

The Stock Market Valuation of Acquirer's R&D Spending in Cross-Border Technology M&As

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The Stock Market Valuation of Acquirer's R&D Spending in Cross-border Technology Mergers and Acquisitions

Abstract: This paper investigates how cross-border technology mergers and acquisitions (M&A) affect the stock market valuation of acquiring firm's research and development (R&D) spending. Our empirical analyses are based on M&As conducted by acquirers in the ten most R&D active countries in Europe. We report that, on average, the stock market valuation of acquirer's R&D spending increases in cross-border M&As if both the acquirer and the target are technology firms. This indicates that investors regard European cross-border M&As to add value to technology acquirer's R&D activity. We also investigate the impact of several macroeconomic factors on the observed increase in the stock market valuation of acquirer's R&D spending in order to identify the environments for cross-border M&As that are most beneficial to acquirer's R&D activities.

1. Introduction

A firm's future growth is driven by innovations that result from the firm's research and development (R&D) efforts. Consistently, numerous studies find that a firm's current R&D spending is positively related to the future cash flows and earnings of a firm (e.g. Lev and Sougiannis 1996; Sougiannis 1994). The stock market has also acknowledged this association, leading investors to regard firms' R&D spending as value-creating investments. Accordingly, finance and economics literature documents a positive stock market valuation of the R&D spending of the firm (e.g. Chan, Lakonishok and Sougiannis 2001; Hall and Oriani 2004; Jaffe 1986; Johnson and Pazderka 1993).

New information regarding the firm's R&D activities can change the value of these R&D activities perceived by the stock market. Several studies find evidence that R&D announcements are significantly positively associated with stock returns (e.g. Chan, Martin and Kensinger 1990; Jarrell, Lehn and Marr 1985; Woolridge and Snow

1990). The positive stock market response to R&D announcements indicates that investors consider these investments to be beneficial for the firm's R&D activity.

Hitt, Hoskisson and Ireland (2001) suggest that a firm can improve its R&D program either internally or through external acquisitions. Due to continuous technical development, fierce competition, and certain constraints involved with internal development, firms with extensive R&D programs are forced to seek also external resources. Mergers and acquisitions (hereafter M&A) provide acquirers means to supplement their internal R&D efforts (Higgins and Rodriguez 2006). Several studies show that M&As are indeed typically motivated by important strategic goals such as pursuing innovations and expanding acquirer's existing R&D activities (e.g. Anand and Singh 1997; Capron, Dussauge and Mitchell 1998; Hitt, Harrison and Ireland 2001; Kozin and Young 1994).

This paper investigates whether technology mergers and acquisitions, many of which are often aimed at supplementing acquirer's R&D activities, enhance the stock market valuation of acquirer's R&D spending. We focus on cross-border M&As because they have become more and more frequent in the past decades due to the continuous integration of capital markets, emergence of new markets and globalization. Also fast technical development forces technology firms not only to acquire external resources, but also to acquire them abroad. Yet, as Bertrand and Zuniga (2006) point out, the research on the impact of cross-border M&As on technological activity is scarce. Prior literature focusing on international acquisitions report that the market rewards acquirers with genuine high growth opportunities for their desire to internationalize through acquisitions (e.g. Doukas 1995; Mathur, Singh and Gleason 2004; Morck and Yeung 1992). On the other hand, Bae and Seungwook (2001) document that the association between a firm's R&D investment and market value is

stronger for multinational corporations than for domestic corporations. Combining these two sets of evidence, we hypothesize, that a technology cross-border acquisition, being a step towards a more multinational corporation, will enhance the stock market valuation of acquirer's R&D spending.

We contribute to the prior literature in the following aspects. First, the main findings of our study contribute to the literature focusing on the stock market valuation of a firm's R&D spending (Chan, Martin and Kensinger 1990; Jaffe 1986; Lev and Sougiannis 1996). We document that the stock market values the technology acquirer's R&D spending higher after a cross-border merger or acquisition if both firms involved are regarded as technology firms. Thus, investors believe that technology firms can successfully use mergers and acquisitions to supplement and improve their existing R&D activities.

The second contribution of the study is situated in the cross-border M&A literature. Bertrand and Zuniga (2006) do not find any consistent evidence of increases in the aggregate R&D investments after cross-border M&As in OECD countries. Our findings are consistent with these results in that we do not find any significant impact of cross-border M&As on the amount acquirer's R&D spending. However, our findings indicate that cross-border technology M&As are successful as they boost the investor confidence on the acquirer's R&D activities, which can be regarded as crucial activities for many of those firms that seek for external resources abroad. These findings are consistent with the arguments of Doukas (1995), according to whom investors reward acquirers who expand abroad due to genuine growth opportunities, rather than for managerial motives. Our evidence also takes the findings of Bae and Seungwook (2001) to a new level. As they report higher stock market valuation of R&D spending for multinational corporations than for domestic corporations, we document that the stock

market valuation of a technology firm's R&D spending actually increases every time it acquires a cross-border technology target.

Third, we broaden the investigation of the differences in the stock market valuation of a firm's R&D spending between countries to the context of mergers and acquisitions. Since M&As can be used as means to improve and supplement acquirer's R&D activity, these transactions can be regarded as one kind of R&D related investment. Several country specific factors, such as financial system, are found to have an effect on the way investors value firms' R&D expenditures. We investigate, whether the same characteristics affect the extent to which investors regard these cross-border technology M&As to increase the value of acquirer's R&D activities.

Fourth, we focus our investigation to European countries and therefore provide results from outside the U.S. We have large evidence on the stock market valuation of R&D in the US and the UK but the analyses for other European countries are still relatively rare. The countries are selected based on their high ranking on the list of the most R&D active countries, making the sample relevant regarding the stock market valuation of R&D spending as well as in terms of cross-border technology acquisitions.

The paper is organized as follows. Section 2 reviews the literature and develops the hypotheses. Section 3 provides the data description and Section 4 describes the research design. Section 5 reports the empirical results and Section 6 concludes.

2. Hypothesis development

Several studies find evidence that R&D announcements are significantly positively associated with stock returns (e.g. Chan, Martin and Kensinger 1990; Jarrell, Lehn and Marr 1985; Woolridge and Snow 1990). Eberhart, Maxwell and Siddique

(2004) document that R&D increases are beneficial investments for firms, even though the market is slow to recognize the extent of this benefit. The observed positive stock market reaction to R&D investments indicates that the investors believe that a firm's R&D operations will generate more value due to the investment.

The production of knowledge through R&D, however, is a lengthy project, with uncertain outcomes, that requires detailed long-term appraisal and careful short-term synchronization (Bae and Seungwook 2001). Even the large leading firms in an industry cannot have full expertise in all related fields, which is why successful innovation requires learning through co-operative networks (Kang and Sakai 2001). This forces technology firms to co-operate with others in order to be more effective and possess the leading-edge technologies. In the past few decades, firms have indeed increasingly used mergers and acquisitions as means to improve their competitive advantages resulting from efficiency, productivity and value of their R&D operations (e.g. Anand and Singh 1997; Capron, Dussauge and Mitchell 1998; Hitt, Harrison and Ireland 2001; Kang and Sakai 2001; Kozin and Young 1994). Even though several studies report M&As to decrease acquirer's R&D activity (e.g. Hitt et al. 1991), M&As can still be beneficial for acquirer's R&D activity because they can make it more efficient as some studies document (e.g. Ahuja and Katila 2001; Cassiman et al. 2005).

Cross-border M&As allow firms an access to new product markets and thus provide other uses for their R&D and production capabilities (Capron 1999). Accordingly, Cebenoyan, Pepaioannou and Travlos (1992) posit that cross-border acquisitions allow firms to gain competitive advantage from the possession of specialized resources. Firms can use M&As to derive benefits by exploiting country differences of financial and product markets, that result from relative difficulties of obtaining information, divergences in the level of technology, and differences in the

regulation (Kiyamaz and Mukherjee 2000). Accordingly, if a firm has know-how that can be used in the markets where the sale or lease of such knowledge is inherently inefficient, then the firm will tend to exploit this knowledge advantage within its own organisation (Seth, Song and Pettit 2002). These arguments are consistent with the ownership location paradigm (OLI), which suggests that a firm needs to have a competitive advantage driven by intangibles (ownership advantage) to undertake foreign direct investment successfully (Kang and Sakai 2001). According to the OLI paradigm, the internationalisation of markets is aimed at extending the exploitation of competitive advantage abroad (Kang and Sakai 2001).

A firm can go abroad not only to exploit its technological capabilities and knowledge assets but also to access foreign technology (Bertrand and Zuniga 2006; Kuemmerle 1999). Firms can use M&As as channels for reorganizing R&D activities since they enable them to quickly expand their knowledge base by accessing new technological assets (Bertrand and Zuniga 2006). Accordingly, Gao and Sudarsanam (2003) posit that a technology target may bring the acquirer the expertise, some technology or some infrastructure which can enhance the acquirer's capabilities to gain sustainable competitive advantage. Similarly, Vasconcellos and Kish (1998) suggest that if a firm falls behind in the level of technological knowledge necessary to compete efficiently in its industry, and it is unable or unwilling to obtain the required technology through research and development, then it may attempt to acquire a foreign firm which is technologically more advanced. In this case, globalisation is motivated by a missing resource rather than by some pre-existent ownership advantage as described in the OLI paradigm (Kang and Sakai 2001). Also, through cross-border mergers and acquisitions, the acquirer can lead the target's resources to a better global use (Doukas 1995), of which the acquirer's R&D activity can benefit as well. These globalisation strategies

aim at creating or reinforcing competitive advantages through an efficient global production network (Kang and Sakai 2001).

Therefore, cross-border M&As provide sources of value different from domestic M&As – sources of value that can improve the acquirer's R&D activities. Cross-border M&As present growth opportunities that are different from domestic transactions, such as risk management, improved technology and favourable government policies (Moeller and Schlingemann 2005). Acquirers may also find specific and complementary technological resources more easily in foreign partners, since countries' specific characteristics, in terms of both natural resources and institutional environment, generate different specialisation and innovation patterns (Kang and Sakai 2001). Moreover, merging partners in cross-border M&As are also more likely to differ in terms of technological characteristics when initially being located in distinct countries, which may lead to more promising R&D programs (Bertrand and Zuniga 2006). These advantages generate growth opportunities that can be favourable for cross-border acquirer's R&D activities.

These arguments are consistent with the theory of the multinational enterprise, which suggests that firms with intangible assets can create synergies, which translate into shareholder value by internalizing their international transactions in the form of foreign direct investments (Moeller and Schlingemann 2005). Moreover, according to the OLI paradigm, a firm needs to have a competitive advantage arising from e.g. intangible assets to undertake internationalisation successfully (Kang and Sakai 2001). Bae and Seungwook (2001) find, consistent with the above suggestions, that the stock market valuation of R&D is stronger for multinational firms than domestic firms. Accordingly, Morck and Yeung (1992) report that the positive relationship between

multinationalism and firm's market value is explained by the presence of intangible assets.

There is, however, one important note to make when considering M&As involving technology firms. Many prior studies emphasize the complementarity of the acquirer's and the targets' operations in successful M&As. Teece (1987), Cohen and Levinthal (1990), and Chesbrough (2003) argue that a firm's absorptive capacity, which comprises of a firm's prior state of knowledge and experience, contributes to the firm's capacity to assimilate external knowledge and is vital for successful integration of acquired technologies. All of these arguments contend that firms should have the absorptive capacity to integrate the external knowledge into their own R&D program (Higgins and Rodriguez 2006), indicating that only a technology firm can effectively use the acquired technology resources. The existing empirical evidence is consistent with this argument (e.g. Gao and Sudarsanam 2003; Higgins and Rodriguez 2006; Kohers and Kohers 2000).

Following the preceding discussion, we construct the following hypothesis.

Hypothesis 1: Cross-border mergers and acquisitions enhance the stock market valuation of the acquirer's R&D spending if both firms involved are technology firms.

The macroeconomic environment influences both the supply and demand for cross-border M&As (Kang and Sakai 2001). The financial environment of the acquirer is likely to affect the way investors look at mergers and acquisitions. Different financial systems vary in their potential to provide effective monitoring and incentives for value-creating investments (Seth, Song and Pettit 2002) as well as in their impact on the

investors' overall attitude towards firms' investments such as R&D. Booth et al. (2006) examine the variation of the relationship between a firm's market value and its R&D spending across countries that exhibit differences in financial system. They report that a firm's R&D expenditures are valued by the stock market more strongly in a market-based than in a bank-based financial system. These findings are consistent with the views of the proponents of the market-based systems, who emphasize that powerful banks frequently stymie innovation and growth by favouring conservative investments and protecting established firms (Beck and Levine 2002).

Following the preceding discussion, we argue that the financial system of the acquirer affects the way investors consider cross-border technology M&As to increase the value related to acquirer's R&D spending. Because prior literature documents higher stock market valuation of a firm's R&D spending in countries of market-based than in countries of bank-based financial system, we expect investors of acquirers in countries of market-based financial system to consider cross-border technology M&As to create more R&D related value for acquirers than do investors of acquirers in countries of bank-based financial system. Therefore we form the following hypothesis:

Hypothesis 2: The effect of cross-border technology M&As on the stock market valuation of acquirer's R&D spending is stronger for acquirers in a countries of market-based financial system than bank-based financial system.

Acquirers can use cross-border M&As to reallocate corporate assets toward more effective use. Consistently, Rossi and Volpin (2004) report that the targets in cross-border M&As are typically from countries with poorer investor protection compared to

their acquirers. This suggests that acquirers are willing to acquire targets with less developed financial markets because they see a potential for better use of resources. This is consistent with the theories explaining cross-border M&As which are based on the assumption that firms enter foreign markets to exploit the firms' specific resources to take advantage of imperfections in the markets (e.g. Buckley and Casson 1976; Doukas and Travlos 1988; Morck and Yeung 1992; Seth, Song and Pettit 2002).

Since the stock market valuation of firms' R&D spending is lower in countries of lower investor protection and less developed stock markets (Booth et al. 2006), the findings of Rossi and Volpin (2004) could be taken further to suggest that the stock market valuation of firms' R&D spending is usually lower in the cross-border target's country compared to acquirer's country. Therefore, acquirers could prefer targets from countries of less developed financial systems, because the R&D spending of these targets is potentially undervalued, calling for better use. Following this discussion we develop the third hypothesis:

Hypothesis 3: The effect of cross-border technology M&As on the stock market valuation of acquirer's R&D spending is stronger the greater the difference between the degrees of financial system's development in acquirer's and target's countries.

Since the 1980s, innovation policies have promoted co-operative R&D on the basis that it leads to knowledge spillovers and economies of scale (Kang and Sakai 2001). EU innovation policy has also promoted co-operative international R&D (Kang and Sakai 2001). Therefore, it is obvious that innovation policy at the very least provides incentives for cross-border technology M&As. It may also affect the value that

investors place on corporate R&D and R&D driven cross-border M&As. Expecting the general high R&D intensity of the acquirer's home country to affect the investors' overall perceptions of technology M&As, we construct the following hypothesis:

Hypothesis 4: The effect of cross-border technology M&As on the stock market valuation of acquirer's R&D spending is stronger the more R&D intensive the acquirer's country.

Since many M&As are motivated by the objective to improve the acquirer's R&D, cross-border M&As may provide targets in countries with the environment more favourable in terms of R&D. Kiyamaz and Mukherjee (2000) stress the divergences in the level of technology among countries in creating wealth effects of cross-border M&As. Therefore, we form the following hypothesis:

Hypothesis 5: The effect of cross-border technology M&As on the stock market valuation of acquirer's R&D spending is stronger the greater the difference between R&D intensities of the acquirer's and target's countries.

3. Data description

The data used in the study is retrieved from Thomson SDC and Worldscope databases by including all M&As conducted by acquirers from ten European countries

that are listed in the R&D Scoreboard list of top fifteen R&D active countries¹. This selection generates a fruitful sample of firms in those countries in which R&D activities are important for the whole economy. Also, in order to be considered in the sample, at least the acquirer or the target firm has to have their primary activity in a technology-intensive industry sector². Mergers and acquisitions are defined 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, as a result of the M&A, increases its ownership to at least 50 per cent. We consider only M&As where the target's net sales is at least 0.1 percent of the acquirer's net sales. We use this exclusion because, in cross-border M&As, small targets are not likely to get any attention in the acquirer's stock market. To reduce overlapping observations, we filter the initial sample by including only one merger or acquisition for each acquirer per year. Therefore, following Danzon, Epstein and Nicholson (2004), we include only the acquirer's largest merger or acquisition in the sample if the same acquirer undertakes more than one of those in one year. A transaction is also excluded from the sample if there is no sufficient yearly data about the acquiring firm³.

The initial sample consists of all cross-border mergers and acquisitions made by acquirers from the selected European countries and with either the acquirer or target or both being technology firms. The period used in the study is 1990–2004⁴. The ultimate sample consists of 586 mergers and acquisitions. Table 1 provides the distribution of mergers and acquisitions by acquirer country and by transaction year.

¹ The selected countries are, from the most R&D active to the least R&D active among the group, Germany, France, United Kingdom, Switzerland, Netherlands, Sweden, Finland, Italy, Denmark and Belgium.

² The two-digit SIC codes regarded as technology-intensive are 28, 35, 36, 37, 38, 48, 73 and 87. These industries are classified as technology- and knowledge-intensive by the OECD. This classification has been used also by Dessyllas & Hughes (2005).

³ The data about the acquirer has to be available at least the year before, the year after and for the year of the transaction.

⁴ The year 1990 is chosen because in the 1990s, liberalisation of international capital movements and foreign direct investments led to cross-border transactions on a larger scale and involved a wider range of countries (Kang and Sakai 2001).

(Insert Table 1 about here)

We further divide our sample into three groups according to the technological classification of the acquirer and target firm. The first group, consisting of M&As with *a technology acquirer and a technology target*, has 4984 firm-year observations from 436 M&As. The second group includes M&As with *a technology acquirer and a non-technology target*, having 1573 firm-year observations from 126 M&As. The third group comprises of M&As with *a non-technology acquirer and a technology target*, totalling 978 firm-year observations from 49 M&As. Later in this paper, we refer to the first group as *technology M&As* and to the other two groups as *non-technology M&As*. Table 2 reports descriptive statistics of the variables used in the regressions by the above M&A groups. The results show that technology acquirers of other technology firms have an average R&D intensity of 14.7 percent, which is significantly greater than that for technology acquirers of non-technology targets. As expected, the R&D intensity for non-technology acquirers of technology targets is significantly smaller than for the acquirers in other two groups. The statistics also show that the stock market valuation of technology acquirers is higher than for the non-technology acquirers, supporting the growth expectations that investors place on these firms after technology M&As. Moreover, the earnings for the technology acquirers is smaller than for non-technology acquirers, which is consistent with acquirers having to expense larger amounts of in-process R&D in technology M&As.

(Insert Table 2 about here)

4. Research design

The hypotheses are tested by estimating the following OLS regression model:

$$\frac{P_{it}}{BV_{it}} = \beta_0 + \beta_1 + \frac{RD_{it}}{BV_{it}} + \beta_2 \frac{E_{it}}{BV_{it}} + \beta_3 M \& A_{it} + \beta_4 \frac{RD_{it}}{BV_{it}} \times M \& A_{it} + \sum_{Y=1993}^{2004} \lambda_{i,y} YEAR_y + \varepsilon_{it} \quad (1)$$

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 ; $M\&A_{it}$ is a dummy variable having a value of one if the observation is from the year of the M&A, zero otherwise. A full set of yearly dummies is added to the regression to account for overall annual variation in the dependent variable due to macroeconomic market effects (not reported in tables). We choose the market-to-book ratio as our dependent variable because we wish to examine how technology M&As change the acquirer's future growth that investors perceive as dependent on acquirer's R&D investments⁵. R&D investments are long-term investments that are generally associated with firm's growth, making the changes in these investments' ability to enhance this growth a relevant matter.

We investigate the impact of several country specific factors of both acquirer to see whether they affect the stock market valuation of acquirer's R&D spending in cross-border technology M&As. We also consider the effect of certain differences between the acquirer's and the target's countries. We test our hypotheses developed in Section 2 by estimating the following OLS regression model from our data:

⁵ The P/B ratio projects future growth in book value, that is, the ability to enhance book values through future earnings (Penman 1996).

$$\begin{aligned}
\frac{P_{it}}{BV_{it}} = & \beta_0 + \beta_1 \frac{RD_{it}}{BV_{it}} + \beta_2 \frac{E_{it}}{BV_{it}} + \beta_3 M \& A_{it} \\
& + \beta_4 \frac{RD_{it}}{BV_{it}} \times M \& A_{it} + \beta_5 X_{it} + \beta_6 \frac{RD_{it}}{BV_{it}} \times M \& A_{it} \times X_{it} \\
& + \sum_{y=1990}^{2004} \lambda_{i,y} YEAR_y + \varepsilon_{i,t},
\end{aligned} \tag{2}$$

where X_{it} represents each of the variables in question. The first variable is the financial structure of the acquirer's home country ($FSTR$), which, following Booth et al. (2006) the ratio of the stock market value of equity of the acquirer's home country to the sum of this value and bank loans to the private sector. The second variable used is the difference between the acquirer's and the target's ratio of financial structure ($\Delta FSTR$). As a third variable we use the R&D intensity of acquirer's home country ($RDINT$), measured as the ratio of total R&D expenditure to GNP. The fourth variable proxies the difference between the acquirer's and the target's countries R&D intensity.

5. Empirical results

5.1. The stock market valuation of acquirer's R&D spending in cross-border technology M&As

Table 3 presents the results from estimating equation (1). First of all the results in all panels confirm the findings of many earlier studies on the significantly positive stock market valuation of a firm's R&D spending (Chan, Martin and Kensinger 1990; Jaffe 1986; Lev and Sougiannis 1996). This significance holds in all of the three model specifications. In addition, the estimated parameter for the 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; Beaver 1968; Collins and Kothari 1989).

The main results in the Panel A of Table 3 show that the estimated parameter for the variable $RD_{it}/BV_{it} \times M\&A_{it}$ is significantly positive, indicating that the stock market valuation of acquirer's R&D spending increases in cross-border mergers and acquisitions, if a technology firm acquires another technology firm⁶. There is no such effect in the other two types of M&As. This finding supports our Hypothesis 1, that the stock market considers technology M&As to increase the value related to acquirer's R&D activities. The results in Appendix 1 support this interpretation by showing that the increase in the stock market valuation of R&D spending is not due to increase in the technology acquirer's R&D intensity, but increase in the actual stock market valuation of acquirer's R&D.

These findings indicate that the stock market believes that technology firms can successfully use acquisitions of technology targets in improving their own R&D. When a technology firm acquires a non-technology firm or a non-technology firm acquires a technology firm, there is no significant change in the stock market valuation of acquirer's R&D spending. These results may suggest that the investors do not believe that the non-technology target can contribute to the technology acquirer's R&D and that the non-technology acquirer cannot utilize the technology target's growth opportunities and rather loses the value of its R&D, respectively.

(Insert Table 3 about here)

⁶ Appendix 2 reports the results from estimating the Model (1) using the technology M&As (technology acquirer and a technology target) by country classes.

The above finding of enhanced stock market valuation of acquirer's R&D spending in cross-border technology M&As corroborates the theory of multinational enterprise (see e.g. Caves 1982), which suggests that firms with intangible assets can create synergies, which translate into firm value by combining their resources. The finding is consistent also with the aspect of the internalization theory (see e.g. Buckley 1989; Buckley and Casson 1976), that when a multinational corporation is created through internalizing markets across national boundaries, it provides a firm with firm specific advantages in knowledge and proprietary information.

5.2. The effect of acquirer's country-specific factors on the stock market valuation of acquirer's R&D spending in cross-border technology M&As

We now focus on the group of technology M&As, where both the acquirer and the target are technology firms, because only this group provided support for our base hypothesis. Table 4 reports...

5.3. The effect of differences in the acquirer's and target's country-specific factors on the stock market valuation of acquirer's R&D spending

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6. Conclusions

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Table 1

Distribution of cross-border mergers and acquisitions involving a technology firm through the years in the sample period

YEAR	Belgium	Denmark	Finland	France	Germany	Italy	Netherlands	Sweden	Switzerland	United Kingdom
1990	0	0	1	2	3	1	0	4	1	9
1991	0	1	2	2	3	2	3	2	3	9
1992	1	0	0	2	3	1	1	3	1	15
1993	0	0	1	1	1	0	1	1	1	24
1994	1	1	2	2	5	2	3	2	4	22
1995	1	1	0	4	2	0	3	3	3	21
1996	1	0	0	3	2	0	1	2	1	10
1997	0	1	2	1	2	0	1	3	2	25
1998	0	0	3	5	6	1	2	4	2	30
1999	1	1	4	9	9	3	2	4	5	42
2000	1	3	6	10	11	1	1	7	12	30
2001	2	2	6	9	10	1	5	7	13	26
2002	0	2	3	3	6	0	0	4	7	9
2003	1	1	1	1	3	0	0	2	3	12
2004	3	0	3	3	2	0	2	4	4	15
Total	12	13	34	57	68	12	25	52	62	251

Notes: The sample includes all cross-border technology mergers and acquisitions, made acquirers from the above ten countries, that meet the selection criteria presented in Section 3.

Table 2

Descriptive statistics of the variables used in the regressions

Variable	Mean	Median	Standard deviation	Min	Max	N
<i>Panel A: Technology acquirers of technology targets</i>						
P/BV _{i,t}	3.723	2.535	3.800	0.539	36.581	4984
E/BV _{i,t}	0.121	0.135	0.236	-1.522	1.326	4984
RD/BV _{i,t}	0.147	0.116	0.126	0.004	0.910	4984
<i>Panel B: Technology acquirers of non-technology targets</i>						
P/BV _{i,t}	2.775	2.270	2.276	0.536	22.325	1573
E/BV _{i,t}	0.134	0.134	0.148	-0.635	0.833	1573
RD/BV _{i,t}	0.101	0.067	0.099	0.003	0.757	1573
<i>Panel C: Non-technology acquirers of technology targets</i>						
P/BV _{i,t}	2.441	1.800	2.065	0.405	17.326	978
E/BV _{i,t}	0.135	0.132	0.158	-0.732	0.963	978
RD/BV _{i,t}	0.054	0.037	0.051	0.000	0.300	978

Notes: RD/B_{i,t} is acquirer i's research and development expenditures divided by book value of equity in the year t; P/B_{i,t} is the acquirer i's price to book ratio in the year t; E/B_{i,t} is the earnings of acquirer i divided by its book value of equity in the year t. Value is the ration of target's net sales to acquirer's net sales year prior to the M&A. All the statistics are statistically significant at 1 per cent level.

Table 3

The results from estimating the equation (1) using the pooled sample of cross-border technology M&As in all countries.

Variable	Expected sign	(1)	(2)	(3)
<i>Panel A: Technology acquirers of technology targets</i>				
<i>Intercept</i>		0.120 (0.611)	0.120 (0.612)	0.182 (0.442)
<i>RD/BV_{i,t}</i>	+	9.303 (0.000)	9.308 (0.000)	8.930 (0.000)
<i>E/BV_{i,t}</i>	+	6.164 (0.000)	6.161 (0.000)	6.146 (0.000)
<i>M&A</i>	-	-	0.142 (0.386)	-0.492 (0.045)
<i>RD/BV_{i,t}×M&A</i>	+	-	-	4.475 (0.001)
N		4984	4984	4984
Adj R ²		0.307	0.307	0.309
<i>Panel B: Technology acquirers of non-technology targets</i>				
<i>Intercept</i>		0.712 (0.003)	0.714 (0.003)	0.732 (0.002)
<i>RD/BV_{i,t}</i>	+	6.926 (0.000)	6.920 (0.000)	6.778 (0.000)
<i>E/BV_{i,t}</i>	+	5.842 (0.000)	5.832 (0.000)	5.814 (0.000)
<i>M&A</i>	-	-	0.181 (0.327)	0.013 (0.961)
<i>RD/BV_{i,t}×M&A</i>	?	-	-	1.593 (0.356)
N		1573	1573	1573
Adj R ²		0.290	0.290	0.290
<i>Panel C: Non-technology acquirers of technology targets</i>				
<i>Intercept</i>		0.000 (1.000)	-0.000 (1.000)	-0.024 (0.923)
<i>RD/BV_{i,t}</i>	+	11.104 (0.000)	11.106 (0.000)	11.467 (0.000)
<i>E/BV_{i,t}</i>	+	8.213 (0.000)	8.213 (0.000)	8.236 (0.000)
<i>M&A</i>	-	-	0.016 (0.931)	0.340 (0.215)
<i>RD/BV_{i,t}×M&A</i>	?	-	-	-6.283 (0.115)
N		978	978	978
Adj R ²		0.475	0.474	0.475

Notes: RD/B_{i,t} is acquirer i's research and development expenditures divided by book value of equity in the year t; P/B_{i,t} is the acquirer i's price to book ratio in the year t; E/B_{i,t} is the earnings of acquirer i divided by its book value of equity in the year t. M&A indicates the year of the merger or acquisition. 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.

Appendix 1

Results from estimating equation (3).

Variable	Technology acquirers of technology targets	Technology acquirers of non- technology targets	Non-technology acquirers of technology targets
<i>Intercept</i>	0.158 (0.000)	0.102 (0.000)	0.051 (0.000)
<i>BEFORE</i>	-0.010 (0.139)	0.007 (0.446)	-0.005 (0.457)
<i>M&A</i>	-0.009 (0.167)	0.007 (0.477)	-0.004 (0.555)
<i>AFTER</i>	-0.008 (0.240)	0.009 (0.333)	-0.007 (0.236)
N	4984	1573	978
Adj R ²	0.003	-0.004	0.021

Notes: $RD/B_{i,t}$ is the dependent variable. *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.

Appendix 2

The results from estimating equation (1) by country classes using M&As with technology acquirers and technology targets.

Variable	Benelux countries	Nordic countries	Germany and Switzerland	France and Italy	United Kingdom
<i>Intercept</i>	−0.657 (0.477)	−0.134 (0.748)	0.570 (0.151)	0.626 (0.175)	0.597 (0.142)
<i>RD/BV_{i,t}</i>	5.446 (0.008)	8.688 (0.000)	7.586 (0.000)	5.200 (0.000)	11.827 (0.000)
<i>E/BV_{i,t}</i>	6.269 (0.000)	6.670 (0.000)	4.706 (0.000)	6.292 (0.000)	5.560 (0.000)
<i>M&A</i>	−0.532 (0.689)	−0.910 (0.056)	0.134 (0.733)	−0.237 (0.647)	−0.663 (0.081)
<i>RD/BV_{i,t} × M&A</i>	5.256 (0.404)	5.951 (0.036)	0.378 (0.842)	4.402 (0.162)	6.305 (0.001)
N	358	875	1088	957	2104
Adj R ²	0.216	0.321	0.261	0.193	0.396

Notes: The variables are as described in Table 3. Benelux countries include Belgium and Netherlands and Nordic countries consist of Sweden and Finland in this case.

