***	2.06***	2.02***
2 Weeks	0.37***	0.06***	4.05***	3.99***
1 Month	0.78***	0.12***	8.70***	8.58***
3 Months	2.31***	0.35***	25.84***	25.50***
6 Months	4.55***	0.65***	51.35***	50.69***
1 Year	9.20***	1.30***	103.92***	102.62***
2 Years	18.16***	2.52***	205.83***	203.30***
3 Years	25.77***	3.42***	293.97***	290.55***
5 Years	34.94***	4.38***	401.67***	397.29***
Firm characteristics				
Firm size	7.39***	7.50***	6.21***	− 1.28***
Firm risk	0.90***	0.18***	8.96***	8.78***
Quick ratio	2.10***	2.09***	2.24***	0.16
Interest coverage	336.67***	355.62***	122.40***	− 233.22***
Debt ratio	6.96***	7.54***	0.47***	− 7.07***
Total assets Turnover	1.18***	1.16***	1.46***	0.30
Return on total equity	4.99**	5.12***	3.57	− 1.55
Price to earnings ratio	34.59***	33.90***	42.03***	8.13
Price to cash flow ratio	17.71***	16.52***	31.89***	15.37*
Firm segments	1.18***	1.20***	1.01***	− 0.18***

The table demonstrates acquirers' default risk, successful takeover probabilities and post-event abnormal returns. Default risk is estimated according to the default probability from Black-Scholes-Merton (Black & Scholes, 1973; Merton, 1974) option pricing model. All observations are decomposed into low and high default risk groups, based on the median of non-zero default probabilities. Acquirers' successful takeover probabilities are obtained from Eqs. (1) and (2). The post-event abnormal returns are measured by the market model adjusted abnormal returns including the periods from 1 week to 5 years immediately after M&A announcement. The market model adjusted abnormal return is the risk adjusted return using the market model $R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$, where R_{it} is individual return for stock i on day t, R_{mt} is concurrent return for CRSP value-weighted market portfolio on day t, and β_i is the systematic risk for stock i, computed using firm's daily returns for CRSP value-weighted market portfolio over the period from $t = -200$ to -20. Firm characteristics are described as follows. The firm size is defined as the natural logarithm of the market capitalization measured at the previous end of the year. Firm risk is the standard deviation of returns of individual stock over the period of one-year prior M&A announcements. The quick ratio is the ratio of sum of cash equivalents, marketable securities and net receivables to current liabilities. The interest coverage is computed as earnings before interest, tax and depreciation divided by interest. The debt ratio indicates the proportion of debt a company has relative to its assets. Total assets turnover is computed as net sales over total assets, measuring the ability of total assets to generate sales dollars. Return on total equity is calculated by the ratio of net income divided by the total assets. Price to earnings ratio is defined as the ratio of price per share to earnings per share. Price to cash flow ratio is calculated as the ratio of share price to cash flow per share. Firm segments are defined as how many segments the firm has. *, ** and *** indicate statistical significance at the 1, 5 and 10 percent level, respectively.

traditional firm risk provide different information with respect to post-event abnormal return.

In other words, acquirers' default risk and firm total risk (measured by the standard deviation of acquirers' daily returns in the previous year) affects abnormal returns immediately following M&A announcements for both short- and long-term return periods. However, these two risk measures provide different information concerning the wealth effects of acquirers' stockholders. For low default risk firms, greater firm total risk is associated with higher abnormal return. For high default risk firms, default risk has the dominant power in explaining the acquirer's abnormal return.

Table 10 presents acquirers' default risk, successful takeover probabilities, and post-event abnormal returns. On average, the default probability of acquirers is 6%. Among acquirers, firms with low default risk have lower default probability of 3%, while firms with high default risk exhibit default probability of 97%. Additionally, firms with low default risk have higher successful takeover probability of 82%, while firms with high default risk have lower successful takeover probability of 38%.

In sum, the results in Table 10 show that takeovers create value for acquirers. In particular, acquirers with high default risk are highly likely to be extreme winners once they take the risk to successfully takeover their targets. Although acquirers with high default risk have lower successful takeover probabilities, they would get extremely higher abnormal returns than acquirers with low default risk. Additionally, compared to firms with low default risk, high default risk acquirers tend to have smaller size, lower interest coverage and debt ratio, lower degree of diversification and higher stock volatility.

5. Conclusion

The main purpose of this study is to investigate how the firms' overall financial risk rather than just debt might be linked in the context of takeovers. This paper deepens the understanding of firm's financial risk and takeover activities, providing a new angle on

the explanations of stockholders' wealth effects in mergers and acquisitions.

Our results show that acquirers exhibit low financial risk regardless of whether the measure was Altman's Z-score or BSM's default risk. On average, acquirers have extremely low probability that they will go into bankruptcy. Default risk demonstrates a more powerful effect on the acquirer's successful takeover probabilities than the Z-score valuation. There exists a negative relation between acquirers' default risk and the successful takeover probability. The negative correlation mainly comes from firms with low default risk. For these firms, the lower default risk the acquirer has, the higher successful takeover probabilities. Firms with low default risk show higher successful takeover probability of 82%, while firms with high default risk only yield a successful takeover probability of 38%.

On the other hand, we find that takeovers create value for acquirers, in particular for acquirers with high default risk. These high default risk acquirers, even though they have relatively lower successful takeover probabilities, are most likely to be extreme winners if they are successful in taking over the targets. In addition, high default risk acquirers tend to have smaller size, lower interest coverage and debt ratio, lower degree of diversification and higher stock volatility.

Acknowledgement

Appendix A. Black-Scholes-Merton model

According to the Black-Scholes-Merton model (Black & Scholes, 1973; Merton, 1974, hereafter BSM), equity can be viewed as a call option on the value of the firm's assets. The firm's liabilities are viewed as contingent claims against the underlying assets; bankruptcy is assumed to occur when the firm's assets are exhausted. We adopt the Black-Scholes-Merton option pricing model to evaluate the default probability for the target and the acquirer firms and investigate the effect of default risk on takeover activities. We assume that the capital structure of the firm includes both equity and debt. The firm's asset value V_A is assumed to follow a lognormal diffusion process.

$$\frac{dV_A}{V_A} = \mu_A(t)dt + \sigma_A(t)dZ_A, \tag{1}$$

where μ_A is the expected continuous compounded return of the asset value, σ_A is volatility of the asset value, and dZ_A is the standard Brownian motion.

Taking the target or the acquirer firm's equity as V_E can be viewed as a European call option on the value of the firm's assets as follow:

$$V_E = V_A N(d_1) - Fe^{-rT}N(d_2), \tag{2}$$

where $N(d_1)$ and $N(d_2)$ are the standard cumulative normal of d_1 and d_2, respectively. F indicates the face value of the firm's debt; r denotes the risk-free rate; and T is the time to maturity.

$$d_1 = \frac{\ln\left(\frac{V_A}{F}\right) + \left(r + \frac{1}{2}\sigma_A^2\right)}{\sigma_A\sqrt{T}}, \tag{3}$$

$$d_2 = d_1 - \sigma_A\sqrt{T}. \tag{4}$$

In the BSM's framework, the default probability is simply the likelihood that the market value of assets is less than the face value of the liabilities. As shown in Vassalou and Xing (2004), the probability of $V_A < F$ is as follows:

$$P_{def,t} = N\left(-\left(\frac{\ln\left(\frac{V_A}{F}\right) + \left(\mu_A - \frac{1}{2}\sigma_A^2\right)T}{\sigma_A\sqrt{T}}\right)\right) = N(-DD), \tag{5}$$

where the distance to default can be evaluated as:

$$DD = \frac{\ln\left(\frac{V_A}{F}\right) + \left(\mu_A - \frac{1}{2}\sigma_A^2\right)T}{\sigma_A\sqrt{T}}. \tag{6}$$

The default probability can be evaluated by the distance between the current firm's asset value and the face value of its liabilities adjusted for the expected continuous compounded return of the asset value relative to asset volatility. Under the assumption of the equity value is a function of time and the firm value, the optimal hedge equation can be implemented from Ito's lemma as follow:

$$\sigma_E = \left(\frac{V_A}{V_E}\right)\frac{\partial V_E}{\partial V_A}\sigma_A. \tag{7}$$

In the BSM's framework, the firm's equity volatility and asset volatility satisfies the following equation:

$$\sigma_E = \frac{\partial V_E N(d_1) \sigma_A}{\partial V_A}.$$

(8)

We can estimate the values of V_A and σ_A by simultaneously solving the nonlinear Eqs. (2) and (8). We follow Vassalou and Xing (2004) and Bharath and Shumway (2008) by implementing an iterative procedure. Once the value of V_A and σ_A are determined, we use these values to estimate μ_A. The default probability can be evaluated by inserting these estimations to Eq. (5).

Appendix B. Supplementary material

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.najef.2018.07.016.

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