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The effect of R&D spending on a firm's profitability and market value in M&As:

evidence from Nasdaq listed companies

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Abstract:

Mergers and acquisitions have been part of companies' strategies to improve their profitability and market valuation. The purpose of this study is to examine the effects of R&D expenditures on the acquirer's profitability and stock market valuation in two different cases: when the acquiring firm is a technological company and a non-technological company. The target company for both is a technological company. Firstly, it is hypothesized that R&Ds of the acquirer enhance the stock market valuation more for technology acquirers than for non-technological counterparts. The comparison of stock market valuations is performed in the year when the company acquires a technological company. Secondly, this study shows how technological and non-technology acquirers can convert R&D spending into future profitability within one year after the M&A being completed.

The sample consist of 186 technological M&As and 50 M&As where the acquirer is a non-technological company. The chosen acquirers are Nasdaq listed companies which completed a merger or acquisition between 2010 and 2017. The methodology used is OLS regression analysis.

The key findings of the study reflect that in the year when the M&A is completed there is no correlation of R&D expenditures with stock price when a technological or a non-technological company acquires a technological company. The other important finding is that in the long run a technological company can convert R&D spending into future profitability more efficiently than a non-technological company by acquiring a technological company. Technological M&As have more potential to realize synergies after the M&A. During the year of the M&A R&D spending increase in both companies, which means that during the year of acquisition companies cannot utilize the synergies created from the acquisition of the technological company.

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

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Abbreviations

M&A	Merger and acquisition
R&D	Research and development
GAAP	Generally accepted accounting principles
GMM	Generalized method of moments
OLS	Ordinary least squares

1. Introduction

Mergers and acquisitions (hereafter M&A) are one option for firms to enhance their profitability and market value (e.g., Hitt et al., 2012; Guo et al., 2006). According to McSweeney (2012) it is very costly for companies to develop new products in a sustainable way when product life cycle is shortening, customers have more different needs and technical knowledge specialization increases. Mergers and acquisitions also provide a possibility to takeover a company and provide a substitute product. In addition, M&As also provide companies an opportunity to access a firm's technological knowledge or innovative capability instead of investing in research and development (hereafter R&D) themselves to improve technological performance. Acquisitions generally refer to deals, where an acquirer buys more than 50 % of the target company's shares (e.g., Ahern & Weston, 2007). In M&A a new company is formed by two merging companies where ownership is broadly equal (Weston & Copeland, 1992).

M&As also might be used to prevent a competitor getting access to technological knowledge or for making R&D local in some specific markets. M&As can be a part of the firm's competitive and external growth strategy (Erez-Rein et al., 2004). Studies tend to focus on the business performance of M&As, usually after the process is completed. There are a lot of factors related to M&A that need to be resolved to make a new entity successful. M&As are part of normal corporate events but very volatile and they can create value-added organizational synergies or turn out to be value-destroying disasters (Brousseau, Driver, Larsson & Sweet, 2004).

1.1 Topicality of the study

Technological M&As are one solution to respond to the demands for innovation and increasing competition in the technology industry. R&D spending has increased over the past ten years in the U.S., which makes R&D a more remarkable expenditure and a more topical subject to study (Ranft et al., 2012; Makri et al., 2010). In technological mergers

synergies are usually associated with the knowledge in the firm and the managers role is emphasized in the process.

This study examines how research and development expenditures affect an acquirer's stock market value and profitability after M&A between technology and non-technology companies. This study focuses on publicly listed U.S. acquirers on NASDAQ from 2010 to 2017. The reason to study M&A in Nasdaq is that in the United States of America R&D expenditures were the highest in the world in 2016 (see table 1). The amount of R&D spending has increased every year from 2010 to 2017 (OECD, 2021) which also means that the number of technology M&As continues to grow. This provides new information to investigate technology M&As.

Table 1.

Top 10 countries with the highest R&D expenditure in 2016 (in PPP, dollars)

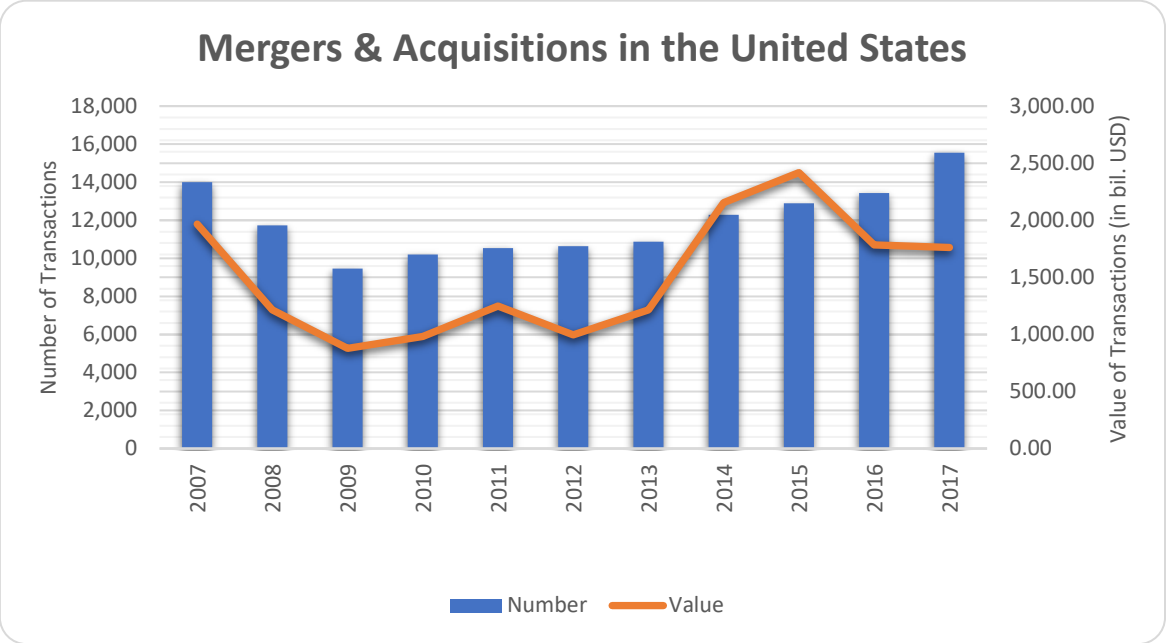
	Country	R&D spending in dollars (billion)
1.	USA	476,5
2.	China	360,7
3.	Japan	170,5
4.	Germany	109,8
5.	South Korea	72,3
6.	France	60,8
7.	India	48,1
8.	United Kingdom	44,2
9.	Brazil	42,1
10.	Russia	39,8

UNESCO (2021).

Figure 1 shows all M&As in numbers and the whole value in the U.S. during 2007–2017. The blue columns represent the number of transactions in each year. The orange line represents the overall value of M&A in each year. Mergers and acquisitions intensity follows economic upswings and economic downturns. Earlier merger waves have occurred in early 1900s, in 1920s, in 1960s, in 1980s, in 1990s and 2000. Since 1990s M&A started to be global. 2010 is considered to be the year when the most current (seventh) wave of mergers and acquisition started (e.g., Junni & Teerikangas, 2019). In 2008 and 2009 there has been a decline in mergers and acquisitions both in value and in volume due to the financial crisis in 2008 which was considered a very severe crisis globally. From 2010 to 2013 the amount of the M&A didn't change, but after that there has been quite a strong increase as figure 1 shows. The examined M&As occurred during the seventh wave.

Typical for the seventh wave is the focus on global growth, acquirers from emerging markets play a very important role, disruptive innovations that change industry landscape and industry boundaries. This has changed acquisitions where firms seek target companies from start-ups and consider complementary or adjacent businesses. Revenue and growth still play a fundamental role in M&A (EY, 2018). According to Deloitte's study (2018) technology acquisition is the number one driver of M&A pursuits in the year 2018 and managers are showing a strong favouritism towards vertical integration, especially in life sciences, health care, technology, and financial services. The highest value of M&A was in the U.S. in the year 2015. The amount of money involved in M&As is huge as figure 1 shows and the number of mergers and acquisitions continue to grow.

Figure 1. Mergers & Acquisitions in the United States



Number of mergers and acquisitions in United States between 2007 and 2017 (The Institute for Mergers, Acquisitions and Alliances (IMAA), 2021).

This study includes four sections after introduction. The second part is devoted to relevant literature, key concepts, and hypotheses development. The third part describes the data which is used in empirical research, data definition and models used in this study. The fourth part introduces results of the study, findings, and a robustness test. The last section concludes with a summary of findings and conclusions.

1.2. Research problem and the purpose of this study

The technology industry has achieved a strong position in the economy compared to other industries. Technological achievements, job growth creation and contribution to efficiency gains has been remarkable during many decades which has led to technology companies being part of M&As as acquirer companies or target companies. Acquirers seek growth potential through acquisitions in high-technology industries from technology targets. High technology target companies might provide greater

shareholder benefits for acquiring companies which target companies in other lower growth industries can't. On the other hand, technology target value is uncertain due to the fact that the development of products in unproven and uncharted field (Kohers & Kohers, 2000). That is why the analysis of specific features of firms involved in M&As is a very interesting topic to study. Data of technology M&As is widely used and many parties focus on technology M&As. In addition to companies and researchers in the field, investors, analysts and financial institutions also pay attention to technology M&As.

The purpose of this study is to investigate if acquiring firms can enhance their current market value and future profitability through a technological M&A. Levin et al. (1988) conclude in their study that technological growth is the primary source of economic growth. The topic is under researched and therefore it is important to study technology M&As and get more empirical evidence about them.

When examining technological companies, research and development expenditures play a very important role in creating value for the firm (Guo et al., 2006; Johnson & Pazderka, 1993). R&D spending's impact on a firm's market value and profitability has been a subject of attention in many studies. As a result, these studies indicate that R&D expenditures have a positive influence on a firm's market value and profitability (e.g., Booth & al., 2006; Chauvin & Hirschey, 1993; Chan et al., 2001). This has inspired research to study what kind of relationship there is between R&D expenditures and the results of mergers and acquisitions. Guo et al. (2006) state that information regarding R&D plays an important role for investors when they make investment decisions internationally and for managers, because R&D expenditures may have a positive effect on a firm's long-term performance. Studying technological M&As makes it possible to directly measure the acquirer's financial performance related to R&D (Higgins & Rodriguez, 2005).

Some authors consider acquisition as an investment decision (e.g., Hodgkinson & Partington, 2007; Hackbarth & Morellec, 2008). A newly formed firm after acquisition

should be more profitable and valuable than two firms in case they were not merged. This is also called synergy theory. There are many industries where innovation is an important part of firm's value creation. Mergers and acquisitions are considered as a strategic option to remain competitive by acquiring new knowledge and capabilities (Makri et al., 2010; Uhlenbruck et al., 2006). Especially in technological industries M&As play an important part of strategy to enhance the company's resources and capabilities (Hagedoorn & Duysters, 2002; King et al., 2008). Investments in R&D further help create technological resources. R&D is a strategic firm-specific expenditure that can be accumulated over a period of time by consistent strategy policy (Dierickx & Cool 1989).

The post-merger innovation performance is affected by the synergy of knowledge of the acquirer and target firms. An important predictor of post-merger innovation performance is the knowledge relatedness of the acquirer and target firm (Cloodt et al., 2006; Hagedoorn & Dyusters 2002; Ahuja & Katila 2001). In previous research there have been differences in results regarding how many of the M&As are unsuccessful. According to Calipha, Tarba and Brock (2010) more than 50% of M&As fail. Bower (2001) states that most of the M&As will fail. He mentioned that for R&D-orientated acquirers it is challenging to hold on to the key people from the target firm after M&A and for people from the acquirer to adapt to the new situation. Post-merger-period is very critical from the acquirer point of view. Cassiman et al. (2005) stated in their literature review that M&As have a positive impact on R&D when the purpose of a M&A is to source technology for the firms. In this case the integration process is efficiently managed during the process and key people are retained after a M&A. Acquirers are able to realize synergies better when combining know-how in M&As if the acquirers have a strong internal knowledge base of their own and can evaluate potential target companies.

According to previous results M&As don't increase effectiveness (Makri et al., 2010) if merging entities are technologically too related (this also includes knowledge-relatedness). When two entities are technologically complementary, but not similar or

substitutive, M&A increases the effectiveness of R&D. Acquired external knowhow increases innovation performance only when the acquirer is engaged at the same time in internal R&D activities. The firm's own internal R&D activities are then complementary with external technology acquisitions (Cassiman et al., 2005).

The research problem will be studied with the help of testing four hypotheses further developing the study of Kallunki et al. (2009). Firstly, this study looks at if M&As can have a positive influence on the relationship between R&D in technology M&As and the firm's stock market value when the acquirer is a technology firm or non-technology firm. Secondly, this study shows that R&D expenditures are also reflected positively in the future profitability of a technology acquirer, but not in the future profitability of a non-technology acquirer.

1.3 Research hypotheses

1.3.1 Acquisitions effect on stock market valuation

As R&D expenditures influence firm's stock market value it is reasonable firstly to perform an analysis regarding if there is any difference in firm's stock market value when a technology firm acquires a technology firm and when a technology firm acquires a non-technology firm. Developing further the research ideas from Kallunki et al. (2009) there are two hypotheses related to a firm's stock market valuation which are tested in this study:

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.*

1.3.2 Acquisitions effect on future profitability of a firm

Secondly, it is reasonable to evaluate stock market prices that reflects a firm's future profitability. In line with Kallunki et al. (2009) it is assumed that stock market prices and the acquirer's profitability should be enhanced when a technology firm acquires a technology firm and decrease when a technology firm acquires a non-technology firm.

Ahuja & Katila (2001) found that acquisitions can improve the technological performance of the acquirer. That means it is not enough to study stock price reactions, but also the future financial performance. Healy et al. (1992) studied large mergers and found that merged firms have significant improvements in asset productivity relative to their industries after the merger, leading to higher post-merger operating cash flow returns. They did not find a decrease in capital expenditure or R&D spending of the acquirer which both are long term investments. A positive strong relation between post-merger increases in operating cash flows and abnormal stock returns in connection with merger announcements indicate a high expectation of financial performance of the newly merged firm.

Al-Sharkas et al. (2008) reported that bank mergers increased cost and profit efficiency. Mergers had a positive effect on technological improvement compared to non-merged banks which allowed them to take more advantage of technological opportunities. Following Kallunki et al. (2009) who state that it is relevant also to study how technological and non-technological M&As affect future profitability in addition to stock market valuation, in this study the following hypotheses are introduced:

HYPOTHESIS 2a: *Acquisitions of technology firms enhance the association between a technology acquirer's R&D spending and its future profitabilit*y.

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

1.4 Methodology of the study

The research approach is empirical. The data used in this study is examined using statistical analysis. The chosen statistical analysis for research design is regression analysis. The purpose of the regression analysis is to investigate the relationship between variables which can be positive or negative or there can be no relationship between variables. Variables are divided in *dependent (referred as Y)* and *independent (referred as X)* variables. A *simple linear regression* model studies the correlation between two variables: dependent (*Y*) and independent (X). The independent variable can be called as explanatory variable. A *multiple linear regression* model uses multiple correlations between the dependent (*Y*) and two or more independent (*Xs*) variables (Martin & Bridgmon, 2012).

For this study it is relevant to choose more than one independent variable to analyze what could affect stock market valuation and the profitability of the acquirer. Therefore, the chosen model is the linear regression model.

Certain requirements must be met to form an applicable model. The first requirement to use the regression model is that the values dependent variable's values should be random, and the importance of the explanatory variable should be fixed or random. Secondly, a correlation between variables should exist and between them a linear dependence can be observed (Tähtinen et al., 2020). For explanatory variables (X) it is better in the model that they don't correlate too much with each other. In case variables correlate strongly with each other the result is multicollinearity and variables do not create new information. The last requirement is that the dependent variable is normally distributed with the explained variables. (Holopainen et al., 2008).

2. Theoretical background of the study

There are multiple theories explaining the motives behind M&As. M&As are usually conducted for financial, strategic, and managerial motives (Faulkner et al., 2012, pp. 686–696). Several studies that examined technological M&As have focused on financial motives such as innovation performance, market value creation and profitability after the M&A (e.g., Ahuja & Katila, 2001; Hitt et al 1991; Kallunki et al., 2009). Weitzel (2011) has categorized different M&A theories in two groups, value increasing and value destroying theories. One value increasing theory, *synergy theory* (also called efficiency theory), is observed closer in this chapter. The reason to focus on *synergy theory* is that it suggests the purpose of the M&A is to bring gains for the owners through operative synergies. McSweeney (2012) consider that the key assets of R&D capabilities are the R&D people of the company weather the company is large or small. Hostile takeovers are not common in these kinds of M&As because it is in the interest of the acquirers to keep the key R&D people during the M&A process. For the acquirers it is more profitable to use M&As as a tool to acquire technology targets and to create operative synergies. Aggressive bids would be considered counterproductive.

Generally, value increasing theories highlight that a merger occurs because they generate synergies that help to get more value for both the acquirer and target. Technology target companies make it possible to study whether the synergies between technology and non-technology acquirers occur. In an ideal situation the M&A is profitable as a firm's basic idea is to create value for its shareholders (Hitt et al., 2001).

Weitzel (2011) also introduced two other value increasing theories: *market power theory* and *corporate control theory*. Market power theory in short suggests that companies with high market power can control the price at which it sells a product or service to increase economic profit and earn greater margins through the appropriation of consumer surplus. According to Chatterjee (1986) market power theory and synergy theory had to be distinguished because they have a different approach to value creating in M&As. According to corporate control theory underperforming companies are taken

over by more efficient companies. This is also related to efficiency theory partially, but it doesn't assume that synergies exist between the target and the acquirer company. Unlike in synergy theory, in corporate control theory it is typical that the target's management is very reluctant regarding any takeover attempts.

2.1 Synergy theory

According to Chatterjee (1986) the general purpose of acquisitions is to create economic value by reducing costs and/or charge higher prices. When a firm is efficient it can sell products more cost-efficiently than rivals and rivals will suffer from that. Chatterjee (1986) highlights efficiency to make M&As successful. M&As enable the merged firms to produce products at lower prices. When products are produced cost-efficiently, demand for factor inputs decreases. Compared to competitors, final prices at the market are lower and manufacturing costs are higher. This is also called *economies of scale*: revenue can be created with less costs. When firms acquire technological targets they especially target operative synergies through M&As.

Bradley et al. (1988) defined synergistic gain in acquisitions as the sum of change in wealth for the stockholders of the acquirer and target firm. The wealth in acquisition is created when the resources of the buyer and seller are greater than the value of the separate entities. Of course, management of the acquirer has a very important impact on how the value is generated after acquisition. Synergized motivations behind an acquisition should create wealth for the new entity. If managers overestimate the value of acquisition and pay more than the synergy is worth, the acquisition is partly or purely hubris (Hodgkinson & Partington, 2007).

M&As drive firms to merge by creating a more profitable and more valuable business. M&As are one option to achieve a quick access to resources of the target firm that are transferred and allocated to the acquirer. By gaining control over the target firm the new entity can exploit some specialized resources and implement a new operating

strategy. The new strategy in corporate synergy can involve more efficient management, economies of scale or scope, improvement of production techniques, the combination of complementary resources, increased market power, the redeployment of assets to more profitable uses, or any number of value-creating mechanisms (Bradley et al., 1983).

Larsson and Finkelstein (1999) studied how multiple elements effect synergy realization, such as economics, finance, strategy, organizational theory, and human resource management in one robust process-oriented model. They found that strategic similarities and complementary operations (also included R&D) in M&A increase synergy realization. According to them, similarities in the management style of the merging companies also reduce employee reluctance during the combination phase.

M&As effect on stock market value has been a very popular topic among previous studies to find out how markets react to the possible synergies created in M&A. Hackbarth and Morellac (2008) analyzed stock behavior of two publicly listed companies after the M&A announcement. The authors emphasize that acquisitions have two main characters. Acquisitions are always more or less risky, and decisions are partly or completely irreversible. A more inefficient firm sells its assets to a more efficient firm and after that a merged entity can make investments in new assets or divest some acquired assets. This is called *economies of scope*. The acquirer increases the efficiency of the combined firm. They found that beta does not have significant impact on stock market price before takeover and after the M&A announcement beta drops moderately. Generally, they found that the M&A announcement has an abnormally positive effect on the target's stock return, while the effect is negative for the acquirer.

According to Lev and Sougiannis (1996) R&D spending is strongly related with subsequent stock prices and returns. R&D spending is value-relevant information for shareholders. They did not find direct effect of R&D spending on the current stock price. It might be due to mispricing of the shares or that the subsequent surplus returns are

compensating for an extra-market risk factor related with R&D. Their finding might indicate that investors react very carefully to R&D spending of the company, or that the investors don't pay attention early enough to the R&D spending.

2.2 Technological mergers and acquisitions: overview

Technological M&As are one solution to respond to the demands for innovation and increasing competition in the technology industry. R&D spending has increased over the past ten years in the U.S., which makes R&D a more remarkable expenditure and a more topical subject to study (Ranft et al., 2012; Makri et al., 2010). In technological mergers synergies are usually associated with the knowledge in the firm and the managers role is emphasized in the process. Knowledge is an important competitive tool and M&As seem to be a prominent strategy to acquire new knowledge (Makri et al., 2010). Trading the knowledge and cooperating in R&D with other firms are part of firms´ innovation strategies. The successful innovation is dependent on integration and the new knowledge of the innovation process (Cassiman and Veugelers 2002). Innovation brings something new into-use and the criteria for success of innovation is commercial. Invention brings something new into being and the criteria for success of invention is technical (Rogers, 1962; Burgelman & Sayles, 1986).

Ensign et al. (2014) studied the impact of dimensions of proximity (geographic, cognitive, and organizational) on knowledge transfer after M&A. They found technological M&As were linked by geographic, cognitive, and organizational factors as well as knowledge transfer and innovation. Cognitive proximity includes base knowledge. Firms with the same base knowledge transferred knowledge and communicated more successfully than firms with different base knowledge. Also, Erez-Rein et al. (2004) highlighted in their case-study big differences between the results of merging or acquired companies and potential less successful outcomes because of the increased risk of conflict. Thus, gaps don't automatically determine the outcome of

M&As. The motive behind M&As is always to create a new entity. Managers need to be active in analyzing the gaps and act to reduce them to achieve a positive outcome.

After a M&A there should be knowledge transfer between the acquirer and the target so that operative synergies are achieved. There may be some processes that don't progress knowledge transfer. For example, fast rotation of key managers with their knowledge limits knowledge transfer (Cannella & Hambrick 1993). Knowledge transfer creates value when new products and processes are identified and implemented to create competitive advantages for the acquirer. This depends a lot on how the organization can share and leverage information, resources and expertise, or so-called knowledge assets (Haspeslagh & Jenison 1991; Inkpen 2000).

One significant motivation behind technological M&As is to speed up the process of getting products to a market and enhance the firm's competitiveness where managers play an important role. Most efficient managers can combine many factors of M&As including completion, realization of planned synergies and discovery of new synergies. Two forms of change exploitation and exploration are both necessary for organizations to survive in dynamic markets (Graebner, 2004). The integration process is very challenging and there are many ways not to succeed. Acquisitions are also an important way to get valuable resources and to renew the firm's strategy (Graebner et al., 2010). Acquisition of new technologies is a necessary means by which established firms add to their technical capabilities and products, enhance their market power, and achieve strategic renewal (Agarwal & Helfat, 2009; Eisenhardt & Martin, 2000; Santos & Eisenhardt, 2009). A firm can develop knowledge base through investments or by acquiring external knowledge through acquisitions (Cohen & Levinthal, 1989; Huber, 1991).

Technology companies have fewer tangible assets by nature. They are future oriented which makes their results dependent on untested technologies and prospects are unpredictable. The benefits of R&D spending will materialize in the long term, and at the same time the life cycle of the products might be short (Chan et al 2001). In a fast-

changing technology area firms seek collaboration through M&A (Kallunki et al., 2009). M&As offer a possibility to redefine R&D processes for the merging firms. R&D expenditure of the target is also an important source of technological change (Bertrand & Zuniga, 2004).

According to Makri et al. (2010) complementary scientific and technological knowledge contribute positively to the post-merger performance. Ahuja & Katila (2001) studied firms in the chemical industry. They emphasize in their study that highly related or unrelated knowledge in acquisitions reduces post acquisition innovation output compared to a moderate level of related knowledge. The larger the absolute size of the acquired knowledge is, the better the post-acquisition performance and innovation outputs are. For the non-technological acquisitions, they didn't find any significant innovation output. It is necessary to evaluate what kind of knowledge-based acquisition has been done and what the value of R&D spending is. Cloodt et al. (2006) studied post-M&A innovative performance of acquiring firms in the high-technology sector. They used patent data to measure innovative performance. As a result, in their study to maximize innovation performance, companies should target M&A targets that are neither too unrelated nor too similar in terms of their knowledge base. In this study the focus is also on non-technological acquirers that acquire a technology target. For them technological knowledge is newer than for the technology acquirers, which presents a challenge.

According to Hitt et al. (2012) M&As increase the profitability of the new entity, when the acquirer and target firm can enhance their innovation (amount and novelty). Scientific and technological knowledge enhance innovation performance most when they are similar enough, but both companies still learn business from each other. For example, Uhlenbruck et al. (2006) contributed by studying market value effect of acquisitions involving internet firms. As a result, stock market return was positive when a firm used acquisitions to adapt to the introduction of a new major technology. They also found that acquisitions brought more value to the acquirer than alliances.

Hagedoorn and Duysters (2002) also concluded that when the acquirer improves technological skills and learning capabilities through acquisitions it has a positive effect on technological performance.

Hagerdoorn and Duysters (2000) highlight the importance of organizational and strategic fit in M&As of research-intensive firms. They found that when the acquirer can improve technological skills and learning capabilities through acquisitions it has a positive effect on technological performance. This is a long-term consequence. When studying M&As' effect on firms' performance the results are not seen immediately and it is individual how quickly the acquirer can benefit after the M&A. The risks of M&As are reduced when firms are operating in similar sectors or have some similarity in product-markets.

Higgins and Rodriguez (2006) found in their study on pharmaceutical firms that R&D activities of a target firm have a positive impact on the acquirer's returns and overall results when the acquirer is able to get information before the acquisition or has a superior negotiation position. Also, if the acquirer and the target firms are similar as regards research, an acquirer should be able to place a more accurate value on the target firm and that way create more value for shareholders. Firms experienced some deterioration on research or sales related to acquisition, but afterwards they were able to stabilize or reverse it.

According to Nguyen et al. (2012) it is difficult to get a clear picture of the motives of mergers and acquisitions because they involve multiple motives which may be at the same time both value increasing and value decreasing. For example, Bradley et al. (1983) state that the motivation behind value-increasing acquisitions is to benefit from synergies by combining the resources of two firms. Value creation in acquisitions can be due to more efficient management, economics of scale, improved production techniques, combination of complementary resources, use of assets in a more profitable way, exploitation of market power or any other mechanisms of corporate synergy.

So far this study has introduced value increasing theories of M&A, but value decreasing theories also exist which entails a value decrease for the shareholders. Weitzel also introduced different value decreasing theories i.e., theory of managerial *hubris*, *theory of managerial discretion*, *theory of managerial entrenchment* and *theory of empire-building*. Managerial hubris suggests that over-confident managers end up paying too much for the target firm because managers of the acquirer suffer from bounded rationality. Jensen (1986) introduced theory of managerial discretion. According to this theory managers end up paying too much for the target firm but not because of managers overconfidence but rather because of an excess of free cash flow. Managers are likely to do fast investment decisions that lead to unprofitable results for the shareholders. Cartwright and Schoenberg (2006) stated when observing M&As that they continue to be a common and even popular option for corporate development. According to their study there is a little change in the failure rate over the same time period in M&A. One big reason is that managers are driven in takeovers by non-maximizing motives instead of their own self-interest.

Higgings and Rodriguez (2006) state that the three major reasons behind failed acquisitions are overbidding for the target firm, selecting the incorrect target firm, or not succeeding at the post-acquisition integration process.

According to Hitt, Harrison and Ireland (2001) there are different managerial implications of transactions related to the acquisitions. For example, an acquired business that is unrelated to the acquirer's core business produces less financial benefit because it can produce only financial synergy. Therefore, an acquired business that relates to the acquirer's core business has a higher probability to have a positive outcome after merging. To be successful in acquisitions, management needs to consider management philosophy and culture. Firms can also learn from diversifying acquisitions. The management's role is to emphasize that new knowledge is created and codified. They also highlight that acquisitions include many complex sub-activities that create

more challenges to M&As. This means that both technological and non-technological acquirers should evaluate how they can exploit the knowledge of the target firm and what impact M&As have in the long term run for their strategy.

2.3 Definition of research and development expenditure

When studying technological M&As it is good to define what R&D means. OECD has defined the research and development concept as follows: “Research and experimental development (R&D) comprises creative work undertaken on a systematic basis in order to increase the stock of human knowledge and to devise new applications based upon it”. This includes basic research, applied research and experimental development activities. Basic research acquires new knowledge by experimental or theoretical work. Applied research is more specified towards an aim or objective in addition to basic research. Experimental development activity is more systematic than applied research. It includes drawing on existing knowledge gained from research and/or practical experience, which is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed (OECD 2019).

This study focuses on research and development expenditures in financial statements, based on accounting data from the US acquirers. US companies prepare their financial statements according to U.S. Generally accepted accounting standards (GAAP). According to U.S. GAAP, in the scope of ASC 730 R&D costs are expensed as incurred. According to ASC 730 *research* requires obtaining technical information or new knowledge when developing a unique product or process. *Development* includes 1) developing a plan or designing a new product or process or 2) making a significant improvement to an existing product or process. Costs related to these activities are reported as expenditures in income statements.

According to Chan et al (2001) accounting data limits the usefulness of R&D information because firms differ regarding what's included in R&D, and spending of R&D is reported as one collective item. It is important to note that R&D expenditures are easily manipulated (Hitt et al., 1991) as R&D should be expensed immediately when the costs are incurred. According to Chan et al (2001) fields that are R&D intensive usually register the expenses directly as R&D can have a substantial bias effect on earnings and book values.

3. Research design and data description

The third chapter provides information on empirical models and variables specification. Afterwards the sample and the process of its selection is described. Finally, different descriptive statistics are presented.

3.1 Empirical models and data definition

The chosen empirical approach in this study is *multiple linear regression* because there is more than one independent (X) variable. To test the hypothesizes *ordinary least squares* (OLS) regression is used which is one type of linear regression model. OLS regression was chosen as the statistical model in this study because it was also used in studies by e.g., Lev and Sougiannis (1996), Weitzel and McCarthy (2001) and Hagedoorn and Duysters (2002).

The variables chosen for the OLS regression model are in line with the study of Kallunki et al. (2009) and Lev & Sougiannis (1996). The first model tests the link between the acquirer's R&D spending and market value. In addition to R&D spending, control variables have been added which may influence the stock market value. To test hypotheses 1a and 1b the following OLS regression model is used:

$$\frac{P_{it}}{BV_{it}} = \beta_0 + \beta_1 \frac{RD_{it}}{BV_{it}} + \beta_2 \frac{E_{it}}{BV_{it}} + \beta_3 M\&A_{it} + \beta_4 \frac{RD_{it}}{BV_{it}} \times MA_{it}, + \beta_5 \frac{E_{it}}{BV_{it}} \times M\&A$$

$$+ \beta_6 X_{it} + \beta_7 \frac{RD_{it}}{BV_{it}} \times MA_{it} \times X_{it} + \sum_{K=1}^{8} \varphi_k \, IND_k + \sum_{y=2010}^{2017} \lambda_k \, YEAR_y + \varepsilon_{it} \quad (1)$$

For hypothesis 2 it is tested how firm acquirers can enhance their future profitability one year after merger using the following OLS regression model:

$$\frac{1}{3}\sum_{k=2}^{4}\frac{E_{it+k}}{BV_{it+k}} = \beta_0 + \beta_1\frac{E_{it+1}}{BV_{it+1}} + \beta_2\frac{RD_{it+1}}{BV_{it+1}} + \beta_3 M\&A_{it} + \beta_4\frac{E_{it+1}}{BV_{it+1}} \times M\&A_{it}$$
$$+ \beta_5\frac{RD_{it+1}}{BV_{it+1}} \times M\&A_{it} + \frac{1}{3}\sum_{k=2}^{4}\frac{E_{it+k}}{BV_{it+k}} + \frac{1}{3}\sum_{k=2}^{4}\frac{RD_{it+k}}{BV_{it+k}} \qquad (2)$$

The data definition used in models 1 and 2 is presented in table 2.

Table 2.

Data Definition

Variable	Definition
RD_{it}	Research and development expenditures of the acquirer in year t
BV_{it}	Book value of the acquirer *i* in year *t*
P_{it}	Market Value of the acquirer *i* in year *t*
E_{it}	Net income before research and development expenditures of the acquirer *i* in year *t*
Ta_{it}	Total assets of the acquirer *i* in year *t* in millions of dollars
$DEALS_{it}$	The number of M&As that the acquirer *i* has conducted during the three years prior to the year of the M&A
CHS_{it}	The number of acquirer *i*'s shares held by insiders scaled by the number of common shares outstanding in year *t*
$SIZE_{it}$	Natural logarithm of deal value in year *t*
IND_k	industry-specific indicator variables
$M\&A_{it}$	$M\&A_{it}$ is an indicator variable equal to one if a firm *i* acquires a technology target during year *t* and zero otherwise
$YEAR_y$	$YEAR_y$ is an indicator variable equal to one in a year *y* otherwise zero

In model 1 vector *X* represents the control variable. Four control variables are included in the model. It is challenging to measure the direct effect of R&D spending on stock

market value and future profitability during the M&A. The first control variable added is total assets (TA_{it}), because the size of the acquirer can potentially affect both value creation and acquisition performance (Kallunki et al., 2009). According to Ahuja and Katila (2001) the larger firm is the more it has resources to exploit from the acquired R&D. The acquired R&D covers only a part of the large acquirer's resources when the acquirer may focus on the actual business of innovation. Eckbo and Thorburn (2000) report that abnormal stock return of the acquirer decreases with the assets of the acquirer, or it is more difficult to register abnormal stock return depending on the firm's size. Dang et al. (2018) investigated in their study 100 empirical papers and they found that the top three measures of a firm's size are total assets, total sales and market value. They concluded that there is a correlation between these measures and profitability and financial performance. Hashmi et al. (2020) concluded that total assets, total sales, and market value firm size measures have significant impact on the firm's performance. For large companies results of operations are shown in sales which leads to higher profits which also means higher returns on investments and return on equity. As a result, total assets have been chosen to measure the acquirer's size.

The second control variable in the model is 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. Stock markets might react positively to the earlier M&A experience of the acquirer and profits gained arising from the acquired R&D activities (Fuller et al., 2002). When the acquirers has more acquisition experience the better it is in integrating the acquired resources into its own business and achieving synergies. (Hitt et al., 2001) consider that firms which have recently completed acquisitions have more experience and are more flexible to adapt to changes required by the new acquisition. Higgins and Rodriguez (2006) found that firms have negative abnormal stock returns if they acquire a new technology firm during the three years prior to the current acquisition. The market reacts negatively if a firm acquires too many technological firms in too short of a time span. This might indicate to the market that firms have weak R&D strategy.

In their original study Kallunki et al. (2009) used the variable $Size_{it}$ as a third control variable, i.e. the net sales of the target firm divided by the net sales of the acquirer i in $year_{t-1}$. Since data was not available for target firms this data is replaced by the natural logarithm of deal value of the acquirer in the year t. Kohers & Kohers, (2000) explain that targets that are large relative to their acquirers can create synergies better than small targets in M&A. The deal value doesn't tell the actual size of the target and might be overvalued. This is one challenge for this study as there was a very limited amount of data available for the target companies.

Cosh et al. (2006) studied takeovers between 1986–1995 in the UK. According to their study there is a strong relation between CEO ownership and both the long-run return and operating performance of the acquiring firms. Therefore, the fourth variable is the number of acquirer shares held by insiders, scaled by the number of common shares outstanding (CHS_{it}). Shares held by insiders include the beneficial ownership of the firm's common stock by all directors and executive officers[1].

Chosen years to test hypotheses 1a and 1b are the year when the M&A was completed and one year before and after the merger. For these three years data had to be available. The four years following the year in which the merger or acquisition was completed has been used to test hypothesis 2. The dependent variable is an average of the three-year future net income before R&D expenditure scaled by book value of the acquirer during the second, third and fourth year after the M&A was completed.

The model 2 tests how acquirers can convert R&D spending into future profitability. During the year of the M&A companies might not have had enough time to adjust to the reorganization of the newly formed firm, and therefore future profitability is also researched. This is also to eliminate the short-term impacts from the acquired company. It takes some time for the acquirer to integrate the processes, especially if the performance of the target company was poor (Hosono et al., 2009).

[1] This data is defined with help of the SEC Form DEF 14A, where insider ownership of the company is mentioned.

3.2 Sample design

The data is collected from the Worldscope and Datastream platforms from the Thomson Reuters Eikon database. The data includes only mergers or acquisitions with a deal value of at least one million dollars so that the target has some impact on an acquirer performance (King et al., 2008). According to Rossi et al. (2013) for technological acquisitions it is typical to find new skills and technical and technological knowledge, and small and micro-size companies are also involved as target companies. Technological mergers and acquisitions have increased since 1990 in high-tech sectors. Target companies chosen for this study are mostly privately owned but there are also 55 publicly listed companies. Acquirers are U.S. firms, but domestic and international companies were chosen as targets. This gives this study a very broad scale as the targets represent different backgrounds.

Financial industry firms e.g., banks, insurance companies and investment trusts are excluded from this study. On the acquirer side, large Nasdaq listed companies were chosen. The reason to focus on large companies is that they are more likely to complete M&As (Moeller et al., 2004) and large firms have been used in previous studies related to M&A (Hitt et al., 1991; Ahuja & Katila 2001). Large companies have more R&D spending and knowledge which could be considerable from the financial performance point of view. There is more data available for large companies than for smaller companies. According to Booth et al. (2006) investor's pay more attention to large firms than small ones. Studying large companies also include challenges as Cloodt et al. (2006) state that especially in large technology companies innovation is harder to implement. Moeller et al. (2004) mentioned that large acquirers are likely to overpay for targets.
This study focuses only on the market valuation and profitability of Nasdaq listed firms which have completed a merger or acquisition. Pending, withdrawn, and intended acquisitions are not taken into consideration, neither is buyback where companies buy their own shares in the market. Firms which have lost tender offers have also been excluded from the study. Most of the M&As are acquisitions not mergers.

The sample M&As are defined as cases where the acquirer owns more than 50 % after acquisition and prior to acquisition less than 50 %. When a firm has acquired more than half of the shares it got control of the acquired companies after a deal. The study will examine how M&As enhance the market value and profitability of the acquirer, not the target firm. This sample is divided in two sub-groups (panels) whether a target firm is a technology firm or not. The collected data is represented in the following table 3. In case there are several companies which fulfill the criteria of data gathering only the largest M&As are included in the sample.

Table 3 *Distribution of M&As over the sample period* shows in numbers how many technology acquisitions technology firms have made as regards the column 2 and on column 3 non-technology acquisitions. In these M&As acquirers got more than 50 % of ownership after the M&A. Acquirers owned prior to acquisition less than 50 % of the target firm's shares. Table 3 shows that it is more common that a technology company acquires a technological company, rather than a non-technological company. The total number of companies chosen in this sample is 236, of which 96 companies had total sales in the year of the M&A of more than 1 billion USD. The sample data consists of very large firms.

Table 3.

Distribution of M&As Over the Sample Period

Year	Technology firm acquired a technology firm	Non-Technology firm acquired a technology firm	All
1	*2*	*3*	*4*
2010	20	6	26
2011	22	7	29
2012	29	5	34
2013	17	7	24
2014	32	4	36
2015	23	7	30
2016	24	7	31
2017	19	7	26
Total	186	50	236

Technology firms are defined with the help of ThomsonReuters using the macro industry of the acquirer and target firm which is high technology. ThomsonReuters macro industries are based on standard industrial codes or SIC-codes. Thomson Reuters has defined 14 macro industries. For this study the chosen technology-intensive industries are those having one of the following two-digit SIC codes defined by OECD and used for the first time by Hall and Vopel (1996). SIC codes and definitions of technology intense industries are listed in table 4.

Table 4.

Standard industrial classification codes

SIC code	Definition
28	Manufacturing: Chemicals and allied products
35	Manufacturing: Industrial and commercial machinery and computer equipment
36	Manufacturing: Electronic and other electrical equipment and components (excl. computer equipment)
37	Manufacturing: Transportation equipment
38	Manufacturing: Measuring, Analyzing, and Controlling instruments; Photographic, medical and optical goods; Watches and clocks
48	Transportation & public utilities: Communications
73	Services: Business services
87	Services: Engineering, Accounting, Research, Management, and related services

Non-technology acquirers represent the following macro industries chosen from ThomsonReuters: consumer products and services, energy and power, government and agencies, healthcare, industrials, materials, media and entertainment, real estate, retail, and telecommunications.

Hitt et al (1991) found that acquisitions don't always have positive effects on acquirers' R&D expenditures and later R&D outputs. The synergized gains are not immediately achieved via acquisitions. According to synergy theory M&As should have a positive effect or no effect on R&D outputs but their results show that innovative outputs decrease compared to competitors. Also, Hall (1990) found that R&D intensity generally declines after M&As in all industries when she studied 2,500 manufacturing companies. Therefor profitability should not be measured immediately after a M&A. According to Kallunki et al. (2009) activity of R&D expenditures increases a year after the M&A. That is the reason, why in this study future profitability is measured in the next four years after the M&A was completed.

3.3 Descriptive statistics

Descriptive statistics of variables used in regression are presented in table 5. In panel A descriptive statistics are presented for technology acquirers and in panel B for non-technology acquirers. Assets (millions) of the acquirer indicate that the companies used in regression are very big corporations, just as with the number of DEALS. DEALS refer to the number of M&As the acquirer conducted during the past three years before the relevant M&A. For some companies

Table 5.

Descriptive statistics of the variables used in the regression

Panel A: Technology Acquirers of Technology Targets N=186					
	1	*2*	*3*	*4*	*5*
Variable	**Mean**	**Median**	**Standard deviation**	**Min**	**Max**
P_{it}/BV_{it}	5.777	3.127	17.745	-43.905	276.891
RD_{it}/BV_{it}	0.351	0.165	1.423	-6.650	30.000
E_{it}/BV_{it}	0.301	0.254	1.471	-30.077	5.348
Ta_{it}	14,943.195	1,197.320	40,174.368	13.877	290,345.000
$DEALS_{it}$	3.532	2.000	4.989	0	35
CHS_{it}	0.069	0.021	0.145	0.000	0.440
$SIZE_{it}$	18.666	18.595	1.849	14.221	24.006
Panel B: Non-Technology Acquirers of Technology Targets N=50					
	1	*2*	*3*	*4*	*5*
Variable	**Mean**	**Median**	**Standard deviation**	**Min**	**Max**
P_{it}/BV_{it}	3.684	2.477	7.446	0.449	85.839
RD_{it}/BV_{it}	0.1686	0.092	0.323	0.003	3.446
E_{it}/BV_{it}	0.060	0.085	0.114	-0.432	0.462
Ta_{it}	5,418.996	1,188.856	19,490.540	39.071	162,648.00
$DEALS_{it}$	2.445	2.000	3.000	0	16
CHS_{it}	0.080	0.027	0.104	0.000	0.055
$SIZE_{it-1}$	18.037	18.015	1.711	13.955	22.056

In chapter five in tables 6 and 7 the results of testing model 1 are presented. Table 8 presents the results for hypothesis 2. To test these models, the OLS regression method is used. A robust test is performed using the statistical Generalized Methods of Moments (GMM) estimation technique, which is also included for hypothesis 1 model 1, with the Newey-West estimator that is consistent with both the presence of heteroskedasticity and autocorrelation. GMM was chosen for the robustness test of the study because it was also used in the studies of e.g. Bertnand and Zuninga (2004) and Kallunki et al. (2009). The results of the robustness test are represented in table 9. In addition, this study analyzes if there is any decline in R&D spending and increase in financial performance during the year of the M&A. These results are presented in table 10.

4. Empirical results

4.1 Results of hypothesis 1 and 2

(i) Stock Market Valuation of R&D Spending in M&As Involving Technology and Non-Technology Acquirers and Technology Targets

This part presents the results for testing model 1. Results for technology acquirers are presented in table 6. Results show that there is no correlation between a *technology company's* acquisition of a technological company and an acquirer's R&D spending and stock market valuation in the short term. Accordingly, hypotheses 1 is rejected. The chosen companies were publicly listed, and they may also have several other acquisitions during the year the M&A took place. It also might be because the larger the company is, the less impact one merger or acquisition has on the results of the whole company. Results are reported without control variables in columns 1–3 and with control variables in column 4. For each column a separate OLS regression was conducted. All variables where one coefficient is MA_{it} are interaction variables, because they might be dependent on values of other independent variables. For the hypothesis 1a nine variables were winsorized because they gave very extreme values (see table 6).

The stock market response to R&D spending in the year of the M&A can be assessed by dividing value $RD_{it}/BV_{it} \times M\&A_{it}$ by value RD_{it}/BV_{it} in column 4. Values for these variables are -20.309 (p-value 0.000) and 7.670 (p-value 0.000). The independent variable p-value $RD_{it}/BV_{it} \times M\&A_{it}$ was 0.000 which is less than 0.050. It can be shown that stock markets react negatively to R&D spending during the year of M&As on a significant level. For big companies there is no change to the value creation of R&D for the technology acquirer. For the variables $E_{it}/BV_{it} \times M\&A_{it}$ and E_{it}/BV_{it} the values are -0.180 (p-value 0.831) and 1.616 (p-value 0.000) respectively in the column 4. $E_{it}/BV_{it} \times M\&A_{it}$ variable is less negative which means investors place more value on earnings of the acquirer while for R&D spending investors do not seem to consider this an important source of value.

One control variable $RD_{it}/BV_{it} \times M\&A_{it} \times CHS_{it}$ gives a significantly negative value -11.020 (p-value 0.091). In the previous study there was relative correlation between the acquirer's shares held by insiders and stock market valuation of acquirer's R&D spending in the year of the M&A (Kallunki et al., 2009). It would mean stock markets react negatively if shares held by insiders are a large part of the total shares. The less insiders own shares the more positively stock markets react to M&As. It is good to consider that there might be some changes in construction of ownership and shares, and that shares held by insiders might increase or decrease due to a reorganization of ownership. One issue troubling investors might be managerial hubris.

Two control variables gave a significantly positive value. The first control variable was $RD_{it}/BV_{it} \times M\&A_{it} \times SIZE_{it}$ (deal value) which gave a value of 1.109 (p-value 0.000). This finding suggests that the deal value is positively associated with the acquirer's R&D spending and stock market value during the year of the M&A. The deal value most likely indicates to the markets how much synergies can be created in technology M&As. The deal value includes for example the target's R&D knowledge, so markets consider that the technology acquirer is able to improve its R&D performance via a technology M&A. The other control variable $RD_{it}/BV_{it} \times M\&A_{it} \times DEAL_{it}$ (deals conducted in the previous three years) gave a value of 0.476 (p-value 0.008) which suggests that the markets react positively regarding R&D spending during M&As when the acquirer has completed other deals recently as well.

Other control variables did not show any strong correlation between R&D spending and stock market valuation during the year of the M&A. This study concentrates on what kind of outputs acquisitions have on R&D. E.g., Hitt et al. (1991) consider that acquisitions have independent effects on R&D as well as broader effects such as replacing inefficient managers. Hitt et al. (1991) emphasize the management's point of view in their study. It is justifiably, because management has a vital role in acquisitions and how much the firm spends on R&D. For the target firm shareholders M&As create remarkable value.

Table 6.

Stock Market Valuation of R&D Spending in M&As Involving Technology Acquirers and Technology Targets

Results of OLS regression model 1

$$\frac{P_{it}}{BV_{it}}=\beta_0+\beta_1\frac{RD_{it}}{BV_{it}}+\beta_2\frac{E_{it}}{BV_{it}}\ \beta_3 M\&A_{it}+\beta_4\frac{RD_{it}}{BV_{it}}\times MA_{it},+\beta_5\frac{E_{it}}{BV_{it}}\times MA_{it}+\beta_6 X_{it}+\beta_7\frac{RD_{it}}{BV_{it}}\times MA_{it}\times X_{it}+\sum_{K=\ 1}^{7}\phi_k\,IND_k+\sum_{y=2010}^{2017}\lambda_k\,YEAR_y+\varepsilon_{it}$$

	1	*2*	*3*	*4*
Intercept	0.481	0.520	0.424	-0.068
	(0.388)	(0.361)	(0.451)	(0.967)
RD_{it}/BV_{it}	5.692	5.699	7.533	7.670
	(0.000)***	(0.000)***	(0.000)***	(0.000)***
E_{it}/BV_{it}	2.883	2.873	1.817	1.616
	(0.000)***	(0.000)***	(0.000)***	(0.000)***
$M\&A_{it}$		-0.105	0.256	0.111
		(0.722)	(0.471)	(0.758)
$E_{it}/BV_{it} \times M\&A_{it}$			1.638	-0.180
			(0.021)**	(0.831)
$RD_{it}/BV_{it} \times M\&A_{it}$			-3.316	-20.309
			(0.000)***	(0.000)***
$SIZE_{it}$				0.032
				(0.709)
$RD_{it}/BV_{it} \times M\&Ait \times SIZE_{it}$				1.109
				(0.000)***
TA_{it}				0.000
				(0.411)
$RD_{it}/BV_{it} \times M\&A_{it} \times TA_{it}$				0.000
				(0.003)***
$DEALS_{it}$				0.116
				(0.004)***
RD_{it}/BV_{it} x $M\&A_{it}$ x $DEALS_{it}$				0.476
				(0.008)***
CHS_{it}				-0.921
				(0.295)
$RD_{it}/BV_{it} \times M\&A_{it} \times CHS_{it}$				-11.020
				(0.091)*
Yearly controls	Included	Included	Included	Included
Industry controls	Included	Included	Included	Included
N	544	544	544	544
Adj R^2	0.585	0.584	0.600	0.675

P-values are in parentheses. 0.000 denotes a *p*-value of less than 0.0005. *N* is the number of observations used in the model. Asterisks $*$, $**$ and $***$ denote significance at 0.10, 0.05 and 0.01 respectively.

Results for non-technology acquirers are presented in table 7. When the acquirer is a *non-technology* firm it seems that the results are different compared to technological firms. Variable $RD_{it}/BV_{it} \times M\&A_{it}$ has a positive value of 15.970 in column 4, but not on a significant level (p-value > 0.050). Value Eit/BVit × M&Ait is a negative value but also not on a significant level.

It is interesting to conclude that for non-technology acquirers there is positive correlation between shares held by insiders and R&D spending for stock markets, as seen in table 7 column 4. The value of RD_{it}/BV_{it} x $M\&A_{it}$ x CHS_{it} 9.660 is not negative as in table 6. The p-value is 0.593 which means markets react positively but not on a significant level (p-value > 0.050). This indicates that markets believe that management is taking risks by acquiring something new for the company. The control variables $RD_{it}/BV_{it} \times M\&A_{it} \times SIZE_{it}$ and $RD_{it}/BV_{it} \times M\&A_{it} \times DEALS_{it}$ are both negative values and their p-value is more than 0.050. This might indicate that a big deal value from acquirer's side and previous M&As completed in recent history have negative effect on stock market valuation. As a conclusion there is no strong between control variables used in this study and stock market valuation of acquirer's R&D spending in the year of the M&A there is no strong correlation.

Table 7.

Stock Market Valuation of R&D Spending in M&As Involving Non-Technology Acquirers and Technology Targets

Results of OLS regression model 1

$$\frac{P_{it}}{BV_{it}}=\beta_0+\beta_1\frac{RD_{it}}{BV_{it}}+\beta_2\frac{E_{it}}{BV_{it}}\ \beta_3 M\&A_{it}+\beta_4\frac{RD_{it}}{BV_{it}}\times MA_{it},+\beta_5\frac{E_{it}}{BV_{it}}\times MA_{it}+\beta_6 X_{it}+\beta_7\frac{RD_{it}}{BV_{it}}\times MA_{it}\times X_{it}+\sum_{K=1}^{7}\ \phi_k\ IND_k+\sum_{y=2010}^{2017}\lambda_k\ YEAR_y+\varepsilon_{it}$$

	1	*2*	*3*	*4*
Intercept	-1.182	-1.198	0.139	-2.411
	(0.165)	(0.170)	(0.863)	(0.300)
RD_{it}/BV_{it}	20.036	20.029	12.521	5.491
	(0.000)***	(0.000)***	(0.000)***	(0.000)***
E_{it}/BV_{it}	12.389	12.397	7.928	2.844
	(0.000)***	(0.000)***	(0.004)***	(0.158)
$M\&A_{it}$		0.046	-1.822	0.431
		(0.926)	(0.001)***	(0.467)
$RD_{it}/BV_{it} \times M\&A_{it}$			9.330	15.970
			(0.000)***	(0.395)
$E_{it}/BV_{it} \times M\&A_{it}$			6.028	-1.121
			(0.120)	(0.747)
$SIZE_{it}$				0.186
				(0.000)***
$RD_{it}/BV_{it} \times M\&Ait \times SIZE_{it}$				-1.141
				(0.259)
TA_{it}				0.000
				(0.000)***
$RD_{it}/BV_{it} \times M\&A_{it} \times TA_{it}$				0.000
				(0.019)**
$DEALS_{it}$				0.208
				(0.009)***
$RD_{it}/BV_{it} \times M\&A_{it} \times DEALS_{it}$				-0.443
				(0.406)
CHS_{it}				-0.566
				(0.755)
$RD_{it}/BV_{it} \times M\&A_{it} \times CHS_{it}$				9.660
				(0.593)
Yearly controls	Included	Included	Included	Included
Industry controls	Included	Included	Included	Included
N	150	150	150	150
Adj R^2	0.450	0.50	0.884	0.943

P-values are in parentheses. 0.000 denotes a *p*-value of less than 0.0005. *N* is the number of observations used in the model. Asterisks $*$, $**$ and $***$ denote significance at 0.10, 0.05 and 0.01 respectively.

b) *R&D Spending and Future Financial Performance of the Acquirer*

For hypotheses 2a and 2b the effects of the M&A on the future profitability of the acquirer were examined. The chosen years were the next four years after the year in which the acquisition or merger was completed. The first year is one $year_{(it+1)}$ after the M&A was completed which is also the last year tested in model 1. For *technology acquires* column 1 in table 8 shows that one year after the merger or acquisition is completed the company cannot yet convert R&D spending into future profitability. In the long-term technological M&As are profitable for the technology acquirer and after one year the technology acquirer has been more efficient in implementing the M&A. The dependent variable is based on the three-year average of net income before research and development expenditures scaled by book value from second to fourth year after the M&A was completed.

Non-technology acquirers' future profitability is more unsure. In column 2 the results show that the M&A is profitable after the second and third year when the M&A was completed but then there is a sudden decline. Compared to non-technology acquirers, non-technological companies are not that efficient in converting R&D spending into future profitability. As a result, when the acquirer is a *non-technology* firm it seems that they do not get the full potential of the M&A.

Tables 6 and 7 shows that the M&A does not have a short-term effect on firm's stock market valuation. For this study very large companies were chosen. Regarding M&As, it seems like it takes these companies more time to convert R&D spending into future profitability.

Table 8.

Effect of Current R&D Spending on the Future Profitability of the Technology and Non-Technology Acquirers of Technology Targets

Results of OLS regression model 2

$$\frac{1}{3}\sum_{k=2}^{4}\frac{E_{it+k}}{BV_{it+k}} = \beta_0 + \beta_1\frac{E_{it+1}}{BV_{it+1}} + \beta_2\frac{RD_{it+1}}{BV_{it+1}} + \beta_3 M\&A_{it} + \beta_4\frac{E_{it+1}}{BV_{it+1}}\times M\&A_{it} + \beta_5\frac{RD_{it+1}}{BV_{it+1}}\times M\&A_{it} + \frac{1}{3}\sum_{k=2}^{4}\frac{E_{it+k}}{BV_{it+k}} + \frac{1}{3}\sum_{k=2}^{4}\frac{RD_{it+k}}{BV_{it+k}}$$

	Technology Acquirers of Technology Targets	*Non-Technology Acquirers of Technology Targets*
	4-Years-Ahead -Earnings	*4-Years-Ahead -Earnings*
Varible	*1*	*2*
Intercept	0.082 (0.000)***	0.037 (0.413)
E_{it}/BV_{it+1}	0,246 (0.000)***	1.212 (0.000)***
RD_{it}/BV_{it+1}	-0.017 (0.791)	-2.220 (0.000)***
RD_{it+2}/BV_{it+2}	0.154 (0.072)*	3.316 (0.000)***
RD_{it+3}/BV_{it+3}	0.171 (0.012)**	1.273 (0.007)***
RD_{it+4}/BV_{it+4}	0.492 (0.000)***	-2.745 (0.000)***
N	143	38
Adj R^2	0,834	0,988

P-values are in parentheses. 0.000 denotes a *p*-value of less than 0.0005. *N* is the number of observations used in the model. Asterisks $*$, $**$ and $***$ denote significance at 0.10, 0.05 and 0.01 respectively.

4.2 Robustness test

a) *GMM Estimation technique*

In table 9 a robustness check is performed using the Generalized method of moments (GMM) estimation to test hypotheses 1a and 1b using the model 1 as in tables 6 and 7. The same extreme variables of technology acquirers are excluded from this test. Results are similar to that of the OLS regression model 1, and they support these findings. Stock markets react negatively to R&D spending of the technology acquirer in the year of M&A. For the non-technology acquirers values $RD_{it}/BV_{it} \times M\&A_{it}$ and $E_{it}/BV_{it} \times M\&A_{it}$ are negative but not on significant level.

As a result, there is no correlation between annual stock market return and R&D spending during the M&A. Results are not presented in any table but are available upon request. In conclusion there might be a short peak to share prices during the acquisition, but one acquisition does not affect the share prices on an annual basis.

Managers can substitute R&D investments with acquisitions and that might lead to the acquirer not fully exploiting acquired technology or the technology being outdated. In the long-term acquisitions reduce innovativeness of the acquired firm. Acquisitions may have a stronger impact on R&D investments than on diversification, but diversifying acquisitions have a strong impact on R&D outputs. M&As have various effects on R&D inputs and outputs and also increase diversification. As a result, Hitt et al. (1991) suggest that diversifying M&As and a sudden reduction in patents due to diversifying M&As may have negative effect on the firm's market value in the long term.

Table 9.

Results from using GMM Estimation Technique

Results of OLS regression model 1

$$\frac{P_{it}}{BV_{it}}=\beta_0+\beta_1\frac{RD_{it}}{BV_{it}}+\beta_2\frac{E_{it}}{BV_{it}}+\beta_3 M\&A_{it}+\beta_4\frac{RD_{it}}{BV_{it}}\times MA_{it},+\beta_5\frac{E_{it}}{BV_{it}}\times MA_{it}+\beta_6 X_{it}+\beta_7\frac{RD_{it}}{BV_{it}}\times MA_{it}\times X_{it}$$
$$+\sum_{K=1}^{7}\phi_k IND_k+\sum_{y=2010}^{2017}\lambda_k YEAR_y+\varepsilon_{it}$$

	Technology Acquirers of Technology Targets	*Non-Technology Acquirers of Technology Targets*
Colum	*1*	*2*
Intercept	0.163	3.238
	(0.912)	(0.398)
RD_{it}/BV_{it}	7.527	1.450
	(0.000)***	(0.544)
E_{it}/BV_{it}	1.762	3.639
	(0.137)	(0.026)**
$M\&A_{it}$	0.069	0.101
	(0.900)	(0.800)
$E_{it}/BV_{it} \times M\&A_{it}$	-0.289	-1.030
	(0.876)	(0.741)
$RD_{it}/BV_{it} \times M\&A_{it}$	-20.430	-2.255
	(0.012)**	(0.559)
Control variables	*Included*	*Included*
N	544	150
Adj R^2	0.668	0.402

P-values are in parentheses. 0.000 denotes a p-value of less than 0.0005. N is the number of observations used in the model. Asterisks $*$, $**$ and $***$ denote significance at 0.10, 0.05 and 0.01 respectively.

b) *Changes in R&D Spending and Earnings in the Year of the M&A*

Kallunki et al. (2009) broadened their study and investigated whether the acquirer's R&D spending decreased, and profitability increased during the year of the M&A. The assumption is that technology acquirers can re-invest their R&D spending more efficiently than non-technology acquirers. In line with Kallunki et al. (2009) the OLS regression models 3 and 4 are the following:

$$\frac{E_{it}}{BV_{it}} = \beta_0 + \beta_1 M\&A_{it} + \sum_{y=2017}^{2010} \lambda_{iy} YEAR_y + \varepsilon_{it} \qquad (3)$$

$$\frac{RD_{it}}{BV_{it}} = \beta_0 + \beta_1 M\&A_{it} + \sum_{y=2017}^{2010} \lambda_{iy} YEAR_y + \varepsilon_{it} \qquad (4)$$

Table 10 shows what happens to the acquirer's R&D spending and financial performance during the year when the M&A is completed. The years chosen for the model are the same as in model 1, i.e., one year before the M&A, the year of the M&A and one year after the M&A. The analysis period (2010–2017) is the same as in model 1. For both technological and non-technology acquirers R&D spending does not decrease. That means companies do not cut their R&D spending in the year of the M&A. This might also be applicable to other kinds of spending on the part of the acquirer. At the same time for technology acquirers there is decrease of earnings during the year of M&A. The results are consistent with the results reported in table 6 that stock market valuation of the R&D and earnings do not increase during the M&A for technology acquirers. For this study very large companies were chosen that also acquired other companies during the same year or before, which might explain the increased R&D spending during the year when the M&A was completed. In this case it is not possible to say whether the increased spending was intentional or not. On the other hand, it might be also good for a company's innovative performance that the R&D expenditure is not cut too early.

Table 10.

Impact of the M&A on Acquirer's Earnings and R&D Expenditures

Panel A: Technology Acquirers of Technology Targets

	E_{it}/BV_{it}	RD_{it}/BV_{it}
Intercept	0.571	0.299
	(0.004)***	(0.113)
$M\&A_{it}$	-0.231	0.176
	(0.081)*	(0.167)
N	558	558
Adj R^2	0.002	0.004

Panel B: Non-Technology Acquirers of Technology Targets

	E_{it}/BV_{it}	RD_{it}/BV_{it}
Intercept	0.079	0.051
	(0.306)	(0.058)
$M\&A_{it}$	0.054	-0.006
	(0.327)	(0.771)
N	150	150
Adj R^2	0.040	0.054

P-values are in parentheses. 0.000 denotes a *p*-value of less than 0.0005. *N* is the number of observations used in the model. Asterisks $*$, $**$ and $***$ denote significance at 0.10, 0.05 and 0.01 respectively.

5. Summary and conclusions

This study investigated how R&D spending of the acquirer increased a firm's market value and future profitability during M&As. The observation period was the seventh merger wave between 2010 and 2017. Two main hypotheses were tested: Can technological and non-technological acquirers enhance their market value, and in turn their future profitability, by completing technological M&As? The first hypothesis tested if R&D spending can enhance the acquirer's stock market value in the short term if a M&A is completed. In the short term there is no statistically significant correlation between R&D spending and the acquirer's current market value, regardless of if the acquirer is a technological or non-technological firm. At the same time some studies have proven that when a technological company acquires a technological company there is a strong correlation between R&D spending and market value and profitability during M&As (e.g., Ahuja & Katila 2001; Higgins & Rodriguez 2006; Hitt et al., 1991; Kallunki et al., 2009).

Secondly the study looked at the correlation between R&D spending and a firm's profitability in the long term. In conclusion, there seems to be an impact in the long term on the firm's profitability when the acquirer is a technological company (hypothesis 2). Technological acquirers are better at converting R&D spending in the long term than non-technological acquirers. This is in line with previous studies. In conclusion it can be suggested that for large companies it takes more time to convert and implement their R&D spending into future profitability after a M&A. Even R&D are counted as expenditures, they have a long-term impact on a firm's result. Failed investments in R&D might lead to an end of the business or part of the business. Management of the acquirers need to evaluate carefully how they can integrate the target company into their operations. R&D spending of the acquirer can be considered valuable information for investors.

For both technological and non-technological firms organizational and strategic fit is very important part in succeeding in M&A when the target is technological. Non-

technological acquires don't seem to have long term strategy how to implement R&D knowledge to profitability while technological acquirers have more clear plan for that. Ahuja and Katila (2001) mentioned that large firms can benefit from the technological M&As because they have more resources to integrate the acquired R&D into their own business and create new innovations. At the same time acquired R&D covers only part of the large firms' businesses which means the acquirer can cope with the failed M&S better than a small company. In a long term more synergies are created when two technological companies merge than when the acquirer is a non-technological company.

The relationship between how reliable and economically relevant information on R&D spending is compared to future revenue has generally not been proven directly (Lev & Sougiannis, 1996). Also, Chan, et al. (2001) did not find a direct link between R&D spending and stock market value but agreed that R&D intensity is associated with return volatility. There are still factors beyond this study's scope that needs to be taken into consideration because there are many motives behind acquisitions, and there are also many factors that affect a large company's stock market valuation and profitability.

Generally, all M&As are individual and some M&As thrive and some fail. M&As are a very popular strategy but they are also rather risky at the same time. Costs of M&As are usually very high. Capital is easily available and M&As are a tempting solution to try and make a business profitable. Fast decisions lead to poor quality of thinking, preparation, and post-merger management. The reasons behind failing might be due to M&As not supporting the acquirer's strategy. The management might also find M&A processes exciting and might prefer to make new deals rather than starting post-merger processes (Bower, 2001). This seems to happen especially when non-technology acquirers acquire technological companies. Technological acquisitions may not support the non-technology acquirer's strategy enough in the long term. Failures in M&As might also be due to managerial hubris or that the management is driven by maximizing their own interest rather than the company's value. According to Cordeiro (2014) we still know very little about the history of M&As and errors that have occurred in the past are likely

to be repeated in the future. Technology M&As provide both great growth opportunities and high risk of failure for the acquirer.

There are certain limitations regarding this study. Due to a small sample size all results cannot be generalized to all technological mergers and acquisitions, especially not to all sizes of companies or all countries. A qualitative approach was taken in observing M&As and all integration mechanisms on how other functions such as marketing, employees and production affected how successful the M&A was, were not part of this study. It is very challenging to prove how much stock market value is affected by the R&D spending of the acquirer.

M&As are very tempting for companies from a strategic point of view, and the money involved is astronomical. Technology companies play a very important role in M&As and the technology industry is still a growing business. This study focused on large companies which play an important role in acquiring technological targets of varying sizes. Also, the seventh merger wave starting from 2010 gives new information on M&As. The M&As studied here occurred during the seventh wave of M&As, which is a period that still hasn't been fully researched. Rossi et al. (2013) studied during their literature review companies and how successful they were at M&As. They found that results have generally been negative due to the complexity of the M&A process where managers have a lot of responsibility for planning and implementing the M&A. Especially in technological M&As these sectors are characterized by a high level of growth in technology and high uncertainty, which can result in various outcomes for stakeholders.

M&As offer several topics to study and there is still a lot to learn from them. The manager's part in succeeding with the M&A cannot be ignored either. The value decreasing theories relate mostly to managers. Their planning and implementing also play an important role in M&As. It is also likely that M&As in technology driven industries will continue to be part of normal business which will give new topics to study in the future, to understand more profoundly the future effects of M&As. It would be an The

different factors affecting the stock market valuation and profitability would also be an interesting topic to study more in dept in the future. For example, do investors pay attention to R&D expenses and return on research capital (RORC) ratio when looking at mergers and acquisitions?

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