Stock Market Valuation, Profitability and R&D Spending of the Firm: The Effect of Technology Mergers and Acquisitions

JUHA-PEKKA KALLUNKI
University of Oulu, Department of Accounting and Finance
P.O. Box 4600, FI-90014 University of Oulu, Finland.

ELINA PYYKKÖ
University of Oulu, Department of Accounting and Finance
P.O. Box 4600, FI-90014 University of Oulu, Finland.

TOMI LAAMANEN
Helsinki University of Technology, Department of Industrial Engineering and Management, P.O.Box 5500, FI-02015 TKK, Finland

Contact Address:
Juha-Pekka Kallunki, Department of Accounting and Finance, University of Oulu, P.O. Box 4600, FI-90014 University of Oulu, Finland. Phone: (+358) 8 553 2956. Fax: (+358) 8 553 2906. E-mail: juha-pekka.kallunki@oulu.fi

Acknowledgements: We gratefully acknowledge the valuable comments and suggestions on the earlier versions of this paper provided by an anonymous referee, Andrew Stark (the Editor), Hannu Ojala and Markku Rahiala. We also thank the seminar participants at the 31st Annual Congress of the European Accounting Association, 2007 Annual Conference of the European Financial Management Association, the 2nd EIASM Workshop on Visualising, Measuring, and Managing Intangibles and Intellectual Capital in 2006, the Faculty Research Workshop at the University of Oulu in 2006 and the 2006 Annual Workshop in Financial Accounting of the Finnish Graduate School of Accounting. We gratefully acknowledge financial support from Jenny and Antti Wihuri Foundation, the Finnish Funding Agency for Technology and Innovation, the Academy of Finland, the Tauno Tönninki Foundation, the Marcus Wallenberg Foundation, the Finnish Foundation for Economic and Technology Sciences KAUTE, the North Ostrobothnia Fund and Oulun Kauppaseuran säätiö.

Stock Market Valuation, Profitability and R&D Spending of the Firm: The Effect of Technology Mergers and Acquisitions

Abstract: In this paper, we investigate whether a firm can enhance the effect of its R&D spending on its current market value and future profitability through technology-oriented M&As. On the basis of an analysis of 1,879 M&As, we find that when a technology firm acquires another technology firm, the magnitude of the stock price response to the R&D spending of an acquirer increases by 107 percent in the year of the M&A. In contrast, we find no such increase in the stock price response to the R&D spending of a non-technology acquirer. We also find that technology acquirers are more successful in converting their R&D spending into positive future profitability than non-technology acquirers. Our results are robust for different alternative specifications of our model and when various firm differences are controlled for.

JEL Classification: M40

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

1. Introduction

The accounting literature has extensively documented that the R&D expenditures (hereafter R&D) of a firm are positively related to its current and future market value as well as future profitability (e.g. Chan et al., 2001; Guo et al., 2006; Jaffe, 1986; Lev and Sougiannis, 1996; Xu et al., 2007)[1]. This has motivated the literature on mergers and acquisitions (hereafter M&A) to explore whether firms can utilize technology M&As to improve their current R&D activities. This literature maintains that technology M&As are often intended to assist technology acquirers to expand their existing R&D activities and to pursue innovations (Higgins and Rodriguez, 2006)[2]. Firms have been found to use technology M&As as a substitute for their internal R&D to fill their research gaps and to reorganize and redefine their R&D activities (Bertrand and Zuniga, 2006). It is, however, the characteristics of the acquiring firm that determine how the acquisition of

[1] In addition, many studies investigate whether R&D should be capitalized rather than expensed under certain circumstances (e.g. Amir et al., 2007; Lev and Sougiannis, 1996; Oswald, 2008).
[2] See also Anand and Singh (1997), Capron et al. (1998) and Hitt et al. (2001).

a technology firm affects its R&D activities. While a technology firm may have the capability to successfully absorb the acquired R&D to utilize it in its current R&D activities, a non-technology acquirer may lack such capability (Cohen and Levinthal, 1990; Higgins and Rodriguez, 2006). Despite the existing research on how a firm can improve its R&D activities through technology M&As, there is no published evidence on whether it can convert this improvement into better future profitability and higher current market value.

In this paper, we investigate whether a firm can enhance the effect of its R&D spending on its current market value and future profitability through technology-oriented M&As. Specifically, we contribute to the literature by developing and empirically testing the following interrelated hypotheses that are grounded on the argument that expected economic benefits from a *technology* acquirer's R&D activities are enhanced by acquisitions of technology firms, but those from a *non-technology* acquirer's R&D activities are not. First, 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; Chan et al., 1990; Jaffe, 1986; Lev and Sougiannis, 1996) is enhanced when a technology firm acquires another technology firm, but not when a non-technology firm acquires a technology firm. Second, we contribute to the studies exploring the economic benefits arising from M&As (e.g. Ahuja and Katila, 2001; Healy et al., 1992) by hypothesizing that the expected improved benefits from R&D activities are also reflected in the future profitability of a *technology* acquirer, but not in the future profitability of a *non-technology* acquirer.

We perform empirical analyses of 1,879 M&As with a U.S. firm acquiring technology targets during 1993-2006. Consistent with the hypotheses, our results show that M&As between two technology firms significantly enhance the stock market

valuation of the R&D spending of the acquiring firm in the year of the M&A, while the M&As with only a target as a technology firm have the opposite effect. We also find that M&As with technology targets enhance the technology acquirer's ability to convert its own R&D into future profitability, while non-technology acquirers do not benefit from the M&As in this respect.

Consistent with the earlier studies (Hitt et al., 1991) our results also show that technology acquirers cut their R&D spending when acquiring technology firms, while non-technology firms do not (but even marginally increase it). In other words, investors regard a technology acquirer's one-dollar investment in R&D as being worth more due to the technology M&A despite the acquirer's cuts in R&D spending in connection with the M&A. Our results are robust for different alternative specifications of our model, including price models and returns with both OLS and GMM with the Newey-West estimators as well as Fama-MacBeth (1973) cross-sectional regressions, and when several firm differences are controlled for.

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 the paper.

2. Hypothesis development

The aim of mergers and acquisitions is to create wealth through synergistic benefits for the acquirer. Specifically, an inefficient firm puts its resources to better use when it sells its assets to a more efficient firm (Hackbarth and Morellec, 2008). As Hodgkinson and Partington (2008) point out, in a synergistic takeover, wealth is created by

combining the resources of acquirer and target such that the value of the combined entity is greater than the sum of the separate entities' values. Similarly, Sudarsanam, Holl, and Salami (1996) argue that where one of the merging firms has an imbalance between its resources and growth opportunities and the other firm has the opposite but complementary imbalance, their combination increases shareholder wealth for both acquirer and target. Devos et al. (2009) report that merger synergies arise primarily from operating sources rather than tax considerations or increased market power. Specifically, they find that focused mergers offer greater opportunities to realize synergies than diversifying mergers.

Several studies provide reasons why expected synergies are an important motivation for technology M&As. In the fast changing and high risk technology field, firms are forced to seek for technological cooperation. Technology-oriented M&As provide firms with means to acquire new innovations to supplement their existing technological capital stock and, consequently, to enhance their R&D activities (e.g. Anand and Singh, 1997; Capron et al., 1998; Higgins and Rodriguez, 2006; Hitt et al., 2001). Even though M&As are generally found not to affect or are even found to destroy acquirer's market value[3], it has been reported that M&As are beneficial for acquirers in technology-driven M&As (e.g. Conn et al., 2005; Higgins and Rodriguez, 2006; Kohers and Kohers, 2000). Higgins and Rodriguez (2006) report that deteriorating R&D productivity may be an underlying motivation for the acquisition of research-intensive firms. In other words, firms can use technology M&As as a substitute for their internal R&D to bridge their research gaps and to reorganize and redefine their R&D activities (Bertrand and Zuniga, 2006).

[3] For empirical evidence on acquirers' long run stock returns, see e.g. Agrawal, Jaffe, and Mandelker (1992), Rau and Vermaelen (1998), Sudarsanam and Mahate (2003), and Antoniou, Petmezas, and Zhao (2007).

Many studies report that in technology-oriented M&As, an acquirer's ability to assimilate external knowledge is vital for the successful integration of the acquired R&D and other technological stock (e.g. Chesbrough, 2003; Cohen and Levinthal, 1990). Consistently, 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 improving and supplementing the acquirer's R&D activities. Therefore, it is the characteristics of the acquiring firm that determine how the acquisition of a technology firm affects their R&D activities. While a non-technology firm may acquire a technology firm in order to obtain the growth opportunities of the target firm, it may not have the capability to create additional value for its current R&D activities through the M&A (Cohen and Levinthal, 1990; Higgins and Rodriguez, 2006). Managers of acquirer companies impaired with hubris may overestimate their capacity to extract value from a target, leading them to pay for synergy that does not exist (Hodgkinson and Partington, 2008; Roll, 1986).

The above-mentioned arguments are consistent with the so-called synergy theory proposed by Bradley et al. (1983). 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 newly 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. Therefore, technology M&As should increase the value of the R&D of the firm because of the enhanced R&D operations achieved through synergies.

In the light of this discussion, we hypothesize that the positive stock market valuation of the R&D spending of the firm reported in earlier studies (Aboody and Lev,

2000; Lev and Sougiannis, 1996, 1999) is enhanced if a technology firm acquires a technology firm, while no such effect exists if a non-technology firm acquires a technology firm.

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

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

Our hypotheses regarding the enhanced (non-existent) stock market valuation of R&D spending of the technology (non-technology) acquirers in the case of technology M&A have a direct implication for the subsequent financial performance of the acquirer, because the stock price is a function of the future profitability of the firm. In addition, as Healy et al. (1992) point out, gains from any M&A should be assessed by examining not only stock price reactions to M&A but also its effect on future financial performance. Therefore, we investigate the direct association between an acquirer's current R&D and its future profitability to confirm that synergies in technology M&As indeed arise from R&D operations.

Prior studies report that M&As have a positive effect on acquirers' future financial performance. For instance, Healy et al. (1992) report that the post-merger improvements in asset productivity increase the operating cash flows of the merged firms. Similarly, Al-Sharkas et al. (2008) find that mergers allow banks to use the most efficient technology available, thereby improving the cost and profit efficiencies of banks. Moreover, Ahuja and Katila (2001) report a positive association between M&As involving two technology firms and subsequent technological performance of the acquirer. These findings suggest that the firms involved in an M&A should possess

mutually complementary assets. In the technology context, this requires the successful combination of the technologies of the two firms.

In sum, the ability of a technology-acquirer to increase the economic benefits from its R&D activities through a technology M&A should increase not only its current stock price but also its future profitability. A technology M&A should likewise not increase the future profitability of a non-technology acquirer, because it does not increase the economic benefits from the current R&D activities of a non-technology acquirer. These arguments lead to the following hypotheses:

Hypothesis 2a: Acquisitions of technology firms enhance the association between a technology acquirer's R&D spending and its future profitability.

Hypothesis 2b: Acquisitions of technology firms do not enhance the association between a non-technology acquirer's R&D spending and its future profitability.

3. Data environment and preliminary data analysis

We retrieved data from the Thomson SDC, Worldscope, Datastream and S&P ExecuComp databases for all M&As with a technology target made by U.S. acquirers during the period of 1993–2006[4]. Following Dessyllas and Hughes (2005), we define technology firms as those having their primary business sector in a technology-intensive industry according to the OECD two-digit SIC code classification[5]. We define M&As as completed control acquisitions 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

[4] We exclude M&As conducted prior to year 1993, because all necessary data are not available for the period prior to year 1993.

[5] Technology-intensive industries are those having one of the following two-digit SIC codes: 28, 35, 36, 37, 38, 48, 73 and 87.

50 per cent after the M&A[6]. We include M&As with targets of all sizes, but in our empirical analyses we control for the potential effect of the size of the target relative to that of the acquirer. Furthermore, if the firm has acquired several firms within one year, we include in our sample only the M&As with the largest targets[7]. We divide the sample into two sub-samples according to whether or not the acquirer is from a technology-intensive industry sector. The first sub-sample containing M&As with technology acquirers and technology targets consists of 20,583 firm-year observations from 1,751 M&As. The sub-sample containing M&As with non-technology acquirers and technology targets consists of 1,515 firm-year observations from 128 M&As.

Table 1 reports the distribution of the M&As in both sub-samples in the sample period. The results show that the number of technology M&As increased steadily during the sample period before turning down towards the end of the period. This is consistent with Sudarsanam (2003), who reports that there is a peak in the number of U.S. M&As in the late 1990s and at the turn of the millennium.

(Insert Table 1 about here)

Table 2 reports summary statistics of the variables used in the regressions[8]. These results show that technology firms acquiring other technology firms invest more in R&D activities, show higher price-to-book ratios and higher R&D-adjusted earnings than non-technology firms acquiring technology targets. The results also indicate that the technology acquirers are larger than non-technology acquirers in terms of total

[6] 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.
[7] This criterion is also used by Danzon et al. (2004). In addition, we estimate all the models without this restriction and the results are still similar to those reported in tables.
[8] T-test (not reported in the tables) shows that all the mean values of the variables in the two sub-samples differ significantly from each other.

assets, and the targets of the former are also larger than the targets of the latter. The results reported in Table 2 also show that the technology targets of non-technology acquirers are more often cross-border targets than the technology targets of technology acquirers.

(Insert Table 2 about here)

We also compare the ratio of the R&D expenditures to the book value of equity in years around M&As for technology and non-technology acquirers. These results (not reported in the table) indicate that in the sub-sample of technology acquirers, on average, the acquirer's R&D spending decreases in the year of the M&A and reverts to the normal level the year after the M&A. This is consistent with the earlier 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 the acquirer's R&D activity one year after the acquisition. For non-technology acquirers, the ratio of R&D expenditures to the book value of equity increases on average in the year of the M&A and reverts to the normal level the year after the M&A. In Section 5.4.3, we perform additional analyses on the change in the R&D spending and earnings of the acquirer in the year of the M&A.

4. Research design

In this section, we describe the empirical models used to test our hypotheses on whether a firm can enhance the effect of its R&D spending on its current market value and future profitability through technology-oriented M&As. When testing *Hypothesis 1a* and *1b* it is important to develop a model that allows us to quantify and statistically test the effect of M&As on the stock market valuation of R&D spending. In the accounting literature, there are numerous studies exploring the value relevance of accounting variables such as earnings, cash flows and R&D expenditures (see e.g. Booth et al., 2006; Kothari and Zimmerman, 1995; Lev and Sougiannis, 1996). Therefore, we choose regression specifications frequently used in the value-relevance studies and use interaction variables to test whether M&As affect the current market valuation of the R&D spending of the firm in the manner predicted by our hypotheses. Specifically, we estimate the following OLS regressions models from our data to test our *Hypotheses 1a* and *1b*:

$$\begin{aligned}\frac{P_{it}}{BV_{it}} &= \beta_0 + \beta_1 \frac{RD_{it}}{BV_{it}} + \beta_2 \frac{E_{it}}{BV_{it}} + \beta_3 M\&A_{it} + \beta_4 \frac{RD_{it}}{BV_{it}} \times M\&A_{it} \\ &+ \beta_5 \frac{E_{it}}{BV_{it}} \times M\&A_{it} + \beta_6 X_{it} + \beta_7 \frac{RD_{it}}{BV_{it}} \times M\&A_{it} \times X_{it} \\ &+ \sum_{k=1}^{7} \varphi_k IND_k + \sum_{y=1993}^{2006} \lambda_y YEAR_y + \varepsilon_{it},\end{aligned} \tag{1}$$

$$\begin{aligned}R_{it} &= \beta_0 + \beta_1 \frac{RD_{it}}{BV_{it}} + \beta_2 \frac{E_{it}}{BV_{it}} + \beta_3 M\&A_{it} + \beta_4 \frac{RD_{it}}{BV_{it}} \times M\&A_{it} \\ &+ \beta_5 \frac{E_{it}}{BV_{it}} \times M\&A_{it} + \beta_6 X_{it} + \beta_7 \frac{RD_{it}}{BV_{it}} \times M\&A_{it} \times X_{it} \\ &+ \sum_{k=1}^{7} \varphi_k IND_k + \sum_{y=1993}^{2006} \lambda_y YEAR_y + \varepsilon_{it},\end{aligned} \tag{2}$$

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*; R_{it} is the annual stock return for acquirer *i* in year *t*; RD_{it} is the research and development expenditures for acquirer *i* in year t; E_{it} is the net income before R&D expenditures for acquirer *i* in year *t*; $M\&A_{it}$ is an indicator variable equal to one if a firm *i* acquires a technology target during year *t*, otherwise equal to zero; and X_{it} refers to each of the firm-specific control variables. We include in the models the following control variables: the total asset (in millions) for acquirer *i* in year *t* (TA_{it}), the number of M&As that the acquirer has conducted during the three years prior to the year of the M&A ($DEALS_{it}$)[9], the net sales of the target firm divided by the net sales of acquirer *i* in year t-1 ($SIZE_{it-1}$), an indicator variable equal to one if the target is a non-US firm, otherwise equal to zero ($TFOR_{it}$), the number of acquirer *i*'s shares held by insiders scaled by the number of common shares outstanding in year *t* (CHS_{it}), the average of the sum of restricted stock granted and the number of shares held by the acquirer *i*'s executive (excluding options) scaled by the number of common shares outstanding in year *t* (OS_{it}), the average value of the acquirer *i*'s top executives' in-the-money options in thousands of dollars in year *t* ($OPTION_{it}$)[10], the average cash-bonus compensation as a proportion of total compensation received by the top executives of the acquirer *i* in year *t* ($BONUS_{it}$), an indicator variable equal to one if the transaction is an acquisition and equal to zero if the transaction is a merger (ACQ_{it}), industry-specific indicator variables (IND_k) and indicator variables equal to one in year *y*, otherwise equal to zero ($YEAR_y$).

Since our results based on both these model specifications are qualitatively similar, we report the results based on Model (1) in Tables 3 and 4. We also estimate these models using Generalized Methods of Moments (GMM) estimation technique with the

[9] These M&As include all transactions, including acquisitions of minority shares or remaining shares.
[10] Results of using the number of options granted and the number of exercisable/nonexercisable options are qualitatively similar to those reported in the tables.

Newey-West estimator, which is robust to autocorrelation and heteroskedasticity in the model. We report these results in Table 6.

We include in the model several control variables 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 the total assets of the acquiring firm (TA_{it}) in the model, because the size of the acquirer can potentially affect both value creation and acquisition performance. As Ahuja and Katila (2001) argue, larger firms have more resources to benefit from the acquired R&D and conduct the actual business of innovation because the absorption and assimilation of the acquired R&D occupies only a part of the larger acquirer's resources. Analysts and investors also analyze large firms more intensively than small firms (Booth et al., 2006). On the other hand, Eckbo and Thorburn (2000) and Moeller et al. (2004) report that abnormal stock returns of the acquirer decrease with the size of the acquirer. Moeller et al. (2004) explain this finding through managers of large firms paying more for acquisitions leading to no synergies from the acquisitions.

Second, we include in our model the variable $DEALS_{it}$, i.e. the number of M&As conducted by an acquirer during the three years prior to the year of the M&A. The earlier M&A experience of the acquirer may affect the extent to which the stock market reacts to the potential gains arising from the acquired R&D activities (Fuller et al., 2002). The greater the acquisition experience, the more successful the acquirer is in integrating the acquired resources into its own business and achieving synergies. Firms with recent M&A experience may also already be in a fluid state and more easily adaptable to changes required by the new acquisition (Hitt et al., 2001). On the other hand, Higgins and Rodriguez (2006) find that firms have negative abnormal stock returns if they engage in an M&A during the three years prior to the current acquisition.

They suggest that the market penalizes firms engaging in multiple technology acquisitions over a short time period, because this behavior may indicate that these firms have weak internal R&D programs.

Third, earlier studies report that target firms that are large in relation to their acquirers are able to provide greater synergies in M&As than small targets (e.g. Asquith et al., 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 to the M&A.

Fourth, we include in the model an indicator variable equal to one if the target is a non-U.S. firm, otherwise equal to 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 et al., 2002). Bae and Noh (2001) argue that multinational corporations (hereafter MNCs) have a broad market environment and have affiliates located in multiple economies, hence providing better diversification opportunities for MNCs, compared to domestic corporations. They also claim that these characteristics could be beneficial for R&D investments of an MNC. In addition, cross-border M&As enable the internalization of synergies arising from intangible assets, which translate into shareholder value (Conn et al., 2005). It is, however, obvious that cross-border M&As are often more challenging to complete successfully than are M&As between firms of the same nationality. Eckbo and Thorburn (2000) argue that domestic acquirers may outperform foreign acquirers, because domestic acquisitions tend to involve more closely related acquirers and targets. Supporting this view, Moeller

and Schlingemann (2005) and Black et al. (2007) report significantly lower returns for cross-border than for domestic acquisitions.

We also control for the effect of the acquirer's ownership structure and management compensation in our model. As one of the most important forms of corporate investment, M&As tend to intensify the inherent conflicts of interest between managers and shareholders (see e.g. Jensen and Meckling, 1976). While shareholders may be able to mitigate firm-specific risk by diversifying their shareholdings across firms and as a result may be risk-neutral as regards firm-specific risk, managers are still considered risk averse if their employment security and wealth are tied to one firm (Gao and Sudarsanam, 2003). A consequence of such risk aversion is that managers may pass up risk-increasing, positive net-present-value projects (Smith and Stulz, 1985). On the other hand, when managers hold little equity in the firm, acquisition decisions may be driven by managerial utility maximization motives and managerial hubris (see e.g. Roll, 1986; Sudarsanam et al., 1996). Cosh, Guest, and Hughes (2006) find strong evidence of a positive relation between CEO ownership and both the long-run return and operating performance for acquiring firms in UK M&As. Therefore, as the fifth and the sixth control variables, we include in our model two variables measuring the ownership structure of the acquirer firm: the number of acquirer shares held by insiders scaled by the number of common shares outstanding (CHS_{it}), and the number of acquirer shares held by an average top executive scaled by the number of common shares outstanding (OS_{it}).

Management compensation is another important agency controlling device. Employee stock options may encourage risk preference, since the negative payoffs from options are limited unlike in the case of stocks (Gao and Sudarsanam, 2003). However, some researchers argue that equity-based compensation could be ineffective, because

managers with such compensation bear more risk, which may drive them to invest less in risky projects such as M&As (Fama, 1980; Wiseman and Gomez-Mejia, 1998). Therefore, we include in our model the average value of the acquirer top executives' in-the-money options in thousands of dollars at year end ($OPTION_{it}$) as the seventh control variable. As the eighth control variable, we use the average cash-bonus compensation as a proportion of total compensation received by the top executives of the acquirer ($BONUS_{it}$) to control for the effect of cash-based executive compensation.

Ninth, we include in our model an indicator variable equal to one if the transaction is an acquisition and equal to zero if the transaction is a merger (ACQ_{it}). Several earlier studies report that acquirer firms in tender offer acquisitions perform better than acquirer firms in mergers (e.g. Agrawal et al., 1992; Rau and Vermaelen, 1998). Two main explanations for this pattern have evolved in the literature. The first interpretation suggests that in acquisitions, acquirer management usually aims to replace the inefficient management of the target firm, while in mergers the possibly inefficient management may stay to cooperate with the acquirer management. Another explanation is grounded on the notion that the form of financing serves as a signal that can explain the difference between acquisitions and mergers (Hansen, 1987). Cash financing, which is typical in acquisitions, is likely to occur when the acquirer is undervalued, while equity financing, which is typical for mergers, is likely to occur when the acquirer is overvalued (Agrawal et al., 1992). On the other hand, operational synergies and the disciplining of target managers may cause greater wealth gains from mergers (Martin and McConnell, 1991). Therefore mergers, which are usually friendly transactions, may actually provide a more rewarding foundation for R&D cooperation than tender offer acquisitions.

We test our *Hypotheses 2a* and *2b* by regressing the average three-years-ahead and five-years-ahead earnings before the R&D expenditures on current earnings and subsequent and current R&D as follows[11]:

$$\frac{1}{3}\sum_{k=1}^{3}\frac{E_{i,t+k}}{BV_{i,t+k}} = \beta_0 + \beta_1\frac{E_{it}}{BV_{it}} + \beta_2\frac{RD_{it}}{BV_{it}} + \beta_3 M\&A_{it} + \beta_4\frac{RD_{it}}{BV_{it}}\times M\&A_{it} + \beta_5\frac{E_{it}}{BV_{it}}\times M\&A_{it} + \sum_{k=1}^{3}\eta_{i,k}\frac{RD_{i,t+k}}{BV_{i,t+k}} + \sum_{k=1}^{3}\gamma_{i,k}\frac{RD_{i,t+k}}{BV_{i,t+k}}\times M\&A_{it} + \varepsilon_{it}, \quad (3)$$

$$\frac{1}{5}\sum_{k=1}^{5}\frac{E_{i,t+k}}{BV_{i,t+k}} = \beta_0 + \beta_1\frac{E_{it}}{BV_{it}} + \beta_2\frac{RD_{it}}{BV_{it}} + \beta_3 M\&A_{it} + \beta_4\frac{RD_{it}}{BV_{it}}\times M\&A_{it} + \beta_5\frac{E_{it}}{BV_{it}}\times M\&A_{it} + \sum_{k=1}^{5}\eta_{i,k}\frac{RD_{i,t+k}}{BV_{i,t+k}} + \sum_{k=1}^{5}\gamma_{i,k}\frac{RD_{i,t+k}}{BV_{i,t+k}}\times M\&A_{it} + \varepsilon_{it}, \quad (4)$$

where E_{it} is the net income before R&D expenditures 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*; and $M\&A_{it}$ is an indicator variable equal to one if a firm *i* acquires a technology target during year *t*, otherwise equal to zero.

We include the subsequent R&D expenditures in Models (3) and (4), i.e. the variables $RD_{i,t+k}$, because they could also affect the future profitability of the firm. In addition, we include the current earnings (E_{it}) in the models, because current earnings have been reported to predict future earnings. Finally, we interact all the variables with the indicator variable for the year of the M&A, because these regressions are intended to examine whether technology M&As strengthen the ability of a technology acquirer to translate current R&D spending into future profitability.

[11] This model is based on Deng and Lev (2006), who regress three-years-ahead cash flows on in-process R&D, controlling for subsequent investments by including the subsequent years' R&D, and on Kothari et al. (2002), who use the standard deviation of earnings for 5 subsequent years to measure earnings variability.

5. Empirical results

5.1. Stock market valuation of R&D spending in M&As involving technology and non-technology acquirers and technology targets

Table 3 and 4 report the results of testing *Hypotheses 1a* and *1b*.[12] To save space, we report the results of estimating only Model (1) in Tables 3 and 4. The results of estimating Model (2) are reported in section 5.4. Consistent with our *Hypotheses 1a*, the results reported in Table 3 indicate that the estimated parameter for the variable $RD_{it}/BV_{it} \times M\&A_{it}$ is significantly positive in the sub-sample of technology acquirers. In other words, M&As between two technology firms enhance the stock market valuation of R&D spending of a technology acquirer in the year of the M&A supporting our argument that the M&A of a technology firm strengthens the R&D activities of an acquirer that is capable of utilizing the acquired technologies in its own operations. The economic benefits from the strengthened R&D activities due to the M&A are reflected in the enhanced stock market valuation of the R&D spending of a technology acquirer.

The increase in the magnitude of the stock price response to the R&D spending of a technology acquirer in the year of a technology M&A can be assessed by comparing the value of the estimated parameters for the variable RD_{it}/BV_{it} and the interaction variable $RD_{it}/BV_{it} \times M\&A_{it}$ in column (4) of Table 3. The values of these estimates for the variables RD_{it}/BV_{it} and $RD_{it}/BV_{it} \times M\&A_{it}$ are 3.827 and 4.109 respectively. In other words, there is a 107 percent (4.109/3.827) increase in the stock price response to the R&D spending in the year of a technology M&A. This clearly illustrates the economic

[12] Due to the lack of space, we do not report the estimated parameters for the industry and yearly indicator variables. All these parameters are significant, supporting the control of yearly variation in the dependent variable.

importance of the effect of a technology M&A on the stock market valuation of a technology acquirer's total R&D spending.

The estimated parameter for the variable E_{it}/BV_{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; Collins and Kothari, 1989). However, the estimated parameter for the interaction variable $E_{it}/BV_{it} \times M\&A_{it}$ is significantly negative, indicating that M&As between two technology firms actually decrease the stock market valuation of the earnings of the acquiring firm. This evidence suggests that investors place less value on earnings and more value on R&D when a technology firm acquires another technology firm. This finding emphasizes the role of technology M&As specifically for the improvement of acquirer's R&D activities.

Column (4) in Table 3 also reports the estimated parameters for the variables measuring the characteristics of the acquirer and target firms. To control for their effect in the stock market valuation of acquirer's R&D spending in the year of the M&A, we interact these variables with RD_{it}/BV_{it} and $M\&A_{it}$. Only two of our control variables are significantly associated with the stock market valuation of its R&D spending in the year of the M&A (interaction variables $RD_{it}/BV_{it} \times M\&A_{it} \times X_{it}$). The degree of closely held shares is negatively associated with the stock market valuation of acquirer's R&D spending in the year of M&A (the variable $RD_{it}/BV_{it} \times M\&A_{it} \times CHS_{it}$) indicating that smaller insider ownership increases the value-creation of R&D when acquiring technology targets. The value of acquirer executives' in-the-money options is also negatively associated with the stock market valuation of acquirer's R&D spending in the year of the M&A (the variable $RD_{it}/BV_{it} \times M\&A_{it} \times OPTION_{it}$). This finding suggests that the stock market expects acquirer executives with valuable options to not carry out

M&As in favor of their R&D operations most likely because these executives want to retain the positive value of their options and avoid risky R&D co-operation.

(Insert Table 3 about here)

Table 4 reports the results of testing *Hypotheses 1b*. The results indicate that the estimated parameter for the variable $RD_{it}/BV_{it} \times M\&A_{it}$ is significantly negative in the sub-sample of non-technology acquirers, and this negative parameter estimate significantly increases in power when including control variables in the model. This finding is consistent with the view that the target firm's resources do not increase the value of acquirer's resources if they do not provide a suitable context for the acquired resources (Anand and Singh, 1997). The parameter estimate for the variable RD_{it}/BV_{it} is relatively high in all model specifications indicating that the R&D operations of non-technology firms that acquire technology targets are important to their core operations even though their M&As have remarkably negative effect on the value embedded in their R&D activities. As can be seen in Column (4) of Table 4, there is over a 75 percent decrease in the stock price response to the R&D spending of the non-technology acquirer in the year of the M&A.

Only one of the control variables has a significant impact on the stock market valuation of acquirer's R&D spending in the year of the M&A (the variable $RD_{it}/BV_{it} \times M\&A_{it} \times OS_{it}$). This finding may indicate that the investors believe acquirer executives with higher ownership to be excessively risk-seeking, leading them to overestimate their own ability to run target firms and utilize them in the acquirer's own R&D operations.

(Insert Table 4 about here)

Taken together, the results reported in Table 3 and 4 show that M&As between two technology firms enhance the stock market valuation of R&D spending of the acquiring firm, while the M&As with only a target as a technology firm have the opposite effect. In other words, the diverse stock market response to R&D spending between technology and non-technology acquirers in connection with the technology M&A rationally reflects the diverse revisions in the expected cash flows of these firms due to the M&A. The M&A of a technology firm strengthens the R&D activities of an acquirer that is capable of utilizing the acquired technologies in its own operations, which is the case with *technology* acquirers, but not with *non-technology* acquirers.

5.2. Current R&D spending and future financial performance of the acquirer

The results from estimating Models (3) and (4) to test *Hypotheses 2a* and *2b* are reported in Table 5. For technology acquirers of technology targets, the results show that the current earnings and the current R&D spending of the firm are significantly positively related to their future profitability. More importantly, the interaction variable $RD_{it}/BV_{it} \times M\&A_{it}$ is significantly positive indicating that when a technology firm acquires another technology firm, its R&D spending in the year of the M&A is reflected more strongly to its future profitability than in other years. Corroborating *Hypothesis 2a*, these findings indicate that technology acquirers can utilize technology M&As to convert their current R&D into higher future profitability, which is reflected in the increased stock market valuation of current R&D in the year of the M&A. Regarding the other interaction variables, the results also show that the ability of the acquirer's

R&D spending to reflect future profitability is not significantly different in the years following the M&A than in other years.

For non-technology acquirers that acquired technology targets, the results reported in Table 5 show that the current R&D spending of the firm is generally not related to their future profitability. Only the current earnings of a non-technology acquirer are significantly related to its future profitability, while the current R&D spending is not. This result may indicate the fact that when a non-technology firm conducts some R&D, it is highly valued by investors, but the impact on future earnings is not notable. In addition, the interaction variable $RD_{it}/BV_{it} \times M\&A_{it}$ is not significant indicating that acquiring a technology firm does not improve the ability of a non-technology firm to convert current R&D spending into its future profitability. Therefore, this result supports *Hypothesis 2b*. The results reported in Table 5 are also consistent with Ahuja and Katila (2001), who report that M&As involving two technology firms have a positive impact on an acquirers' subsequent technological performance.

(Insert Table 5 about here)

When these results are combined with the results that we reported in connection with *Hypotheses 1a* and *1b*, we can conclude that technology firms acquiring technology targets are more successful in converting their current R&D expenditures into positive future profitability than non-technology acquirers that acquire technology targets. This is reflected in the enhanced stock market valuation of the current R&D spending of the technology acquirer in the year of M&A. These findings provide new insights into the role of technology improvement as a motive for M&As to create

synergies, as suggested by Conn et al. (2005), Higgins and Rodriguez (2006) and Kohers and Kohers (2000).

5.4. Robustness checks and additional analyses

5.4.1 Alternative model specification and estimation techniques

We begin our robustness checks by using three alternative model specifications. Column (1) of Table 6 reports the results of estimating Model (1) using the GMM estimation method with the Newey-West sandwich-estimators, which is robust to autocorrelation and heteroskedasticity in the model[13]. Column (2) reports the results for Model (2), where yearly stock return is the dependent variable. Column (3) reports the results of yearly cross-sectional Fama-MacBeth (1973) regressions, i.e. we first estimate the yearly cross-sectional regressions and then test whether the sample means of the parameter estimates of these regressions are different from zero.

The results reported in Table 6 show that, across all the alternative model specifications, the estimated parameter for the interaction variable $RD_{it}/BV_{it} \times M\&A_{it}$ is significantly positive in the case of technology acquirers, but insignificant or even negative in the case of non-technology acquirers. These findings confirm our earlier findings, i.e., they support our *Hypotheses 1* and *2*. In other words, the M&As of technology targets enhance the stock market valuation of the R&D spending of the technology acquirer, but do not enhance the valuation of the R&D spending of non-technology acquirers.

[13] All the explanatory variables are taken as exogenous, which allows us to use them as instruments in the estimation.

(Insert Table 6 about here)

We also estimate Models (1–2) and Models (3–4) for both technology and non-technology acquirers by using seemingly unrelated regression (SUR) techniques. The results from these SUR regressions are qualitatively similar to those reported in Tables 3–5. The value of the estimated parameter for the interaction variable $RD_{it}/BV_{it} \times M\&A_{it}$ in the valuation model is 5.271 ($p<0.000$) in the sub-sample of technology acquirers, whereas the corresponding parameter estimate is -1.025 ($p<0.883$) in the sub-sample of non-technology acquirers. Accordingly, the value of the parameter estimate for the interaction variable $RD_{it}/BV_{it} \times M\&A_{it}$ in the earnings model is 0.222 ($p<0.010$) in the sample of technology acquirers, whereas the value of the parameter estimate is -0.369 ($p<0.550$) in the sample of non-technology acquirers.

5.4.2. Possible delayed stock market response to M&A

Several earlier studies (e.g. Bernard and Thomas, 1990) report that stock prices may adjust to value-relevant information, such as earnings figures, with some delay. In addition, Eberhart et al. (2004) report slow stock market reactions after economically significant increases in the R&D spending of the firm. It is therefore 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 be markedly the case if the M&A is announced at the end of the year. We explore this possibility by adding an additional indicator variable for the year after the M&A year in Model (1). We also add an interaction variable to the model, constructed by multiplying this indicator variable by the R&D spending of the firm. These two variables capture the

stock price response and the value creation effects of R&D spending one year post M&A. The results of this regression (not reported in the tables) indicate no significant delayed reaction in stock price or value relevance of the R&D spending.

5.4.3 Changes in R&D spending and earnings in the year of M&A

We also investigate whether the R&D spending and financial performance of the acquirer change in the year of the M&A, as reported in earlier studies (e.g. Hitt et al., 1991). We therefore estimate the following OLS regressions (all variables are as described in Model 1):

$$\frac{E_{it}}{BV_{it}} = \beta_0 + \beta_1 M\&A_{it} + \sum_{y=1990}^{2004} \lambda_{iy} YEAR_y + \varepsilon_{it}, \quad (5)$$

$$\frac{RD_{it}}{BV_{it}} = \beta_0 + \beta_1 M\&A_{it} + \sum_{y=1990}^{2004} \lambda_{iy} YEAR_y + \varepsilon_{it}. \quad (6)$$

The results of estimating Models (5) and (6) are reported in Table 7. They show that in the case of technology acquirers, there is a significant decline in the R&D spending of the acquirer in the year of the M&A. This result is consistent with earlier studies, according to which technology firms cut their own R&D investments when acquiring technology targets (e.g. Hitt et al., 1991). In the case of technology targets, these M&As offer merging firms an opportunity to redefine their internal R&D process by removing duplicated R&D, leading to smaller but more efficient and valuable R&D (Bertrand and Zuniga, 2006). The results are moreover consistent with earlier research reporting that non-technology firms do not cut their own R&D investments when acquiring technology targets (Hitt et al., 1991).

The results reported in Table 7 are consistent with the earlier research reporting that the earnings of the acquirer decrease in connection with the M&A. Furthermore, the results reported in Table 7, 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 technology acquirer increases even though the acquirer actually cuts its R&D spending. In other words, the technology acquirer's one-dollar investment in R&D is worth more in the year of the M&A than in other years. This shows that the increased stock market valuation of the R&D spending of the technology acquirer in the year of the M&A is due to investors regarding the R&D spending as more valuable due to the M&A – not, for example, because of the higher level of the R&D. In contrast, the stock market valuation of the R&D spending of the non-technology acquirer does not increase even though the non-technology acquirer actually invests more in its R&D.

(Insert Table 7 about here)

5.4.4. Results for M&As with non-technology targets

As a final additional analysis, we estimate Model (1) using a sample of M&As with non-technology targets. This analysis verifies that our results are indeed valid for the M&As of technology targets but not for all M&As. The results for M&As with non-technology targets (not reported in the tables) show no significant change in the stock market valuation of an acquirer's R&D spending in the year of the M&A. These results confirm that the enhanced stock market valuation of an acquirer's R&D spending occurs only if the acquirer and the target are technology firms.

6. Conclusions

In this paper, we investigate whether a firm can enhance the effect of its R&D spending on its current market value and future profitability through technology-oriented M&As. In light of earlier studies (e.g. Ahuja and Katila, 2001; Higgins and Rodriguez, 2006), we argue that technology M&As assist technology acquirers to expand their existing R&D activities and to pursue innovations. We address this issue from two interrelated perspectives that are based on the argument that expected economic benefits from a *technology* acquirer's R&D activities are enhanced by acquisitions of technology firms, but those from a *non-technology* acquirer's R&D activities are not. Specifically, we hypothesize that, for technology acquirers, the acquisition of another technology firm should enhance the stock market valuation of R&D expenditures and strengthen the positive association between the R&D expenditures and future profitability. Conversely, no such effects should occur when a non-technology firm acquires a technology firm.

Consistent with these predictions, we find that M&As between two technology firms enhance the stock market valuation of an acquirer's R&D spending, but the M&As with only targets as technology firms do not. We in fact find evidence of a decrease in the stock market valuation of a non-technology acquirer's R&D spending in the M&As of technology firms. This corroborates the arguments of earlier studies claiming that the value of an acquirer's R&D activities may even decrease if the acquirer cannot utilize the technology stock of the target. This finding may also be an indication of managerial hubris (Roll, 1986), because managers of non-technology acquirers may have overestimated their capacity to extract value from technology targets. We also find that technology acquirers can convert their current R&D spending

more successfully into future profitability than non-technology acquirers. This finding contributes to the literature on the acquirer's improved future performance after M&As reported in several prior studies (e.g. Ahuja and Katila, 2001; Al-Sharkas et al., 2008; Healy et al., 1992).

Our findings have important implications for studies exploring the economic benefits of M&As (e.g. Agrawal et al., 1992; Bradley et al., 1983; Devos et al., 2009) and R&D (e.g. Chan et al., 2001; Jaffe, 1986; Lev and Sougiannis, 1996). Specifically, our results suggest that only technology acquirers can utilize technology M&As to convert their current R&D spending into better future profitability, which is reflected in the enhanced stock market valuation of their R&D in the year of M&A.

References

Aboody, D., and B. Lev (2000), 'Information Asymmetry, R&D, and Insider Gains', *Journal of Finance*, Vol. 55, No. 6 (December), pp. 2747-66.

Agrawal, A., J. Jaffe, and G. Mandelker (1992), 'The Post-Merger Performance of Acquiring Firms: A Re-Examination of an Anomaly', *Journal of Finance*, Vol. 47, No. 4 (September), pp. 1605-21.

Ahuja, G., and R. Katila (2001), 'Technological Acquisitions and the Innovation Performance of Acquiring Firms: A Longitudinal Study', *Strategic Management Journal*, Vol. 22, No. 3 (March), pp. 197-220.

Al-Sharkas, A. A., M. K. Hassan, and S. Lawrence (2008), 'The Impact of Mergers and Acquisitions on the Efficiency of the US Banking Industry: Further Evidence', *Journal of Business Finance & Accounting*, Vol. 35, No. 1&2 (January/March), pp. 50-70.

Amir, E., Y. Guan, and G. Livne (2007), 'The Association of R&D and Capital Expenditures with Subsequent Earnings Variability', *Journal of Business Finance & Accounting*, Vol. 34, No. 1&2 (January/March), pp. 222-46.

Anand, J., and H. Singh (1997), 'Asset Redeployment, Acquisitions and Corporate Strategy in Declining Industries', *Strategic Management Journal*, Vol. 18, No. S1 (July), pp. 99-118.

Antoniou, A., D. Petmezas, and H. Zhao (2007), 'Bidder Gains and Losses of Firms Involved in Many Acquisitions', *Journal of Business Finance & Accounting*, Vol. 34, No. 7&8 (September/October), pp. 1221-44.

Asquith, P., R. F. Bruner, and D. W. J. Mullins (1983), 'The Gains to Bidding Firms from Merger', *Journal of Financial Economics*, Vol. 11, No. 1-4 (April), pp. 121-39.

Bae, S. C., and S. Noh (2001), 'Multinational Corporations Versus Domestic Corporations: A Comparative Study of R&D Investment Activities', *Journal of Multinational Financial Management*, Vol. 11, No. 1 (February), pp. 89-104.

Ball, R., and P. Brown (1968), 'An Empirical Evaluation of Accounting Income Numbers', *Journal of Accounting Research*, Vol. 6, No. 2 (Autumn), pp. 159-78.

Bernard, V. L., and J. K. Thomas (1990), 'Evidence That Stock Prices Do Not Fully Reflect the Implications of Current Earnings for Future Earnings', *Journal of Accounting and Economics*, Vol. 13, No. 4 (December), pp. 305-40.

Bertrand, O., and P. Zuniga (2006), 'R&D and M&A: Are Cross-Border M&A Different? An Investigation on OECD Countries', *International Journal of Industrial Organization*, Vol. 24, No. 2 (March), pp. 401-23.

Black, E. L., T. A. Carnes, T. Jandik, and C. Henderson (2007), 'The Relevance of Target Accounting Quality to the Long-Term Success of Cross-Border Mergers', *Journal of Business Finance & Accounting*, Vol. 34, No. 1&2 (January/March), pp. 139-68.

Booth, G. G., J. Junttila, J.-P. Kallunki, M. Rahiala, and P. Sahlström (2006), 'How Does the Financial Environment Affect the Stock Market Valuation of R&D Spending?' *Journal of Financial Intermediation*, Vol. 15, No. 2 (April), pp. 197-215.

Bradley, M., A. Desai, and E. H. Kim (1983), 'The Rationale Behind Interfirm Tender Offers: Information or Synergy?' *Journal of Financial Economics*, Vol. 11, No. 1-4 (April), pp. 183-206.

Capron, L., P. Dussauge, and W. Mitchell (1998), 'Resource Redeployment Following Horizontal Acquisitions in Europe and North America, 1988-1992', *Strategic Management Journal*, Vol. 19, No. 7 (July), pp. 631-61.

Chan, L. K. C., J. Lakonishok, and T. Sougiannis (2001), 'The Stock Market Valuation of Research and Development Expenditures', *Journal of Finance*, Vol. 56, No. 6 (December), pp. 2431-56.

Chan, S. H., J. D. Martin, and J. W. Kensinger (1990), 'Corporate Research and Development Expenditures and Share Value', *Journal of Financial Economics*, Vol. 26, No. 2 (August), pp. 255-76.

Chesbrough, H. W. (2003), *Open Innovation: The New Imperative for Creating and Profiting from Technology* (Boston, MA: Harvard Business School Press).

Cohen, W. M., and D. A. Levinthal (1990), 'Absorptive Capacity: A New Perspective on Learning and Innovation', *Administrative Science Quarterly*, Vol. 35, No. 1 (March), pp. 128-52.

Collins, D. W., and S. P. Kothari (1989), 'An Analysis of Intertemporal and Cross-Sectional Determinants of Earnings Response Coefficients', *Journal of Accounting and Economics*, Vol. 11, No. 2&3 (July), pp. 143-81.

Conn, R. L., A. Cosh, P. M. Guest, and A. Hughes (2005), 'The Impact on UK Acquirers of Domestic, Cross-Border, Public and Private Acquisitions', *Journal of Business Finance & Accounting*, Vol. 32, No. 5&6 (June), pp. 815-70.

Cosh, A., P. M. Guest, and A. Hughes (2006), 'Board Share-Ownership and Takeover Performance', *Journal of Business Finance & Accounting*, Vol. 33, No. 3&4 (April/May), pp. 459-510.

Danzon, P. M., A. Epstein, and S. Nicholson (2004), 'Mergers and Acquisitions in the Pharmaceutical Industries', Working Paper no.10536 (NBER).

Deng, Z., and B. Lev (1998), 'The Valuation of Acquired R&D', Working Paper (New York University).

——— (2006), 'In-Process R&D: To Capitalize or Expense?' *Journal of Engineering and Technology Management*, Vol. 23, No. 1&2 (March/June), pp. 18-32.

Dessyllas, P., and A. Hughes (2005), 'R&D and Patenting Activity and the Propensity to Acquire in High Technology Industries', Working Paper (Centre for Business Research).

Devos, E., P.-R. Kadapakkam, and S. Krishnamurthy (2009), 'How Do Mergers Create Value? A Comparison of Taxes, Market Power, and Efficiency Improvements as Explanations for Synergies', *Review of Financial Studies*, Vol. 22, No. 3 (March), pp. 1179-211.

Eberhart, A. C., W. F. Maxwell, and A. R. Siddique (2004), 'An Examination of Long-Term Abnormal Stock Returns and Operating Performance Following R&D Increases', *Journal of Finance*, Vol. 59, No. 2 (April), pp. 623-50.

Eckbo, B. E., and K. S. Thorburn (2000), 'Gains to Bidder Firms Revisited: Domestic and Foreign Acquisitions in Canada', *Journal of Financial and Quantitative Analysis*, Vol. 35, No. 1 (March), pp. 1-25.

Fama, E. F. (1980), 'Agency Problems and the Theory of the Firm', *Journal of Political Economy*, Vol. 88, No. 2 (January), pp. 288-307.

Fama, E. F., and J. MacBeth (1973), 'Risk, Return, and Equilibrium: Empirical Tests', *Journal of Political Economy*, Vol. 81, No. 3 (January), pp. 607-36.

Fuller, K., J. Netter, and M. Stegemoller (2002), 'What Do Returns to Acquiring Firms Tell Us? Evidence from Firms That Make Many Acquisitions', *Journal of Finance*, Vol. 57, No. 4 (August), pp. 1763-93.

Gao, L., and P. S. Sudarsanam (2003), 'Value Creation of UK High Technology Acquisitions', Working Paper (Cranfield University).

Guo, R.-J., B. Lev, and C. Shi (2006), 'Explaining the Short- and Long-Term IPO Anomalies in the US by R&D', *Journal of Business Finance & Accounting*, Vol. 33, No. 3&4 (April/May), pp. 550-79.

Hackbarth, D., and E. Morellec (2008), 'Stock Returns in Mergers and Acquisitions', *Journal of Finance*, Vol. 63, No. 3 (June), pp. 1213-52.

Hansen, R. (1987), 'A Theory for the Choice of Exchange Medium in the Market for Corporate Control', *Journal of Business*, Vol. 60, No. 1 (January), pp. 75-95.

Healy, P. M., K. G. Palepu, and R. S. Ruback (1992), 'Does Corporate Performance Improve after Mergers?' *Journal of Financial Economics*, Vol. 31, No. 2 (April), pp. 135-75.

Higgins, M. J., and D. Rodriguez (2006), 'The Outsourcing of R&D through Acquisitions in the Pharmaceutical Industry', *Journal of Financial Economics*, Vol. 80, No. 2 (May), pp. 351-83.

Hitt, M. A., J. S. Harrison, and R. D. Ireland (2001), *Mergers and Acquisitions: A Guide to Creating Value for Stakeholders* (Cary, NC: Oxford University Press).

Hitt, M. A., R. E. Hoskisson, R. D. Ireland, and J. S. Harrison (1991), 'Effects of Acquisitions on R&D Inputs and Outputs', *Academy of Management Journal*, Vol. 34, No. 3 (September), pp. 693-706.

Hodgkinson, L., and G. H. Partington (2008), 'The Motivation for Takeovers in the UK', *Journal of Business Finance & Accounting*, Vol. 35, No. 1&2 (January/March), pp. 102-26.

Jaffe, A. B. (1986), 'Technological Opportunity and Spillovers of R&D: Evidence from Firms' Patents, Profits, and Market Value', *American Economic Review*, Vol. 76, No. 5 (December), pp. 984-1001.

Jarrell, G. A., and A. B. Poulsen (1989), 'The Returns to Acquiring Firms in Tender Offers: Evidence from Three Decades', *Financial Management*, Vol. 18, No. 3 (Autumn), pp. 12-19.

Jensen, M. C., and W. H. Meckling (1976), 'Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure', *Journal of Financial Economics*, Vol. 3, No. 4 (October), pp. 305-60.

Kohers, N., and T. Kohers (2000), 'The Value Creation Potential of High-Tech Mergers', *Financial Analysts Journal*, Vol. 56, No. 3 (May/June), pp. 40-50.

Kothari, S. P., T. E. Laguerre, and A. J. Leone (2002), 'Capitalization Versus Expensing: Evidence on the Uncertainty of Future Earnings from Capital Expenditures Versus R&D Outlays', *Review of Accounting Studies*, Vol. 7, No. 4 (December), pp. 355-82.

Kothari, S. P., and J. L. Zimmerman (1995), 'Price and Return Models', *Journal of Accounting and Economics*, Vol. 20, No. 2 (September), pp. 155-95.

Lev, B., and T. Sougiannis (1996), 'Capitalization, Amortization, and Value-Relevance of R&D', *Journal of Accounting and Economics*, Vol. 21, No. 1 (February), pp. 107-38.

——— (1999), 'Penetrating the Book-to-Market Black Box: The R&D Effect', *Journal of Business Finance & Accounting*, Vol. 26, No. 3&4 (April/May), pp. 419-49.

Martin, K., and J. McConnell (1991), 'Corporate Performance, Corporate Takeovers, and Management Turnover', *Journal of Finance*, Vol. 46, No. 1 (March), pp. 671-87.

Moeller, S. B., and F. P. Schlingemann (2005), 'Global Diversification and Bidder Gains: A Comparison between Cross-Border and Domestic Acquisitions', *Journal of Banking & Finance*, Vol. 29, No. 3 (March), pp. 533-64.

Moeller, S. B., F. P. Schlingemann, and R. M. Stulz (2004), 'Firm Size and the Gains from Acquisitions', *Journal of Financial Economics*, Vol. 73, No. 2 (August), pp. 201-28.

Oswald, D. R. (2008), 'The Determinants and Value Relevance of the Choice of Accounting for Research and Development Expenditures in United Kingdom', *Journal of Business Finance & Accounting*, Vol. 35, No. 1&2 (January/March), pp. 1-24.

Rau, P. R., and T. Vermaelen (1998), 'Glamour, Value and the Post-Acquisition Performance of Acquiring Firms', *Journal of Financial Economics*, Vol. 49, No. 2 (August), pp. 223-53.

Roll, R. (1986), 'The Hubris Hypothesis of Corporate Takeovers', *Journal of Business*, Vol. 59, No. 2 (April), pp. 197-216.

Seth, A., K. P. Song, and R. R. Pettit (2002), 'Value Creation and Destruction in Cross-Border Acquisitions: An Empirical Analysis of Foreign Acquisitions of US Firms', *Strategic Management Journal*, Vol. 23, No. 10 (October), pp. 921-40.

Smith, C., and R. Stulz (1985), 'The Determinants of Firm's Hedging Policies', *Journal of Financial and Quantitative Analysis*, Vol. 20, No. 4 (December), pp. 391-405.

Sudarsanam, P. S. (2003), *Creating Value from Mergers and Acquisitions: The Challenges* (Harlow: Pearson Education Limited).

Sudarsanam, S., P. Holl, and A. Salami (1996), 'Shareholder Wealth Gains in Mergers: Effect of Synergy and Ownership Structure', *Journal of Business Finance & Accounting*, Vol. 23, No. 5&6 (July), pp. 673-98.

Sudarsanam, S., and A. A. Mahate (2003), 'Glamour Acquirers, Method of Payment and Post-Acquisition Performance: The UK Evidence', *Journal of Business Finance & Accounting*, Vol. 30, No. 1&2 (January), pp. 299-341.

Wiseman, R. M., and L. R. Gomez-Mejia (1998), 'A Behavioral Agency Model of Managerial Risk Taking', *Academy of Management Review*, Vol. 23, No. 1 (January), pp. 133-53.

Xu, B., M. L. Magnan, and P. E. André (2007), 'The Stock Market Valuation of R&D Information in Biotech Firms', *Contemporary Accounting Research*, Vol. 24, No. 4 (Winter), pp. 1291-318.

Table 1
Distribution of M&As over the sample period

Year	Type of M&A		All
	Technology acquirers of technology targets	Non-technology acquirers of technology targets	
1993	71	8	79
1994	111	7	118
1995	123	8	131
1996	103	8	111
1997	150	13	163
1998	137	11	148
1999	162	12	174
2000	161	12	173
2001	142	12	154
2002	93	4	97
2003	122	11	133
2004	137	8	145
2005	139	11	150
2006	100	3	103
Total	1751	128	1879

Notes:
M&As are those made by U.S. acquirers during the period 1993–2006 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. Following e.g. Dessyllas and Hughes (2005), technology-intensive industries are defined according to the OECD two-digit SIC code classification, leading technology-intensive industries to be those that have one of the following two-digit SIC codes: 28, 35, 36, 37, 38, 48, 73 and 87

Table 2

Descriptive statistics of the variables used in the regressions

Variable	Mean	Median	Standard deviation	Min	Max
Panel A: Technology acquirers of technology targets (N = 20,583)					
RD_{it}/BV_{it}	0.144	0.110	0.129	0.006	1.283
P_{it}/BV_{it}	3.979	2.978	3.438	0.525	30.006
E_{it}/BV_{it}	0.199	0.217	0.263	–2.041	1.020
TA_{it}	8171	685	39770	0.917	795337
$DEALS_{it}$	0.544	0.000	1.290	0.000	17.000
CHS_{it}	17.452	12.746	18.302	0.000	100.000
OS_{it}	0.302	0.025	1.082	0.000	37.065
$OPTION_{it}$	6108	651	20218	0.000	4.980
$BONUS$	23.501	22.381	22.676	–117	628694
$SIZE_{it-1}$	6.047	0.084	197.075	0.000	7044.220
$TFOR_{it}$	0.212	0.000	0.408	0.000	1.000
ACQ_{it}	0.449	0.000	0.497	0.000	1.000
Panel B: Non-technology acquirers of technology targets (N = 1,515)					
RD_{it}/BV_{it}	0.073	0.060	0.072	0.004	0.842
P_{it}/BV_{it}	3.369	2.569	3.257	0.365	50.629
E_{it}/BV_{it}	0.148	0.177	0.255	–1.988	0.959
TA_{it}	4067	1185	6386	1.332	41798
$DEALS_{it}$	2.007	1.000	2.623	0.000	20.000
CHS_{it}	18.497	13.702	18.667	0.067	93.648
OS_{it}	0.251	0.043	0.630	0.000	8.663
$OPTION_{it}$	2662	486	6027	0.000	63916
$BONUS$	25.718	27.890	22.051	0.000	72.668
$SIZE_{it-1}$	0.222	0.041	0.523	0.000	4.717
$TFOR_{it}$	0.278	0.000	0.448	0.000	1.000
ACQ	0.555	1.000	0.497	0.000	1.000

Notes:

See Table 1 for the definition of *technology* acquirers and *non-technology* acquirers. This table reports the descriptive statistics for both subsamples of observations. The variables are as follows: RD_{it} is the research and development expenditures for acquirer i in year t; BV_{it} is the book value of equity for acquirer i in year t; P_{it} is the market value of equity for acquirer i in year t; E_{it} is the net income before R&D expenditures for acquirer i in year t; TA_{it} is the total asset (millions) for acquirer i in year t; $DEALS_{it}$ is the number of M&As that the acquirer has conducted during the three years prior to the year of the M&A; CHS_{it} is the number of acquirer i's shares held by insiders scaled by the number of common shares outstanding in year t; OS_{it} is the average of the sum of restricted stock granted and the number of shares held by the acquirer i's executive (excluding options) scaled by the number of common shares outstanding in year t; $OPTION_{it}$ is the average value of the acquirer i's top executives' in-the-money options in thousands of dollars in year t; $BONUS_{it}$ is the average cash-bonus compensation as a proportion of total compensation received by the top executives of the acquirer i in year t; $SIZE_{it-1}$ is the net sales of the target firm divided by the net sales of acquirer i in year t-1; $TFOR_{it}$ is an indicator variable equal to one if the target is a non-US firm, otherwise equal to zero; ACQ_{it} is an indicator variable equal to one if the transaction is an acquisition and equal to zero if the transaction is a merger. N is the number of observations.

Table 3

Stock market valuation of R&D spending in M&As involving technology acquirers and technology targets

Variable	(1)	(2)	(3)	(4)
Intercept	2.747	2.744	2.733	2.728
	(0.000)	(0.000)	(0.000)	(0.000)
RD_{it}/BV_{it}	3.590	3.593	3.395	3.827
	(0.000)	(0.000)	(0.000)	(0.000)
E_{it}/BV_{it}	2.762	2.766	2.876	1.883
	(0.000)	(0.000)	(0.000)	(0.000)
$M\&A_{it}$	-	0.093	–0.037	–0.0054
		(0.239)	(0.767)	(0.639)
$E_{it}/BV_{it}\times M\&A_{it}$	-	-	–0.976	–0.989
			(0.000)	(0.000)
$RD_{it}/BV_{it}\times M\&A_{it}$	-	-	2.122	4.109
			(0.000)	(0.000)
$SIZE_{it-1}$	-	-	-	0.000
				(0.000)
$RD_{it}/BV_{it}\times M\&A_{it}\times SIZE_{it-1}$	-	-	-	–0.001
				(0.556)
TA_{it}	-	-	-	–0.000
				(0.000)
$RD_{it}/BV_{it}\times M\&A_{it}\times TA_{it}$	-	-	-	–0.000
				(0.099)
$TFOR_{it}$	-	-	-	–0.149
				(0.004)
$RD_{it}/BV_{it}\times M\&A_{it}\times TFOR_{it}$	-	-	-	–0.057
				(0.956)
$DEALS_{it}$	-	-	-	–0.007
				(0.673)
$RD_{it}/BV_{it}\times M\&A_{it}\times DEALS_{it}$	-	-	-	–0.871
				(0.062)
ACQ_{it}	-	-	-	–0.330
				(0.000)
$RD_{it}/BV_{it}\times M\&A_{it}\times ACQ_{it}$	-	-	-	–0.298
				(0.704)
CHS_{it}	-	-	-	0.010
				(0.000)
$RD_{it}/BV_{it}\times M\&A_{it}\times CHS_{it}$	-	-	-	–0.089
				(0.000)
OS_{it}	-	-	-	0.159
				(0.000)
$RD_{it}/BV_{it}\times M\&A_{it}\times OS_{it}$	-	-	-	0.209
				(0.734)
$BONUS_{it}$	-	-	-	0.014
				(0.000)
$RD_{it}/BV_{it}\times M\&A_{it}\times BONUS_{it}$	-	-	-	0.026
				(0.231)

$OPTION_{it}$	-	-	-	0.000 (0.000)
$RD_{it}/BV_{it} \times M\&A_{it} \times OPTION_{it}$	-	-	-	–0.000 (0.023)
Yearly controls	Included	Included	Included	Included
Industry controls	Included	Included	Included	Included
N	20583	20583	20583	20583
Adj R^2	0.160	0. 160	0.161	0.303

Notes:

See Table 1 for the definition of *technology* acquirers and *non-technology* acquirers. This table reports the coefficient estimates and significance levels from estimating the following model using the sub-sample of technology acquirers of technology targets:

$$\frac{P_{it}}{BV_{it}} = \beta_0 + \beta_1 \frac{RD_{it}}{BV_{it}} + \beta_2 \frac{E_{it}}{BV_{it}} + \beta_3 M\&A_{it} + \beta_4 \frac{RD_{it}}{BV_{it}} \times M\&A_{it} + \beta_5 \frac{E_{it}}{BV_{it}} \times M\&A_{it} + \beta_6 X_{it} + \beta_7 \frac{RD_{it}}{BV_{it}} \times M\&A_{it} \times X_{it} + \sum_{k=1}^{7} \varphi_k IND_k + \sum_{y=1993}^{2006} \lambda_y YEAR_y + \varepsilon_{it}.$$

BV_{it} is the book value of equity for acquirer *i* in year *t*; P_{it} is the market 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 net income before R&D expenditures for acquirer *i* in year *t*; $M\&A_{it}$ is an indicator variable equal to one if a firm *i* acquires a technology target during year *t*, otherwise equal to zero; TA_{it} is the total asset (millions) for acquirer *i* in year *t*; $DEALS_{it}$ is the number of M&As that the acquirer has conducted during the three years prior to the year of the M&A; CHS_{it} is the number of acquirer *i*'s shares held by insiders scaled by the number of common shares outstanding in year *t*; OS_{it} is the average of the sum of restricted stock granted and the number of shares held by the acquirer *i*'s executive (excluding options) scaled by the number of common shares outstanding in year *t*; $OPTION_{it}$ is the average value of the acquirer *i*'s top executives' in-the-money options in thousands of dollars in year *t*; $BONUS_{it}$ is the average cash-bonus compensation as a proportion of total compensation received by the top executives of the acquirer *i* in year *t*; $SIZE_{it-1}$ is the net sales of the target firm divided by the net sales of acquirer *i* in year t-1; $TFOR_{it}$ is an indicator variable equal to one if the target is a non-US firm, otherwise equal to zero; ACQ_{it} is an indicator variable equal to one if the transaction is an acquisition and equal to zero if the transaction is a merger; $YEAR_y$ represents indicator variables equal to one in year *y*, otherwise equal to zero. Results are reported without control variables (columns 1-3) and with including control variables (column 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 4

Stock market valuation of R&D spending in M&As involving non-technology acquirers and technology targets

Variable	(1)	(2)	(3)	(4)
Intercept	1.348	1.159	1.287	0.438
	(0.000)	(0.001)	(0.000)	(0.231)
RD_{it}/BV_{it}	18.299	18.539	19.526	19.382
	(0.000)	(0.000)	(0.000)	(0.000)
E_{it}/BV_{it}	3.557	3.552	3.432	2.349
	(0.000)	(0.000)	(0.000)	(0.000)
$M\&A_{it}$	-	–0.117	0.364	0.523
		(0.658)	(0.429)	(0.249)
$E_{it}/BV_{it}\times M\&A_{it}$	-	-	1.261	–0.517
			(0.279)	(0.771)
$RD_{it}/BV_{it}\times M\&A_{it}$	-	-	–9.149	–14.714
			(0.009)	(0.009)
$SIZE_{it-1}$	-	-	-	0.233
				(0.121)
$RD_{it}/BV_{it}\times M\&A_{it}\times SIZE_{it-1}$	-	-	-	1.391
				(0.645)
TA_{it}	-	-	-	0.000
				(0.001)
$RD_{it}/BV_{it}\times M\&A_{it}\times TA_{it}$	-	-	-	–0.000
				(0.869)
$TFOR_{it}$	-	-	-	–0.206
				(0.234)
$RD_{it}/BV_{it}\times M\&A_{it}\times TFOR_{it}$	-	-	-	4.721
				(0.586)
$DEALS_{it}$	-	-	-	–0.044
				(0.143)
$RD_{it}/BV_{it}\times M\&A_{it}\times DEALS_{it}$	-	-	-	2.016
				(0.254)
ACQ_{it}	-	-	-	–0.445
				(0.003)
$RD_{it}/BV_{it}\times M\&A_{it}\times ACQ_{it}$	-	-	-	2.600
				(0.622)
CHS_{it}	-	-	-	0.013
				(0.002)
$RD_{it}/BV_{it}\times M\&A_{it}\times CHS_{it}$	-	-	-	0.068
				(0.611)
OS_{it}	-	-	-	0.520
				(0.000)
$RD_{it}/BV_{it}\times M\&A_{it}\times OS_{it}$	-	-	-	–14.035
				(0.049)
$BONUS_{it}$	-	-	-	0.017
				(0.000)
$RD_{it}/BV_{it}\times M\&A_{it}\times BONUS_{it}$	-	-	-	0.057
				(0.807)
$OPTION_{it}$	-	-	-	0.000

$RD_{it}/BV_{it} \times M\&A_{it} \times OPTION_{it}$	-	-	-	(0.000) 0.001 (0.184)
Yearly controls	Included	Included	Included	Included
Industry controls	Included	Included	Included	Included
N	1515	1515	1515	1515
Adj R^2	0.240	0.242	0.245	0.349

Notes:

See Table 1 for the definition of *technology* acquirers and *non-technology* acquirers. This table reports the coefficient estimates and significance levels from estimating the following model using the sub-sample of non-technology acquirers of technology targets:

$$\frac{P_{it}}{BV_{it}} = \beta_0 + \beta_1 \frac{RD_{it}}{BV_{it}} + \beta_2 \frac{E_{it}}{BV_{it}} + \beta_3 M\&A_{it} + \beta_4 \frac{RD_{it}}{BV_{it}} \times M\&A_{it} + \beta_5 \frac{E_{it}}{BV_{it}} \times M\&A_{it} + \beta_6 X_{it} + \beta_7 \frac{RD_{it}}{BV_{it}} \times M\&A_{it} \times X_{it} + \sum_{k=1}^{7} \varphi_k IND_k + \sum_{y=1993}^{2006} \lambda_y YEAR_y + \varepsilon_{it},$$

BV_{it} is the book value of equity for acquirer *i* in year *t*; P_{it} is the market 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 net income before R&D expenditures for acquirer *i* in year *t*; $M\&A_{it}$ is an indicator variable equal to one if a firm *i* acquires a technology target during year *t*, otherwise equal to zero; TA_{it} is the total asset (millions) for acquirer *i* in year *t*; $DEALS_{it}$ is the number of M&As that the acquirer has conducted during the three years prior to the year of the M&A; CHS_{it} is the number of acquirer *i*'s shares held by insiders scaled by the number of common shares outstanding in year *t*; OS_{it} is the average of the sum of restricted stock granted and the number of shares held by acquirer *i*'s executive (excluding options) scaled by the number of common shares outstanding in year *t*; $OPTION_{it}$ is the average value of acquirer *i*'s top executives' in-the-money options in thousands of dollars in year *t*; $BONUS_{it}$ is the average cash-bonus compensation as a proportion of total compensation received by the top executives of acquirer *i* in year *t*; $SIZE_{it-1}$ is the net sales of the target firm divided by the net sales of acquirer *i* in year t-1; $TFOR_{it}$ is an indicator variable equal to one if the target is a non-US firm, otherwise equal to zero; ACQ_{it} is an indicator variable equal to one if the transaction is an acquisition and equal to zero if the transaction is a merger; $YEAR_y$ represents indicator variables equal to one in year *y*, otherwise equal to zero. Results are reported without control variables (columns 1-3) and with including control variables (column 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 5

Effect of current R&D spending on the future profitability of the technology and non-technology acquirers of technology targets

Variable	Technology acquirers of technology targets		Non-technology acquirers of technology targets	
	3-years-ahead-earnings (Model 3)	5-years-ahead-earnings (Model 4)	3-years-ahead-earnings (Model 3)	5-years-ahead-earnings (Model 4)
Intercept	0.077	0.088	0.080	0.092
	(0.000)	(0.000)	(0.000)	(0.000)
E_{it}/BV_{it}	0.430	0.363	0.346	0.272
	(0.000)	(0.000)	(0.000)	(0.000)
RD_{it}/BV_{it}	0.219	0.046	–0.125	0.166
	(0.000)	(0.029)	(0.442)	(0.247)
RD_{it+1}/BV_{it+1}	0.139	0.182	0.052	–1.036
	(0.000)	(0.000)	(0.749)	(0.000)
RD_{it+2}/BV_{it+2}	–0.047	0.039	0.539	0.858
	(0.007)	(0.077)	(0.000)	(0.000)
RD_{it+3}/BV_{it+3}	-	0.062	-	–0.008
		(0.007)		(0.960)
RD_{it+4}/BV_{it+4}	-	–0.003	-	0.521
		(0.858)		(0.000)
$M\&A_{it}$	–0.029	–0.019	–0.071	–0.111
	(0.000)	(0.032)	(0.023)	(0.001)
$E_{it}/BV_{it} \times M\&A_{it}$	–0.012	–0.030	0.317	0.257
	(0.581)	(0.232)	(0.010)	(0.039)
$RD_{it}/BV_{it} \times M\&A_{it}$	0.268	0.243	–0.646	0.804
	(0.000)	(0.005)	(0.299)	(0.240)
$RD_{it+1}/BV_{it+1} \times M\&A_{it}$	–0.104	–0.117	0.720	0.142
	(0.188)	(0.199)	(0.308)	(0.882)
$RD_{it+2}/BV_{it+2} \times M\&A_{it}$	–0.057	0.001	–0.118	–1.304
	(0.346)	(0.989)	(0.802)	(0.204)
$RD_{it+3}/BV_{it+3} \times M\&A_{it}$	-	0.138	-	1.185
		(0.211)		(0.246)
$RD_{it+4}/BV_{it+4} \times M\&A_{it}$	-	–0.133	-	0.219
		(0.085)		(0.758)
N	14109	10873	1051	833
Adj R^2	0.338	0.307	0.235	0.248

Notes:

See Table 1 for the definition of *technology* acquirers and *non-technology* acquirers. The coefficient estimates and significance levels from estimating the following model are reported in column (1) for *technology* acquirers of technology targets and in column (3) for *non-technology* acquirers of technology targets:

$$\frac{1}{3}\sum_{k=1}^{3}\frac{E_{i,t+k}}{BV_{i,t+k}} = \beta_0 + \beta_1\frac{E_{it}}{BV_{it}} + \beta_2\frac{RD_{it}}{BV_{it}} + \beta_3 M\&A_{it} + \beta_4\frac{RD_{it}}{BV_{it}}\times M\&A_{it} + \beta_5\frac{E_{it}}{BV_{it}}\times M\&A_{it} + \sum_{k=1}^{3}\eta_{i,k}\frac{RD_{i,t+k}}{BV_{i,t+k}} + \sum_{k=1}^{3}\gamma_{i,k}\frac{RD_{i,t+k}}{BV_{i,t+k}}\times M\&A_{it} + \varepsilon_{it}.$$

The coefficient estimates and significance levels from estimating the following model are reported in Column (2) for Technology acquirers of technology targets and in Column (4) for Non-technology acquirers of technology targets:

$$\frac{1}{5}\sum_{k=1}^{5}\frac{E_{i,t+k}}{BV_{i,t+k}} = \beta_0 + \beta_1\frac{E_{it}}{BV_{it}} + \beta_2\frac{RD_{it}}{BV_{it}} + \beta_3 M\&A_{it} + \beta_4\frac{RD_{it}}{BV_{it}}\times M\&A_{it} + \beta_5\frac{E_{it}}{BV_{it}}\times M\&A_{it} + \sum_{k=1}^{5}\eta_{i,k}\frac{RD_{i,t+k}}{BV_{i,t+k}} + \sum_{k=1}^{5}\gamma_{i,k}\frac{RD_{i,t+k}}{BV_{i,t+k}}\times M\&A_{it} + \varepsilon_{it}.$$

Dependent variable is either the average three-years-ahead or five-years-ahead earnings before research and development expenses deflated by the book value of equity (E_{it}/BV_{it}) 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; RD_{it+k} is the research and development expenditures for acquirer *i* in year $t+k$; E_{it} is the net income before R&D expenditures for acquirer *i* in year *t*; $M\&A_{it}$ is an indicator variable equal to one if a firm *i* acquires a technology target during year *t*, otherwise equal to 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 6
Results from using alternative estimation techniques

Variable	Technology acquirers of technology targets			Non-technology acquirers of technology targets		
	(1) Newey-West	(2) Return model	(3) Cross-section	(4) Newey-West	(5) Return model	(6) Cross-section
Intercept	2.728	0.327	4.069	0.438	0.002	1.155
	(0.000)	(0.000)	(0.000)	(0.372)	(0.985)	(0.005)
RD_{it}/BV_{it}	3.827	0.004	6.227	19.381	–0.066	3.360
	(0.000)	(0.110)	(0.000)	(0.000)	(0.149)	(0.000)
E_{it}/B_{it}	1.883	0.008	6.330	2.349	–0.016	3.122
	(0.000)	(0.004)	(0.000)	(0.001)	(0.181)	(0.000)
$M\&A_{it}$	–0.054	–0.086	–0.203	0.523	0.242	–0.048
	(0.667)	(0.003)	(0.398)	(0.156)	(0.044)	(0.806)
$E_{it}/BV_{it}\times M\&A_{it}$	–0.989	0.004	–0.388	–0.517	–0.525	–0.373
	(0.033)	(0.794)	(0.359)	(0.751)	(0.251)	(0.109)
$RD_{it}/BV_{it}\times M\&A_{it}$	4.109	0.307	0.887	–14.714	–1.630	–0.682
	(0.003)	(0.010)	(0.085)	(0.020)	(0.270)	(0.007)
Control variables	Included	Included	Included	Included	Included	Included
N	20583	19593	14	1515	1445	14
Adj R^2	0.303	0.091	-	0.349	0.115	-

Notes:
See Table 1 for the definition of *technology* acquirers and *non-technology* acquirers. The columns (1) for *technology* acquirers and (4) for *non-technology* acquirers report the coefficient estimates and significance levels from estimating the following model using GMM method with all the explanatory variables as instruments, where all the parameters are estimated using the Newey-West sandwich-estimators in order to control for heteroskedasticity and autocorrelation:

$$\frac{P_{it}}{BV_{it}} = \beta_0 + \beta_1 \frac{RD_{it}}{BV_{it}} + \beta_2 \frac{E_{it}}{BV_{it}} + \beta_3 M\&A_{it} + \beta_4 \frac{RD_{it}}{BV_{it}} \times M\&A_{it} + \beta_5 \frac{E_{it}}{BV_{it}} \times M\&A_{it} + \beta_6 X_{it} + \beta_7 \frac{RD_{it}}{BV_{it}} \times M\&A_{it} \times X_{it} + \sum_{k=1}^{7} \varphi_k IND_k + \sum_{y=1993}^{2006} \lambda_y YEAR_y + \varepsilon_{it}.$$

The columns (2) for *technology* acquirers and (5) for *non-technology* acquirers report the coefficient estimates and significance levels from estimating the following return model:

$$R_{it} = \beta_0 + \beta_1 \frac{RD_{it}}{BV_{it}} + \beta_2 \frac{E_{it}}{BV_{it}} + \beta_3 M\&A_{it} + \beta_4 \frac{RD_{it}}{BV_{it}} \times M\&A_{it} + \beta_5 \frac{E_{it}}{BV_{it}} \times M\&A_{it} + \beta_6 X_{it} + \beta_7 \frac{RD_{it}}{BV_{it}} \times M\&A_{it} \times X_{it} + \sum_{k=1}^{7} \varphi_k IND_k + \sum_{y=1993}^{2006} \lambda_y YEAR_y + \varepsilon_{it}.$$

The columns (3) for *technology* acquirers and (6) for *non-technology* acquirers report the averages of coefficient estimates from yearly cross-sectional estimations and their significance levels from estimating the same model as in columns (1) and (4).
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 net income before R&D expenditures for acquirer i in year t; $M\&A_{it}$ is an indicator variable equal to one if a firm i acquires a technology target during year t, otherwise equal to zero; R_{it} is the annual stock return for acquirer i in year t; $YEAR_y$ represents indicator variables equal to one in year y, otherwise equal to 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 7

Impact of the M&A on acquirer's earnings and R&D expenditures

Dependent Variable	*Intercept*	*M&A*	N	Adj R^2
Panel A: Technology acquirers of technology targets				
E_{it}/BV_{it}	0.206	–0.041	20583	0.031
	(0.000)	(0.000)		
RD_{it}/BV_{it}	0.134	–0.008	20583	0.006
	(0.000)	(0.013)		
Panel B: Non-technology acquirers of technology targets				
E_{it}/BV_{it}	0.177	–0.020	1515	0.033
	(0.000)	(0.389)		
RD_{it}/BV_{it}	0.068	–0.001	1515	0.001
	(0.000)	(0.885)		

Notes:

See Table 1 for the definition of *technology* acquirers and *non-technology* acquirers. The coefficient estimates and significance levels from estimating the following models are reported in panel A for *technology* acquirers of technology targets and in panel B for *non-technology* acquirers of technology targets:

$$\frac{E_{it}}{BV_{it}} = \beta_0 + \beta_1 M\&A_{it} + \sum_{y=1990}^{2004} \lambda_{iy} YEAR_y + \varepsilon_{it}, \qquad \frac{RD_{it}}{BV_{it}} = \beta_0 + \beta_1 M\&A_{it} + \sum_{y=1990}^{2004} \lambda_{iy} YEAR_y + \varepsilon_{it}.$$

BV_{it} is the book value of equity for acquirer i in year t; P_{it} is the market 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 net income before R&D expenditures for acquirer i in year t; $M\&A_{it}$ is an indicator variable equal to one if a firm i acquires a technology target during year t, otherwise equal to zero; $YEAR_y$ represents indicator variables equal to one in year y, otherwise equal to zero. To save space, we do not report the estimated parameters for the yearly indicator variables in the table. 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.