Do Technology-oriented Mergers and Acquisitions Strengthen the Stock Market Valuation of R&D Spending?

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Do Technology-oriented Mergers and Acquisitions Strengthen the Stock Market Valuation of R&D Spending?

Abstract: This paper investigates how mergers and acquisitions (M&A) affect the stock market valuation of research and development (R&D) spending of the acquiring firm in technology-intensive industries. Our empirical analyses are based on a sample of 1701 M&As made by technology-intensive US firms during the period from 1990-2004. Consistent with our hypothesis that technology M&As enhance the value creation ability of an acquirer's existing R&D activities we find that they increase the stock market valuation of acquirer's R&D spending. We also find that the observed value creation is a curvilinear function of the acquirer and target firms' technological relatedness. Finally, our results show that technology M&As enhance an acquirer's ability to translate its R&D spending to future financial performance. Our results are robust for different alternative specifications of our model and when controlling for firm and industry differences.

JEL Classification: G15, M40

Keywords: R&D, stock market, valuation, mergers and acquisitions

1. Introduction

In the literature, much research has been devoted to the investigation of how the R&D expenditures (hereafter R&D) of the firm are reflected in its current market value and future profitability (e.g. Chan, Lakonishok and Sougiannis 2001; Jaffe 1986; Lev and Sougiannis 1996). Generally, these studies have found a positive relation between the firm's market value and R&D spending, that is, investors regard the R&D spending as a value-creative investment of the firm. For example, Jaffe (1986) reports a positive stock market valuation of the R&D spending of the firm. Similarly, Lev & Sougiannis (1996) report that the current R&D spending of the firm is positively related to the future cash flows and earnings of the firm.

Despite the extensive research on the stock market valuation of the R&D spending of the firm, the effect of mergers and acquisitions (hereafter M&A) on the market

response to the firm's R&D efforts has received little attention. However, while firms acquire other firms for many reasons, several studies show that M&As are typically aimed at assisting acquirers to achieve important strategic goals such as pursuing innovations and expanding existing R&D activities (e.g. Hitt, Harrison and Ireland 2001)[1]. Even though M&As do not often create significant value for acquiring firm shareholders (Agrawal, Jaffe and Mandelker 1992; Bradley, Desai and Kim 1988; Loderer and Martin 1992; Servaes 1991)[2], some studies maintain that positive value creation can be observed in specific type of M&As. For instance, technological synergies arising in M&As among technology-intensive firms (Gao and Sudarsanam 2003; Hitt et al. 1998; Kohers and Kohers 2000) and the gains from the acquisitions of privately held targets (Chang 1998; Faccio, McConnell and Stolin 2006; Fuller, Netter and Stegemoller 2002) can increase the market value of the acquirer.

This paper investigates whether the acquisitions of other technology firms enhance the stock market valuation of a technology acquirer's existing R&D spending. Based on earlier literature, we argue that one important objective of technology M&As is to strengthen the existing R&D activities of the acquirer through technological synergies between the acquirer and target (Higgins and Rodriguez 2006). This in turn increases the expected future profitability of the existing R&D activities of the acquirer, which increases its market value (e.g. Gao and Sudarsanam 2003; Hitt, Harrison and Ireland 2001; Kohers and Kohers 2000). Consistent with this view, we hypothesize that the positive relation between the firm's market value and its R&D spending reported in many earlier studies (e.g. Booth et al. 2006; Jaffe 1986; Lev and Sougiannis 1996) is enhanced when a technology firm acquires another technology firm, but not when it

[1] Other strategic goals of M&As include serving as a platform for corporate growth, gaining market share, and reducing organizational expenses by eliminating duplication in operations and transferring knowledge.

[2] Sudarsanam (2003) provides an extensive list of studies examining the effects of M&As on the acquiring firm market value.

acquires a non-technology firm. We also hypothesize that the stock market valuation of R&D spending in technology M&As depends on the relatedness of the technologies of the acquirer and target (e.g. Maquieira, Megginson and Nail 1998). Our paper contributes to the literature on the stock market valuation of the R&D spending of the firm by exploring the role of M&As in the observed positive market response to R&D spending. We also contribute to the literature on the M&As by examining whether the increased value creation of R&D spending of the acquirer explains the previously observed increase in the market value of the acquirer in technology M&As (Gao and Sudarsanam 2003; Kohers and Kohers 2000).

We perform empirical analyses of 1 701 M&As with a technology U.S. acquirer during the period 1990-2004. Consistent with our hypotheses, the results show that the positive stock market response to a firm's R&D expenditures significantly increases in technology M&As but not in non-technology M&As. We also find that the market response to the R&D spending is a curvilinear function of the technological relatedness of an acquirer and a target firm. In addition, our results show that technology M&As enhance the ability of an acquirer to translate its R&D spending to future financial performance. Finally, consistent with the earlier studies (e.g. Hitt, Hoskisson and Ireland 1990; Hitt et al. 1991) we find that firms cut their own R&D investments when acquiring technology targets. In summary, our results show that investors regard an acquirer's one dollar investment in R&D worth of more due to the technology M&A, even though the acquirer cuts its R&D spending in connection with the M&A. All these results are robust for different alternative specifications of our model and when controlling for several firm differences.

The remainder of the paper is structured as follows. Section 2 reviews the relevant literature and develops our hypotheses. Section 3 describes our data. Section 4 and

Section 5 describe our research method and report the empirical results together with the robustness tests. Section 6 concludes.

2. Hypothesis development

There is a significant body of literature investigating the stock market valuation of the R&D expenditures the firm. Generally, the results of this literature show that there is a positive market response to the R&D spending. In other words, investors see the R&D spending as a value-creative investment of the firm. For instance, many studies report that various R&D based measures can explain and predict long-run stock returns and operating performance of the firm (e.g. Booth et al. 2006; Chan, Lakonishok and Sougiannis 2001; Eberhart, Maxwell and Siddique 2004; Lev and Sougiannis 1996). In a similar vein, many studies find a positive short-run reaction of stock prices to announcements concerning R&D activities (e.g. Chan, Martin and Kensinger 1990; Doukas and Switzer 1992; Woolridge and Snow 1990).

Despite the extensive research on the stock market valuation of the R&D spending of the firm, there are no published papers investigating how M&As affect investors' opinions regarding the value of the existing R&D spending of the firm. However, M&As provides especially technology firms with a mean to acquire new innovations to supplement their existing technological capital stock and, consequently, to enhance their existing R&D activities. Earlier research on the stock market response to M&As reports that, on average, M&As create value losses or insignificant gains for acquiring firm shareholders (e.g Bradley, Desai and Kim 1988; Franks, Harris and Titman 1991; Loderer and Martin 1992; Moeller, Schlingemann and Stulz 2005). However, some studies report that M&As increase the market value of the acquirer, if the target is a

private firm, the acquirer is a small in size and, more importantly, if M&A is expected to generate technology-specific synergies.

For example, Chang (1998), Fuller, Netter and Stegemoller (2002), Draper and Paudyal (2006) and Faccio McConnell and Stolin (2006) find that the acquisitions of private firms outperform the acquisitions of public targets. Draper and Paudyal (2006) explain these findings to occur because of the illiquid markets for privately held companies, and because managers who prefer to maximize the size of the firm tend to pay high premiums for large listed targets but not for private targets[3]. In addition, Moeller, Schlingemann, and Stulz (2004) find that acquirer's stock return is roughly two percentage points higher for small acquirers than for large acquirers. They conclude that small acquirers may gain more from acquisitions by increasing their scale and by decreasing their default risk.

Chesbrough (2003) and Higgins and Rodriquez (2006) maintain that technology M&As increase the market value of the acquirer as they generate technology-specific synergies by improving and supplementing acquirer's existing R&D activities.[4] Chesbrough (2003) reports that M&As are an important method to fill acquirer's research gaps in a timely manner. Higgins and Rodriguez (2006) report that value gains arise in technology M&As, because the acquiring and target firms can create technology-specific synergies by combining their existing technologies[5]. Similar results are also reported by Ahuja and Katila (2001) who find that when the acquirer and the target combine their R&D efforts, the productivity of the joint R&D activities can

[3] These explanations are consistent with those of the imperfect markets of privately held firms suggested by Giliberto and Varaiya (1989), Varaiya (1988) and Varaiya and Ferris (1987).
[4] In addition, Kohers and Kohers (2000) argue that high technology targets create value for acquirers, because they possess desirable growth opportunities and since investors recognize the growth benefits resulting from the M&A.
[5] In addition, the so-called diversification research has examined whether the acquirers of related or non-related targets perform better. A common finding in this literature is that diversified firms tend to have a market value significantly below that of portfolios of matched, single-business firms (Berger & Ofek 1995; 1996; Denis, Denis and Sarin 1997).

increase. They conclude that the increased productivity of the R&D may be due to the firms' ability to choose the best of the two organization's R&D persons in every R&D task or the external influences and fresh perspectives that the target firm's R&D can bring to the acquirers' existing R&D activities.

The above-mentioned arguments are consistent with the so-called synergy theory suggested by Bradley et al. (1983; 1988). They posit that '*the acquisition of control over the target enables the acquirer to redeploy the combined assets of the two firms toward higher-valued uses*'. The value created in the combination of technologies may result from any value-creating mechanism that fall under the general rubric of corporate synergy. Consistent with this view, Hitt et al. (2001) maintain that private synergies arise when two firms combine their complementary resources in a way that creates more value than would any other combination of the resources of the two firms. They suggest that when both firms are committed to the pursuit of R&D, the new combined firm can create more value through its R&D activities than could be generated through the independent R&D activities of an acquirer and a target.

In addition to providing technology-specific synergies, acquisitions of technology targets can even substitute for a firm's own internal R&D. For instance, Hitt et al. (1991) find that M&As can have a negative impact on the R&D intensity of the firms involved. Pollak (1989) report that firms that had undergone M&As or other restructurings in the previous three years cut their R&D expenditures, while the other firms increase their R&D spending. Even if acquisitions were used as substitutes for the acquirer's own internal R&D, the joint effect of the acquired and internal R&D on the acquirer's performance can be higher than if the acquirer would have performed its research only internally. Higgins & Rodriguez (2006) find support for this proposition

by reporting that the acquisitions of biopharmaceutical firms appear to supplement effectively a firm's internal R&D efforts.

Finally, Gao and Sudarsanam (2003) find that M&As involving two technology firms create significantly more value than acquisitions where only one of the firms is technology-intensive. While a non-technology firm may buy a technology firm in order to acquire the growth opportunities of the target firm to the joint firm, it may not have the absorptive capabilities to create additional value from the combination (Cohen and Levinthal 1990; Higgins and Rodriguez 2006). Therefore, the acquiring firm should have a comprehensive internal research program, which the target firm's growth options can supplement (Cohen and Levinthal 1990; Higgins and Rodriguez 2006).

Based on the preceding discussion, we hypothesize that the positive stock market response to the R&D spending of the firm reported in earlier studies (e.g. Lev, Sarath and Sougiannis 1999; Lev and Sougiannis 1996, 1999; Aboody and Lev 2000 and Booth et al. 2006) is enhanced in technology M&As but not in non-technology M&As.

Hypothesis 1a: Acquisitions of technology firms enhance the stock market valuation of the existing R&D spending of the acquiring firm

Hypothesis 1b: Acquisitions of non-technology firms do not enhance the stock market valuation of the existing R&D spending of the acquiring firm.

Hitt, Harrison and Ireland (2001) argue that M&As provide synergies and enhance performance most, if the resources of the acquirer and target firms are mutually supporting each others. They maintain that combining complementary rather than highly similar resources increases the probability that economic value will be created, because firms with highly similar resources also have highly similar capabilities and vulnerabilities in the markets. Consistent with this view, Ahuja and Katila (2001) find

that the relationship between relatedness and performance in technology acquisitions is non-linear. If the technologies of the acquirer and target are too closely related, they may not learn as much from each other as less related firms. Similarity can also cause internal friction between the research teams causing inferior R&D performance. While overlaps in a merger may increase the potential for cost savings (e.g. Healy, Palepu and Ruback 1992), cost synergies are commonly not the main driver of performance in technology acquisitions.

In summary, by building on the research streams above, we hypothesize that in technology M&As, the effect of the relatedness of an acquirer and a target to the stock market valuation of the R&D spending of the acquirer is curvilinear. In other words, the stock market valuation of the R&D spending of acquiring firms increases with the degree of the relatedness of the acquiring and target firms until the optimal degree of relatedness has been achieved. After that level, the stock market valuation of the R&D spending of the acquiring firms begins to decrease as the operation of the acquirer and the target are too similar. Formally stated:

Hypothesis 2: *In technology M&As, the stock market valuation of the acquirers' R&D spending is curvilinearly (inverted U) related to the degree of the relatedness of the acquirer and the target.*

3. Data environment and preliminary data analysis

We retrieve data from the Thomson SDC and Worlscope databases for all M&As with a U.S. technology acquirer during the period of 1990–2004. Following Dessyllas and Hughes (2005), we define technology acquirers as those having the primary

business sector in a technology-intensive industry according to the OECD two-digit SIC code classification[6]. We define M&As as transactions where the acquirer owns less than 50 per cent of the voting shares of the target firm prior to the M&A and increases its ownership to at least 50 per cent after the M&A[7]. We include M&As with targets of all size, but we control for the potential effect of the size of the target relative to that of the acquirer in our empirical analyses. Furthermore, if the firm has acquired several firms within one year (Fuller, Netter and Stegemoller 2002), we include only the M&As with the largest target into our sample[8]. We divide the sample into two sub-samples based on whether the target is from a technology-intensive industry sector. The first sub-sample containing technology targets is referred to as a sub-sample of *technology M&As*. This sub-sample consists of 18 591 firm-year observations from 1 466 M&As. The sub-sample containing non-technology targets is referred to as *non-technology M&As*, and it contains 3 080 firm-year observations from 235 M&As.

(Insert Table 1 about here)

Table 1 reports the distribution of the M&As in both sub-samples over the sample period and summary statistics on the M&As. The results show that the number of technology M&As has steadily increased during the sample period. This is consistent with Sudarsanam (2003) who report that there is a peak in the number of U.S. M&As in the late 1990s and in the beginning of 2000. We also compare the ratio of the R&D expenditures to the book value of equity in years around the technology and non-technology M&As. These results (not reported in the table) indicate that in the sample

[6] The two-digit SIC codes regarded as technology-based are 28, 35, 36, 37, 38, 48, 73 and 87.
[7] The data for the acquirer has to be available at least for the year of the transaction as well as for one year before and after the transaction.
[8] We have also estimated all the models without this restriction and the results remain similar to those reported in tables.

of technology M&As, on average, acquirer's R&D spending decreases in the year of the M&A and again increases to the normal level in the year after the M&A. This pattern is not observed in the sample of non-technology M&As. These findings are consistent with the prior literature reporting that the R&D-intensity of the acquirer declines in the case of technology M&As (Hitt et al. 1991). In addition, Deng and Lev (1998) suggest that the benefits of the acquired R&D begin to show up a year after the consummation of the acquisition, which is in line with the observed increase in acquirer's R&D activity one year after the acquisition. In Section 5.6.3., we perform additional analyses on the change in the R&D spending and earnings of the acquirer in years around the M&As.

Finally, Table 2 reports summary statistics of the variables used in the regressions[9]. These results show that firms acquiring other technology firms invest more on R&D activities, show higher stock market valuation and lower earnings than firms acquiring non-technology targets. In addition, the results indicate that non-technology M&As are relatively more often cross-border transactions as compared to technology M&As. The results in Table 2 also show that firms acquiring technology targets conduct more acquisitions during the three years before the year of the acquisition in question than firms acquiring non-technology targets.

(Insert Table 2 about here)

4. Research design

We test our hypothesis by estimating the following OLS regression model from our data:

[9] T-test (not reported in tables) shows that all of the mean values of the variables of the two samples are significantly different from each other, except for the relative size of the target and the acquirer.

$$\frac{P_{it}}{BV_{it}} = \beta_0 + \beta_1 \frac{RD_{it}}{BV_{it}} + \beta_2 \frac{E_{it}}{BV_{it}} + \beta_3 M\&A_{it} + \beta_4 \frac{RD_{it}}{BV_{it}} \times M\&A_{it} + \beta_5 TA_{it} + \beta_6 DEALS_{it} + \beta_7 SIZE_{it} + \beta_8 TFOR_{it} + \sum_{y=1990}^{2004} \lambda_{i,y} YEAR_y + \varepsilon_{it}, \quad (1)$$

where P_{it} is the market value of equity for acquirer i in year t; BV_{it} is the book value of equity for acquirer i in year t; RD_{it} is the research and development expenditures for acquirer i in year t; E_{it} is the earnings for acquirer i in the year t; $M\&A_{it}$ is a dummy variable with a value of one for the year of the M&A, otherwise zero; TA_{it} is the total asset for acquirer i in the year of the M&A; $DEALS_{it}$ is the number of M&As that the acquirer has conducted during the three years prior to the year of the M&A; $SIZE_{it-1}$ is the net sales of the target firm divided by the net sales of acquirer i in year t-1; $TFOR_{it}$ is a dummy variable with a value of one if the target is a non-US firm, otherwise zero; and $YEAR_y$ is a dummy variable having a value of one in year y, otherwise zero.

In order to control for annual variation in the dependent variable, we include yearly dummy variables in Model (1). In addition, we use several control variables in the model to control for the effect of other factors potentially affecting the value relevance of R&D spending in connection with M&As. First, we include total assets of the acquiring firm ($TA_{i,t}$) in the model, because the size of the acquirer can potentially affect both value creation and acquisition performance. As Adam and Goyal (2006) argue, larger firms have more resources to benefit from the acquired R&D and they are better equipped for the accumulation of R&D related knowledge and capabilities. Analysts and investors also analyze more intensively large firms than small firms (e.g. Booth et al. 2006). On the other hand, Eckbo and Thorburn (2000) and Moeller, Schlingemann and Stulz (2004) report that abnormal stock returns of the acquirer

decrease with the size of the acquirer. Moeller, Schlingemann and Stulz (2004) explain this finding with managers of large firms paying more for acquisitions, leading to no synergies from the acquisitions.

Second, we include in our model the variable $DEALS_{i,t}$, i.e. the number of acquisitions that an acquirer has conducted during the three years prior to the year of the M&A. The previous M&A experience of the acquirer may affect the extent to which the stock market perceives gains arising from the acquired R&D activities (Fuller, Netter and Stegemoller 2002; Haleblian and Finkelstein 1999). The greater the acquisition experience, the more successful the acquirer is in integrating the acquired resources to its own business and achieving synergies. Firms having recent M&A experience may also already be in a fluid state and be more easily adaptable to changes required by the new acquisition (Hitt, Harrison and Ireland 2001). On the other hand, Higgins and Rodriguez (2006) find that firms have negative abnormal stock returns if they engage in an M&A within three years prior to the current acquisition. They suggest that the market is penalizing firms that engage in multiple technology acquisitions during a short time period, because this behaviour may indicate that these firms have weak internal R&D programs.

Third, earlier studies report that target firms that are large relative to their acquirers are able to provide greater synergies in M&As than small targets can (e.g. Asquith, Bruner and Mullins 1983; Kohers and Kohers 2000). In addition, Jarrell and Poulsen (1989) report that the abnormal stock return of the acquirer increases with the ratio of the size of the target to the size of the acquirer. Therefore, we include in our model the variable $SIZE_{it}$, i.e. the ratio of the net sales of the target firm to the net sales of the acquirer in the last year prior the M&A.

Fourth, we include in the model a dummy variable having a value of one if the target is a non-U.S. firm and, otherwise zero ($TFOR_{it}$). Some studies report that M&As in which the acquirer and the target are from different countries may lead to superior post-acquisition performance (Seth, Song and Pettit 2002; Weber and Camerer 2003). Hoecklin (1995) argues that international acquisitions may have a positive effect in particular on an acquirer's innovation performance, because international acquisitions may force the acquirer to rethink its R&D strategy in a more international context. In addition, intangible assets can create synergies in multinational firms, and these synergies translate into shareholder value by internalizing the international M&As of these firms (e.g. Caves 1982; Moeller and Schlingemann 2005). It is, however, evident that cross-border M&As are often more challenging to complete successfully than M&As between the domestic firms are. Eckbo and Thorburn (2000) argue that domestic acquirers may outperform the foreign ones, because domestic acquisitions tend to involve more closely related acquirers and targets. Supporting this view, Moeller and Schlingemann (2005) report significantly lower returns for cross-border than for domestic acquisitions.

5. Empirical results

5.1. The effect of technology-related and non-technology related M&As on the stock market valuation of the acquirer's R&D spending

Table 3 reports the results of estimating Model (1). Panel A of Table 3 reports the results for the sub-sample of technology M&As, whereas panel B of Table 3 reports the

results for sub-sample of non-technology M&As[10]. The results indicate that the estimated parameter for the variable $RD/B_{it} \times M\&A_{it}$ is significantly positive in the sub-sample of technology M&As, but it is insignificant in the non-technology M&As. These findings support our *Hypotheses 1a* and *1b*, that is, M&As between two technology firms enhance the stock market valuation of R&D spending of the acquiring firm, but the M&As with only an acquirer as a technology firm do not.

The results reported in Table 3 also confirm the findings of many earlier studies (Chan, Martin and Kensinger 1990; Lev and Sougiannis 1996) that there is a significantly positive relation between the stock market value and R&D spending of the firm, that is, investors regard R&D spending as a value-creating investment rather than a cost. This significance holds in all three of our model specifications. In addition, the estimated parameter for the E_{it}/B_{it} is significantly positive in all cases confirming the results of the value-relevance of earnings reported in earlier studies (e.g. Ball and Brown 1968; Beaver 1968; Collins and Kothari 1989).

Finally, Table 3 shows that the estimated parameter for the dummy variable M&A is marginally significant in column (2) of panel A (p=0.092). This result is in line with Kohers and Kohers (2000) who find that acquires of technology-intensive targets tend to experience a positive market reaction. However, the estimated parameter for the dummy variables $M\&A_{it}$ is insignificant in column (3) where the interaction variable $RD_{it}/B_{it} \times M\&A_{it}$ is included in the model. This indicates that Kohers and Kohers' (2000) results on the positive stock market response to acquirers of technology targets comes via the value creation of R&D spending of the acquirer.

(Insert Table 3 about here)

[10] In order to save space, we do not report the estimated parameters for the yearly dummy variables. All these parameters were significant supporting the control of yearly variation in the dependent variable.

5.2. Stock market valuation of the acquirer's R&D spending after controlling for the effect of the firm-specific factors

Table 4 reports the results of estimating Model (1) for the technology M&As after controlling for the characteristics of the acquirer and target firms.[11] Characteristics that we are controlling for are the relative size of the target firm ($SIZE_{it}$), the absolute size of the acquirer (TA_{it}), the nationality of the target ($TFOR_{it}$) and the number of deals the acquirer has conducted in the three years prior to the year of the acquisition ($DEALS_{it}$), respectively. The results indicate that the estimated parameter for the variable $RD_{it}/B_{it} \times M\&A_{it}$ is statistically significantly positive in all model specifications, that is, the results reported in panel A of Table 3 remain the same even after controlling for the effect of these characteristics of acquirer and target firms. In other words, these findings support our *Hypothesis 1a*. Regarding the effect of the control variables on the value relevance of R&D expenditures, only the absolute size of the acquirer (TA_{it}) has a significant albeit weak negative effect on the value relevance of acquirer's R&D in the year of the acquisitions. The observed negative effect of the size of acquirer on the value creation of R&D spending in technology M&As is consistent with the findings by Moeller, Schlingemann and Stulz (2004).

Panel B of Table 4 reports the results of estimating Model (1) for non-technology M&As after controlling for the characteristics of the acquirer and target firms. The estimated parameter for the variable $RD_{it}/B_{it} \times M\&A_{it}$ is insignificant or even significantly negative in two cases, that is, these results are similar to those reported in panel A of Table 4 therefore supporting our *Hypothesis 1b*.

[11] In order to save space, Table 4 shows the results of using the control variables one at a time in the regressions. We also estimate Model (1) such that we use all control variables in the model. Results for this regression are materially similar to those reported in Table 4.

(Insert Table 4 about here)

5.3. The degree of relatedness between the acquirer and target firms

Our *Hypothesis 2* predicts that M&As between technology firms enhance the stock market valuation of R&D spending of the acquiring firm, if the operations of the two firms are related, but not if their operations are too similar. We test this hypothesis by first dividing the sub-sample of technology M&As into three categories based on the degree of the relatedness of an acquirer and a target, and then estimating Model (1) in these three categories. Following earlier studies (e.g. Agrawal, Jaffe and Mandelker 1992; Eckbo and Thorburn 2000; Vijh and Yang 2006), we measure the degree of relatedness of an acquirer and a target firm based on the similarity of the SIC codes of the firms. More specifically, operations of the acquirer and the target firm are highly related or similar, if all four digits of their SIC codes are the same. Accordingly, operations of the acquirer and the target firm are only weakly related, if none or only the first digit of their SIC codes are the same[12]. Between the above mentioned two categories are the acquirer and the target firms for which the 2-digit or 3-digit SIC codes are the same, indicating that the operations of the two firms are moderately related[13].

The results reported in Table 5 show that the estimated parameter for the variable $RD_{it}/B_{it} \times M\&A_{it}$ is significantly positive for the weakly and, especially, for the moderately related technology M&As, but not for highly related, i.e. similar technology M&As. In other words, the stock market valuation of acquirer's R&D spending

[12] Note that even if none of the digits of the SIC codes of the acquirer and target are the same, the operations of the two firms are complementary because both firms are operating in a technology industry.
[13] Gao and Sudarsanam (2003) use the approach in determining the different degrees of relatedness except that they use SDC high tech industry classification.

increases with the degree of relatedness until the level of moderate relatedness between an acquiring and a target firm. After that level, M&As do not enhance the stock market valuation of acquirer's R&D spending. These results support our *Hypothesis 2*, that is, the effect of the relatedness of the operations of an acquirer and a target to the stock market valuation of the R&D spending of the acquirer is curvilinear in technology M&As.

(Insert Table 5 about here)

5.4. R&D spending and future real financial performance of the acquirer

Our hypotheses on the enhanced value-creation of R&D spending of the acquiring firm in the case of technology M&A has an implication to the subsequent financial performance of the acquirer, because stock price is a function of future cash-flows of the firm. An increase in the ability of an acquirer to utilize R&D activities in its business operations should increase not only the stock price but also the future cash flows of the acquirer. The relation between the R&D spending and future cash flows of the firm is obviously very complex, since the R&D spending in a given year is likely to affect the cash flows of the firm in many subsequent years and the cash flow of the firm in a given year is likely to be affected by the R&D spending in many previous years. In other words, it is not possible to isolate the effect of the R&D spending in each year on the firm's cash flows in the future years. Therefore, we take the approach used in many earlier studies investigating the effect of R&D on the future operating performance of the firm (e.g. Lev and Sougiannis 1996). We regress the operating cash flow of the firm in a given year on the lagged R&D spending of the firm from several years. Since we

assume that the M&A activity of the firm enhances the relation between the R&D spending and future performance of the firm, the model also includes interaction variables between the R&D spending of the firm and the number of technology and non-technology M&As by technology and non-technology acquirers, respectively, during the sample period. Thus, we estimated the following OLS regressions:

$$\frac{OI_{it}}{BV_{it}} = \beta_0 + \sum_{k=1}^{5} \eta_{i,k} \frac{RD_{i,t-k}}{BV_{i,t-k}} + \sum_{k=1}^{5} \gamma_{i,k} \frac{RD_{i,t-k}}{BV_{i,t-k}} \times ALLDEALS_i + \varepsilon_{it}, \quad (2)$$

where OI_{it} is the operating income before depreciations, amortizations and R&D expenditures for acquirer i in the year t; BV_{it} is the book value of equity for acquirer i in year t; $RD_{i,t-k}$ is the R&D expenditures for acquirer i in the year t-k, where $k \in \{1, 2, 3, 4, 5\}$; and $ALLDEALS_i$ is the number of all M&As the acquirer has conducted during the sample period. Since many firms acquire both technology and non-technology targets and we want to isolate the effects of these two types of M&As on the future performance of the firm, we estimate Model (2) separately for those firms that have acquired only technology firms and for those firms that have acquired only non-technology firms.

The results from estimating Model (2) are reported in Table 6. The results show that with one execption, the estimated parameters for the interaction variables $RD_{it-k}/BV_{it-k} \times ALLDEALS_i$ are significantly positive for those firms that have acquired only technology targets (column 2 of Table 6). In other words, the more technology M&As these acquirers have made during the sample period, the more the past R&D spending of the acquirers enhances their future financial performance. A similar phenomenon is not observed in the case of firms that have acquired only non-technology targets

(column 4 of Table 6). In addition, the results reported in column 1 of Table 6 show that the past R&D spending of the firms that have acquired only technology targets is positively, albeit not significantly, related to the future financial performance of the acquirer. In the case of the firms that have acquirerd only non-technology targets (panel 3 of Table 6), the past R&D spending is negatively related to the future performance of the acquirer with significant parameter estimates for R&D spending lagged by four and five years. In summary, the results reported in Table 6 indicate that technology M&As enhance the ability of an acquirer to translate its R&D spending to better operating performance. This finding is in line with the predictions of our *Hypotheses 1a* and *1b*.

(Insert Table 6 about here)

5.6. Robustness checks and additional analyses

5.6.1. Alternative model specifications

We begin our robustness checks of the results by using alternative specifications of Model (1). First, we estimate Model (1) by using a stock return rather than the ratio of market equity to book equity as a dependent variable, because this so-called returns model is also frequently used in the earlier literature (e.g. Lev and Sougiannis 1999). Second, we estimate Model (1) such that we do not divide any of the variables by the book value of equity, because as Kothari and Zimmerman (1995) point out, estimated parameters in the deflated models can be biased. This bias can be mitigated by using the un-deflated variables in regressions. Third, we estimate Model (1) such that we add the lagged dependent variable, i.e. the ratio of market value of equity to book value of

equity, as an additional independent variable into the model. This model specification takes into account a potential auto-regressive pattern in the dependent variable. More specifically, we estimate the following three OLS regressions from our data[14]:

$$R_{it} = \beta_0 + \beta_1 \frac{RD_{it}}{BV_{it}} + \beta_2 \frac{E_{it}}{BV_{it}} + \beta_3 M\&A_{it} + \beta_3 \frac{RD_{it}}{BV_{it}} \times M\&A_{it} + \sum_{y=1990}^{2004} \lambda_{iy} YEAR_y + \varepsilon_{it}, \quad (3)$$

$$\frac{P_{it}}{BV_{it}} = \beta_0 + \beta_1 \frac{P_{it-1}}{BV_{it-1}} + \beta_2 \frac{RD_{it}}{BV_{it}} + \beta_3 \frac{E_{it}}{BV_{it}} + \beta_4 M\&A_{it} + \beta_5 \frac{RD_{it}}{BV_{it}} \times M\&A_{it} + \sum_{y=1990}^{2004} \lambda_{iy} YEAR_y + \varepsilon_{it}, \quad (4)$$

$$P_{it} = \beta_0 + \beta_1 RD_{it} + \beta_2 E_{it} + \beta_3 M\&A_{it} + \beta_4 RD_{it} \times M\&A_{it} + \sum_{y=1990}^{2004} \lambda_{iy} YEAR_y + \varepsilon_{it}, \quad (5)$$

where R_{it} is the annual stock return for acquirer i in year t. All other variables are as described in Model (1).

The results from estimating the Models (3) – (5) are reported in Table 7. The results indicate that the estimated parameter for the interaction variables $RD_{it}/B_{it} \times M\&A_{it}$ and $RD_{it} \times M\&A_{it}$ are significantly positive in the case of technology M&As, but insignificant in the case of non-technology M&As. These findings confirm our earlier findings, that is, they support our *Hypotheses 1a* and *1b*. In other words, M&As of technology firms enhance the stock market valuation of the R&D spending of the acquiring firm, but the M&As of non-technology firms do not.

[14] In addition, we estimate all these three models such that the models include the same firm-specific control variables as in Model (1). Results of these regressions are materially similar to those reported in Table 7.

(Insert Table 7 about here)

5.6.2. Possible delayed stock market response to M&A

Several earlier studies (e.g. Bernard and Thomas 1990) report that stock prices may adjust to the value-relevant information such as earnings figures with a delay. Similarly, (Eberhart, Maxwell and Siddique 2004) report slow stock market reactions after economically significant increases in the R&D spending of the firm. Thus, it is also possible that the observed increase in the value relevance of the R&D spending of the acquirer in the year of the M&A is partly delayed to the year after the M&A. This would especially be the case, if the M&A is announced at the end of the year. We explore this possibility by adding an additional dummy variable for the year after the M&A year in Model (1). We also add an interaction variable constructed by multiplying this dummy with the R&D spending of the firm in the model. These two variables capture the stock price response and the value creation effects of R&D spending in the year after the M&A. Results of this regression (not reported in tables) indicate no significant delayed reaction in stock price or value relevance of the R&D spending.

5.6.3. Changes in R&D spending and earnings around M&A

We also investigate whether the R&D spending and financial performance of the acquirer change around the year of the M&A as reported in earlier studies (e.g. Hitt, Hoskisson and Ireland 1990; Hitt et al. 1991). Therefore, we estimate the following OLS regressions:

$$\frac{E_{it}}{BV_{it}} = \beta_0 + \beta_1 BEFORE_{it} + \beta_2 M\&A_{it} + \beta_3 AFTER_{it} + \sum_{y=1990}^{2004} \lambda_{iy} YEAR_y + \varepsilon_{it}, \quad (6)$$

$$\frac{RD_{it}}{BV_{it}} = \beta_0 + \beta_1 BEFORE_{it} + \beta_2 M\&A_{it} + \beta_3 AFTER_{it} + \sum_{y=1990}^{2004} \lambda_{iy} YEAR_y + \varepsilon_{it}, \quad (7)$$

where $BEFORE_{i,t}$ is a dummy variable having a value of one for the year prior to the M&A, otherwise zero and $AFTER_{i,t}$ is a dummy variable having a value of one for the year after to the M&A, otherwise zero. All other variables are as described in Model (1).

The results of estimating Models (6) and (7) are reported in Table 8. They show that in the case of technology M&As, there is a significant decline in the R&D spending and earnings of the acquirer in the year of the M&A. However, a similar decline is not observed in the case of non-technology M&As. These results are consistent with the earlier studies according to which firms cut their own R&D investments when acquiring technology targets (e.g. Hitt, Hoskisson and Ireland 1990; Hitt et al. 1991). In addition, the results are consistent with the earlier research reporting that the earnings of the acquirer decrease in the year of the M&A most likely because the acquirer expenses the in-process R&D of the target firm.

More importantly, the results reported in Table 8 together with those reported in Tables 3 and 4 show that, in the year of the M&A, the stock market valuation of the R&D spending of the acquirer increases even though the acquirer actually cuts its R&D spending. In other words, the acquirer's one dollar investment in R&D is worth of more in the year of the M&A than in other years. This clearly shows that the increased stock market valuation of the R&D spending of the acquirer in the year of the M&A is

because investors regard the R&D spending more valuable due to the M&A – not e.g. simply because of the increased level of the R&D.

(Insert Table 8 about here)

5.6.4. Results for the firms that have acquired both technology and non-technology targets

As a final robustness check of the results, we combine the sub-samples of technology and non-technology M&As that we have used in our previous analyses. In the combined sample, we select firms that have acquired both technology and non-technology targets[15]. In this sub-sample, the potential bias in the results arising from uncontrolled differences in the characteristics of the acquirer is minimized, because the technology and non-technology M&As are now made by the same firms. We estimate Model (1) for this sub-sample and the results are similar to those reported in previous tables. In the case of technology M&As, the stock market valuation of the acquirer's R&D spending increases in the year of the M&A. In the case of non-technology M&As, the stock market valuation of the acquirer's R&D spending actually decreases strongly.

6. Conclusions

This paper investigates whether the acquisitions of technology firms enhance the value creation of a technology acquirer's existing R&D spending. We maintain that technology M&As strengthen the existing R&D activities of the acquirer through

[15] The data include at least one technology and at least one non-technology M&A for each acquirer.

technological synergies between the acquirer and target (e.g. Higgins and Rodriguez 2006). Consequently, the expected future profitability of the existing R&D activities of the acquirer increases (e.g. Hitt, Harrison and Ireland 2001), which in turn results in the increased market value of the acquirer (e.g. Gao and Sudarsanam 2003; Kohers and Kohers 2000). Therefore, we hypothesize that the positive relation between the firm's market value and its R&D spending reported in earlier studies (e.g. Booth et al. 2006; Jaffe 1986; Lev and Sougiannis 1996) is enhanced when a technology firm acquires another technology firm, but not when it acquires a non-technology firm. We also hypothesize that the value creation of R&D in technology M&As depends on the relatedness of the technologies of the acquirer and target. Our paper contributes to earlier studies on the stock market valuation of the R&D spending of the firm by exploring the issue in the context of M&As (e.g. Booth et al. 2006; Jaffe 1986; Lev and Sougiannis 1996). We also contribute to the literature on the M&As by exploring whether the increased value creation of R&D spending of the acquirer explains the previously observed increase in the market value of the acquirer (e.g. Gao and Sudarsanam 2003; Kohers and Kohers 2000).

Our empirical analyses show that the value creation effect of R&D spending of the acquirer is enhanced in technology M&As but not in non-technology M&As. A positive stock market valuation of the R&D spending is observed for the acquirer in the year of a technology M&A. The results remain the same even after controlling for acquirer's size, target's relative size, acquirer's past acquisition experience and the effect of acquisitions with a foreign (non-U.S.) target. Moreover, we find that technology M&As do not enhance the stock market valuation of the R&D spending of the acquiring firm, if the acquirer and the target firms are highly related. This finding supports our second hypothesis that technological relatedness moderates value creation in an inverted U-

shaped manner. We also find that technology M&As enhance the ability of an acquirer to translate its R&D spending to future financial performance. Finally, consistent with the earlier studies (e.g.Hitt, Hoskisson and Ireland 1990; Hitt et al. 1991) our results show that firms cut their own R&D investments when acquiring technology targets. This result indicates that the stock market valuation of the R&D spending of the acquirer increases in technology M&As, because investors regard an acquirer's R&D efforts more valuable due to the M&A – not e.g. simply because of the increased level of the R&D spending.

Our findings provide several interesting directions for future research. While we did not find any industry differences in the value creation through technology acquisitions, we would expect the different industries to differ from each other (Higgins and Rodriguez 2006). Future research could also develop more fine-grained measures of relatedness based on the patenting behaviour of the acquiring and target firms.

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Table 1

Distribution of M&As over the sample period.

	Type of M&A		
Year	Technology	Non-technology	All
1990	33	5	38
1991	31	12	43
1992	47	9	56
1993	59	25	84
1994	81	14	95
1995	87	17	104
1996	81	11	92
1997	123	28	151
1998	137	17	154
1999	108	12	120
2000	162	33	195
2001	143	20	163
2002	104	11	115
2003	121	9	130
2004	149	12	161
Total	1466	235	1701

Table 2

Descriptive statistics of the variables used in the regressions.

Variable	Mean	Standard deviation	Min	Max
Panel A: Technology M&As				
RD_{it}/BV_{it}	0.145	0.135	–0.515	1.248
P_{it}/BV_{it}	3.856	3.476	–3.116	28.938
E_{it}/BV_{it}	0.062	0.293	–2.823	1.278
$SIZE_{it}$	0.549	5.181	0.000	263.348
TA_{it}	7100	33046	0.204	570833
$TFOR_{it}$	0.209	0.406	0.000	1.000
$DEALS_{it}$	4.157	6.226	0.000	77.000
N	18591	18591	18591	18591
Panel B: Non-technology M&As				
RD_{it}/BV_{it}	0.096	0.103	–0.448	0.854
P_{it}/BV_{it}	3.117	2.643	–8.786	20.564
E_{it}/BV_{it}	0.091	0.248	–2.331	0.924
$SIZE_{it}$	0.826	10.092	0.000	444.076
TA_{it}	7070	38594	0.144	570833
$TFOR_{it}$	0.285	0.452	0.000	1.000
$DEALS_{it}$	3.514	4.345	0.000	29.000
N	3080	3080	3080	3080

Notes:

In technology M&As, both the acquirers and the target firms have their primary business sectors in technology-intensive industries. In non-technolgy M&As, the acquirers have their primary business sectors in technology-intensive industries, but the target firms are operating in other industries. Following e.g. Dessyllas and Hughes (2005), technology-intensive industries are defined based on the OECD two-digit SIC code classification. The variables are as follows: P_{it} is the market value of equity for acquirer i in year t; BV_{it} is the book value of equity for acquirer i in year t; RD_{it} is the research and development expenditures for acquirer i in year t; E_{it} is the earnings for acquirer i in the year t; and $SIZE_{it}$ is the net sales of the target firm divided by the net sales of acquirer i in year TA_{it} is the total asset for acquirer i in the year of the M&A; $TFOR_{i,t}$ is a dummy variable with a value of one if the target is a non-US firm, otherwise zero; and $DEALS_{i,t}$ is the number of M&As that the acquirer has conducted during the three years prior to the year of the M&A. N is the number of observations.

Table 3

Estimation results for technology and non-technology M&As

Variable	Expected sign	(1)	(2)	(3)
Panel A: Technology M&As				
Intercept		**1.251**	**1.246**	**1.270**
		(0.000)	**(0.000)**	**(0.000)**
RD_{it}/BV_{it}	+	**6.697**	**6.706**	**6.547**
		(0.000)	**(0.000)**	**(0.000)**
E_{it}/BV_{it}	+	**2.974**	**2.980**	**2.982**
		(0.000)	**(0.000)**	**(0.000)**
$M\&A_{it}$	+	-	0.149	–0.197
			(0.092)	(0.136)
$RD_{it}/BV_{it} \times M\&A_{it}$	+	-	-	**2.508**
				(0.000)
N		18591	18591	18591
Adj R^2		0.142	0.143	0.143
Panel B: Non-technology M&As				
Intercept	+	**0.822**	**0.821**	**0.799**
		(0.000)	**(0.000)**	**(0.000)**
RD_{it}/BV_{it}	+	**9.514**	**9.516**	**9.521**
		(0.000)	**(0.000)**	**(0.000)**
E_{it}/BV_{it}	+	**2.853**	**2.854**	**2.860**
		(0.000)	**(0.000)**	**(0.000)**
$M\&A_{i,t}$	–	-	0.052	0.322
			(0.751)	(0.152)
$RD_{it}/BV_{it} \times M\&A_{it}$	–	-	-	–2.845
				(0.081)
N		3080	3080	3080
Adj R^2		0.198	0.198	0.198

Notes:

The subscripts *i* and *t* denote respectively acquirer and year. The table displays the results of estimating Model (1) without the firm-specific control variables. P_{it}/BV_{it}, the market value of equity divided by the book value of equity for acquirer *i* in the year *t*, is the dependent variable. BV_{it} is the book value of equity for acquirer *i* in year *t*; RD_{it} is the research and development expenditures for acquirer *i* in year t; E_{it} is the earnings for acquirer *i* in the year *t*; and $M\&A_{it}$ is a dummy variable with a value of one for the year of the M&A, otherwise zero. P-values are reported in parentheses with 0.000 denoting a p-value of less than 0.0005. N is the number of observations used in the estimations.

Table 4

Estimation results for technology and non-technology M&As when controlling for the effect of other factors affecting the stock market valuation of R&D spending

Variable	Expected sign	X_{it} = $SIZE_{it}$	TA_{it}	$TFOR_{it}$	$DEALS_{it}$
Panel A: Technology M&As					
Intercept		**1.270**	**1.268**	**1.300**	**1.005**
		(0.000)	**(0.000)**	**(0.000)**	**(0.000)**
RD_{it}/BV_{it}	+	**6.548**	**6.529**	**6.525**	**6.440**
		(0.000)	**(0.000)**	**(0.000)**	**(0.000)**
E_{it}/B_{it}	+	**2.983**	**2.974**	**2.985**	**2.801**
		(0.000)	**(0.000)**	**(0.000)**	**(0.000)**
$M\&A_{it}$	+	–0.198	–0.193	–0.196	–0.157
		(0.136)	(0.145)	(0.139)	(0.238)
$RD_{it}/BV_{it} \times M\&A_{it}$	+	**2.454**	**2.695**	**2.579**	**2.820**
		(0.001)	**(0.000)**	**(0.000)**	**(0.000)**
X_{it}	+/–	–0.001	0.000	–0.110	**0.058**
		(0.864)	(0.102)	(0.065)	**(0.000)**
$RD_{it}/BV_{it} \times M\&A_{it} \times X_{it}$	+/–	0.122	–0.000	–0.535	–0.124
		(0.557)	(0.064)	(0.683)	(0.204)
N		18591	18591	18591	18591
Adj R^2		0.143	0.143	0.143	0.153
Panel B: Non-technology M&As					
Intercept		**0.793**	**0.783**	**0.888**	**0.625**
		(0.000)	**(0.000)**	**(0.000)**	**(0.000)**
RD_{it}/BV_{it}	+	**9.743**	**9.718**	**9.741**	**9.744**
		(0.000)	**(0.000)**	**(0.000)**	**(0.000)**
E_{it}/BV_{it}	+	**2.896**	**2.753**	**2.877**	**2.783**
		(0.000)	**(0.000)**	**(0.000)**	**(0.000)**
$M\&A_{it}$	+	0.273	0.302	0.331	0.317
		(0.224)	(0.179)	(0.144)	(0.158)
$RD_{it}/BV_{it} \times M\&A_{it}$	+	**–3.462**	**–3.210**	–2.601	–2.604
		(0.034)	**(0.049)**	(0.121)	(0.144)
X_{it}	+/–	0.002	**0.000**	**–0.334**	**0.048**
		(0.690)	**(0.000)**	**(0.001)**	**(0.000)**
$RD_{it}/BV_{it} \times M\&A_{it} \times X_{it}$	+/–	**2.140**	0.000	–1.865	–0.042
		(0.000)	(0.139)	(0.528)	(0.882)
N		3080	3080	3080	3080
Adj R^2		0.203	0.212	0.201	0.204

Notes:

The subscripts *i* and *t* denote respectively acquirer and year. The table displays the results of estimating Model (1). All the variables are as defined in Tables 2 and 3. P-values are reported in parentheses with 0.000 denoting a p-value of less than 0.0005. N is the number of observations used in the estimations.

Table 5

Estimation results for the three categories of technology M&As based on the degree of operational relatedness of an acquirer and a target firm.

Variable	Weakly related (0 or 1 digits)	Moderately related (2 or 3 digits)	Highly related (4 digits)
Intercept	**0.937**	**0.845**	**1.099**
	(0.000)	**(0.000)**	**(0.000)**
RD_{it}/BV_{it}	**5.677**	**8.280**	**6.669**
	(0.000)	**(0.000)**	**(0.000)**
E_{it}/BV_{it}	**2.073**	**3.102**	**3.482**
	(0.000)	**(0.000)**	**(0.000)**
$M\&A_{it}$	–0.057	–0.482	–0.027
	(0.764)	(0.062)	(0.906)
$RD/BV_{it} \times M\&A_{it}$	**3.181**	**7.794**	–0.307
	(0.003)	**(0.000)**	(0.802)
$SIZE_{it}$	0.004	–0.011	0.007
	(0.690)	(0.282)	(0.305)
$RD_{it}/BV_{it} \times M\&A_{it} \times SIZE_{it}$	0.147	0.137	0.448
	(0.684)	(0.596)	(0.472)
TA_{it}	**0.000**	**–0.000**	**–0.000**
	(0.000)	**(0.002)**	**(0.000)**
$RD_{it}/BV_{it} \times M\&A_{it} \times TA_{it}$	0.000	–0.000	**–0.000**
	(0.425)	(0.172)	**(0.000)**
$TFOR_{it}$	–0.329	–0.151	**0.233**
	(0.000)	(0.162)	**(0.039)**
$RD_{it}/B_{it} \times M\&A_{it} \times TFOR_{it}$	–1.577	–2.953	2.306
	(0.381)	(0.245)	(0.269)
$DEALS_{it}$	**0.052**	**0.061**	**0.084**
	(0.000)	**(0.000)**	**(0.000)**
$RD_{it}/B_{it} \times M\&A_{it} \times DEALS_{it}$	–0.127	–0.231	–0.036
	(0.301)	(0.395)	(0.855)
N	6585	5403	6599
Adj R^2	0.168	0.171	0.168

Notes:

The subscripts *i* and *t* denote respectively acquirer and year. The table displays the results of estimating Model (1). Following earlier studies (e.g. Agrawal, Jaffe & Mandelker 1992), we measure the degree of relatedness of the acquirer and the target firms based on the similarity of the SIC codes of the firms. More specifically, operations of the acquirer and the target firm are highly related or similar, if all four digits of their SIC codes are the same. Accordingly, operations of the acquirer and the target firm are not related, if none or only the first digit of their SIC codes are the same. Between the above mentioned two categories are the acquirer and the target firms for which the 2-digit or 3-digit SIC codes are the same, indicating that the operations of the two firms are related. All the variables are the same as in the Table 4. P-values are reported in parentheses with 0.000 denoting a p-value of less than 0.0005; N is the number of observations used in the estimations.

Table 6

The effect of the R&D spending on the profitability of the firms that have acquired either technology or non-technology targets.

Variable	Firms that have acquired only technology targets		Firms that have acquired only non-technology targets	
	(1)	(2)	(3)	(4)
Intercept	**0.217**	**0.206**	**0.198**	**0.211**
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**
RD_{it-1}/BV_{it-1}	0.004	–0.009	0.053	0.339
	(0.281)	(0.090)	(0.623)	(0.755)
RD_{it-2}/BV_{it-2}	**0.032**	0.011	–0.054	1.897
	(0.000)	(0.248)	(0.479)	(0.093)
RD_{it-3}/BV_{it-3}	0.000	0.002	–0.068	–1.137
	(0.964)	(0.574)	(0.267)	(0.230)
RD_{it-4}/BV_{it-4}	0.003	**–0.005**	**–0.115**	–1.383
	(0.129)	**(0.074)**	**(0.004)**	(0.101)
RD_{it-5}/BV_{it-5}	0.000	**–0.005**	**–0.139**	0.363
	(0.822)	**(0.064)**	**(0.003)**	(0.394)
$RD_{it-1}/BV_{it-1} \times ALLDEALS_i$	-	**0.007**	-	–0.293
		(0.002)		(0.787)
$RD_{it-2}/BV_{it-2} \times ALLDEALS_i$	-	**0.007**	-	**–1.946**
		(0.006)		**(0.083)**
$RD_{it-3}/BV_{it-3} \times ALLDEALS_i$	-	–0.002	-	1.063
		(0.419)		(0.259)
$RD_{it-4}/BV_{it-4} \times ALLDEALS_i$	-	**0.007**	-	1.267
		(0.001)		(0.132)
$RD_{it-5}/BV_{it-5} \times ALLDEALS_i$	-	**0.004**	-	–0.502
		(0.002)		(0.234)
N	4196	4196	269	269
Adj R^2	0.007	0.017	0.069	0.075

Notes:

The subscripts *i* and *t* denote respectively acquirer and year. The table displays the results of estimating Model (2).The dependent variable is operating income before depreciation and amortization and research and development expenditures; $ALLDEALS_i$ is the number of all M&As the acquirer has conducted during the sample period. All other variables are as defined in Tables 2 and 3. P-values are reported in parentheses with 0.000 denoting a p-value of less than 0.0005. N is the number of observations used in the estimations.

Table 7

Estimation results from using alternative regression model specifications

Variable	Expected sign	Returns model (Model 3)	AR-model (Model 4)	Un-deflated model (Model 5)
Panel A: Technology acquisitions				
Intercept		**–0.179**	**1.054**	**–1872**
		(0.000)	**(0.000)**	**(0.000)**
P_{it-1}/BV_{it-1}		-	**0.002**	-
			(0.000)	
RD_{it}/BV_{it} or RD_{it}	+	**0.246**	**6.736**	**8.439**
		(0.000)	**(0.000)**	**(0.000)**
E_{it}/BV_{it} or E_{it}	+	**0.282**	**3.217**	**17.072**
		(0.000)	**(0.000)**	**(0.000)**
$M\&A_{it}$	–	**–0.055**	–0.147	–190
		(0.024)	(0.262)	(0.444)
$RD_{it}/BV_{it} \times M\&A_{it}$ or $RD_{it} \times M\&A_{it}$	+	**0.491**	**2.558**	**3.023**
		(0.000)	**(0.000)**	**(0.000)**
N		16795	17260	18514
Adj R^2		0.156	0.148	0.785
Panel B: Non-technology acquisitions				
Intercept		**–0.246**	**0.659**	–1877
		(0.000)	**(0.002)**	**(0.000)**
P_{it-1}/BV_{it-1}		-	–0.000	-
			(0.604)	
RD_{it}/BV_{it} or RD_{it}	+	0.126	**9.416**	**12.346**
		(0.131)	**(0.000)**	**(0.000)**
E_{it}/BV_{it} or E_{it}	+	**0.258**	**2.972**	**19.470**
		(0.000)	**(0.000)**	**(0.000)**
$M\&A_{i,t}$	–	0.048	0.279	280
		(0.218)	(0.216)	(0.458)
$RD_{it}/BV_{it} \times M\&A_{it}$ or $RD_{it} \times M\&A_{it}$	+	–0.496	–1.516	**–3.838**
		(0.075)	(0.349)	**(0.010)**
N		2772	2858	3075
Adj R^2		0.174	0.194	0.895

Notes:

The subscripts i and t denote respectively firm and year. The table displays the results of estimating alternative specifications of Model (1). In the returns model, the dependent variable is the annual stock return of the acquirer i in the year t. In the AR-model, the dependent variable is P_{it-1}/BV_{it-1}, the one-year lagged market value of equity divided by the one-year lagged book value of equity for acquirer *i* in the year *t*. In the un-deflated model, the dependent variable is P_{it}, the market value of equity for acquirer *i* in the year *t*. All the other variables are as defined in Tables 2 and 3. P-values are reported in parentheses with 0.000 denoting a p-value of less than 0.0005. N is the number of observations used in the estimations.

Table 8

Earnings and R&D expenditures of the acquirer around the year of M&A.

Dependent Variable	Variable					
	Intercept	*BEFORE*	*M&A*	*AFTER*	N	Adj R^2
Panel A: Technology M&As						
E_{it}/BV_{it}	**0.103**	–0.001	**–0.034**	**–0.045**	18591	0.035
	(0.000)	(0.883)	**(0.000)**	**(0.000)**		
RD_{it}/BV_{it}	**0.142**	–0.007	**–0.011**	0.000	18591	0.005
	(0.000)	(0.053)	**(0.004)**	(0.953)		
Panel B: Non-technology M&As						
E_{it}/BV_{it}	**0.111**	–0.024	–0.016	**–0.051**	3080	0.020
	(0.000)	(0.161)	(0.338)	**(0.003)**		
RD_{it}/BV_{it}	**0.094**	–0.001	–0.005	0.001	3080	0.003
	(0.000)	(0.945)	(0.524)	(0.866)		

Notes:

The subscripts i and t denote respectively firm and year. The table displays the results of estimating Models (7) and (8). *BEFORE* is a dummy variable having a value of one if the observation is from one year before the year of the M&A, zero otherwise; M&A is the same as in previous tables; *AFTER* is a dummy variable having a value of one if the observation is from one year after the year of the M&A, zero otherwise. P-values are reported in parentheses with 0.000 denoting a p-value of less than 0.0005; N is the number of observations used in the estimations.