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# Do higher levels of R&D intensity create more shareholder value in acquisitions? Evidence from high-tech targets and non-high-tech acquirers

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## Abstract

This study attempts to investigate the impacts of absorptive capacity as well as the knowledge level of target and acquirer on the creation of shareholder value for high-tech targets and non-high-tech acquirers. The cumulative abnormal returns of acquirers will be analyzed taking into account the R&D intensities of players as well as their high-tech classification. The study in this paper focuses on firms that are publicly listed in US. Model 1 finds a U-shaped relationship between the acquirer's R&D intensity and the market response for deals involving high-tech targets. This indicates that acquirers with high levels of research intensity can create value from acquiring a high-tech target by assimilating and utilizing the new knowledge inflow. On the other hand, acquirers with low levels of R&D intensity can also benefit from acquiring a high-tech target by gaining access to the knowledge base and resources of the target. Model 2 discovers a negative relationship between target's R&D intensity and a non-high-tech acquirer's value creating potential from acquisitions. This indicates that there can be significant variables other than the target's technological level in creating shareholder value for non-high-tech acquirers.

**Key words**: M&A, R&D intensity, High-tech targets, Non-high-tech acquirers, Cumulative abnormal returns

## 1. Introduction

Mergers and acquisitions (M&A) have long been a popular strategic move for companies willing to innovate itself. Only in 2016, 26000 deals took place globally amounting up to $2.5 trillion according to the Boston Consulting Group (BCG) 2017 M&A report. The dominant reason for such an aggressive activity is to acquire higher performance and generate shareholder value (Bergh, 1997; Sirower, 1997). As a result, finding the adequate factors that will drive acquisitions to success have long been a quest for researchers. Many relevant factors were found as knowledge accumulated through the decades, yet to remain inconsistent when predicting post-acquisition performances (King et al., 2004). So even with vast accumulated research over 50 years, still less than half of acquisitions results in a success (Bruner, 2002; Calipha, Tarba and Brock, 2015). Some scholars even argue that only about 20 percent of all mergers actually succeed while others typically erode shareholder wealth (Christensen et al., 2011; Grubb and Lamb, 2000). Albeit such outcomes, firms continue to leverage M&A as a strategic tool without much supporting evidence in its value creating potential (King et al., 2008). Consequently, this unsolved puzzle (Agrawal and Jaffe, 2000) of M&A as a tool of value creation led to continued demand for further research in identifying a theoretical framework which helps explain the M&A performance and value creation potential (Hitt et al., 1998; Sirower, 1997).

One branch of M&A research that can offer a framework of meaningful discussion especially regarding long term value creation is the resource-based theory (RBT). RBT considers firms as a broad set of resources that it owns (Das and Teng, 2000). Wernerfelt (1984) defined resources as "those (tangible and intangible) assets which are tied semi-permanently to the firm." The features of these 'resources' vary significantly according to which industry or culture the firm belongs to. Yet, most resources share the common feature of being firm-specific and not being imitable which allows for continuous heterogeneity in its resource basis (Das and Teng, 2000). According to Das and Teng, this continued heterogeneity is one of the main source of long-term competitive advantage. Applying this concept to the field of M&A, acquisitions can be an opportunity and an impactful method in trading otherwise non-marketable resources that generates future competitive advantage (Wernerfelt, 1984).

Building on the framework of resource-based theory, this paper aims to deepen the understanding on the value creation potential of M&A with relation to high-tech and non-high-tech firms. According to Chesbrough (2003), the current paradigm of innovation is on a shift from a closed model to an open model which he defines this shift as 'Open Innovation'. In this method of innovation, competitive advantage and value creation often comes from inbound open innovations through the leveraging of others' discoveries. Chesbrough and Crowther (2006) mention that open innovation was once the model that only precisely characterized high-tech industries, but which is now proliferating to other non-high-tech industries as a paradigm. As M&A is a dominant method of acquiring flexibility and innovation for both high-tech and non-high-tech firms, firms are actively engaging in acquisition as a tool for open

innovation (Hagedoorn and Duysters, 2002; Chesbrough and Crowther, 2006). Lusyana and Sherif (2016) show in their research that 266 tech-related M&A were executed only in first half of 2016 which is approximately five times more than that of the same period in 2009 while four times more than the same period in 2010. On the other hand, non-high-tech players are also highly involved in this trend as 70% of all tech-related deals in 2016 were reported to be non-high-tech buyers (BCG M&A report, 2017). Consequently, this paper aims to examine the value creation potential and its drivers with consideration of high-tech and non-high-tech classifications as both groups, which share different characteristics, are important stakeholders in technology related acquisitions.

Particularly, this paper aims to understand the interaction between external acquisitions with acquirer's existing resource basis. Studies focusing in the interaction consequences of acquisitions mainly view that performance will be higher if the firms' resources can complement or supplement each other (Capron and Pistre, 2002; Hitt et al., 1998; Wernerfelt, 1984). The first analysis of this paper aims to find out whether the absorptive capacity of acquirers have a positive or negative influence on value creation potential of acquisitions involving high-tech targets. The main focus is to find out whether acquirers of high-tech targets can utilize (link, learn and leverage) the knowledge base of targets without much absorptive capacity or whether they need a sufficient level of absorptive capacity to do so. On the other hand, this paper further aims to explore the knowledge accessing side of M&A as well. In this line of theory, firms choose acquisition as sort of a tool for acquiring knowledge basis from an external source rather than developing through internal measures. Combined with the concept of open innovation, non-high-tech firms are expected to realize better market responses when acquiring firms with more knowledge as better knowledge basis (which might be costly to develop oneself) will follow from the acquisition.

Therefore, this study contributes to existing literature as it tries to investigate the value creating potential of acquisitions by combining the resource-based view with the theoretical perspectives of organizational learning while taking into account the trend of open innovation and high-tech classification.

The following part of the paper is organized as follows. Section 2 will further review relevant literatures while developing the hypotheses that will be tested in this paper. Section 3 describes the data and methodology that are used to test the hypotheses in the paper. Section 4 will provide the results as well as the analysis of the model that were ran. Finally, section 5 will conclude with a brief summary on the findings as well as remarks for further research.

## 2. Theoretical background and hypothesis development

### 2.1 High tech targets

Acquisitions are indeed a very efficient way of innovation if used well, yet do accompany many challenges (Bruner, 2002; Tuch and O'Sullivan, 2007). Especially regarding acquisitions involving high-tech firms, each sides of gain and loss became more intense as high-tech firms emerged to be the leaders in the economy by their growth potential as well as contribution to efficiency gains (Kohers and Kohers, 2000). According to Kohers and Kohers (2000), the main driver of high growth potential of high-tech firms is their capability of innovation. With their accumulated knowledge and their relatively dynamic nature, they realize higher rate of growth and hence higher potential to create value. However, another inherent feature of high-tech firms is the uncertainty that comes from the nature of relying on values that are yet to be realized or are under development. Furthermore, if the acquiring firm fails to adequately absorb the accumulated knowledge of the high-tech target, the risks of acquisition can increase significantly. Moreover, if there are any chance of the acquirer to wrongly value the target during the due diligence stage, the acquirer can wrongly pay higher premiums and realize lower value created as a result of acquisition (Hitt et al., 2001).

As a result, along with the overall trend of acquisitions not generating above normal returns for acquirers, acquisitions involving high-techs also failed to realized systematic above average returns (Bouwman et al., 2009; Kohers and Kohers, 2000; Sudarsanam, 2010; Zhu, Xia and Makino, 2015; Chaudhuri and Tabrizi, 1999). However, high-tech targets still remain as the one of the most popular ways of innovation from external sources, so called the 'Outbound Open Innovation' (Chesbrough, 2003). Few theoretical approaches that try to explain the constant demand for acquisitions and its potentials creating shareholder value are the absorptive capacity concept and the knowledge accessing model in acquisitions involving high-tech firms (Beule and Sels, 2016). With the following sections, this paper aims to study the relationship between research capacity of the acquirer and its market response after an acquisition of a high-tech target. Rather than the relationship being strictly positive nor negative, this paper theorize that the relationship might be curvilinear. The first reason is that acquirers that buy companies that possess higher level of knowledge can better analyze and utilize the resource only if they have the capability to do so (Cohen and Levinthal, 2000). On the other hand, for acquirers that does not even have the basis knowledge to perform a high-level analysis of target, the benefits from acquisition can come from the simple fact that they now can have access to the knowledge that can possibly generate value (Grant and Baden-Fuller, 2004).

## 2.2 Absorptive capacity

Under the theory of resource-based view on integration of firms, the main driver of value creation are the resources of the two merging companies being able to complement or supplement each other (Capron and Pistre, 2002; Hitt et al., 1998; Wernerfelt, 1984). According to Peteraf (1993) as well as Beuele and Sels (2016), these resources can be considered as a bundle of both tangible and intangible assets that heterogeneously help the firm create value. These assets include the firm's managerial and human resource competency, organizational structure and process as well as technology and knowledge the firm possesses. Many scholars in the field mention that the firm's capability to integrate and utilize these kinds of assets are needed in order to accomplish a positive post-acquisition performance (Zahra and George, 2002; Morck and Yeung, 1992). However, the premise of good interaction between resources is that the acquiring firm is capable of learning from, and innovating with the new absorbed knowledge (Cohen and Levinthal, 2000). This ability of the firm to perceive and assimilate information as well as to use it to its benefit is called the 'Absorptive Capacity' (Cohen and Levinthal, 1990; Beule and Sels, 2016; Tzokas et al., 2015).

Absorptive capacity theory has been one of the popular theories in analyzing not only M&A but also strategic management, alliances, organization learning and knowledge acquisitions (Beule and Sels, 2016; Lane et al., 2006; Todorova and Durisin, 2007). During such, existing literatures commonly use R&D expenses as an estimator of a firm's adaptive capacity (Li, 2011; Kostopoulos et al., 2011; Beule and Sels, 2016). They see that investments in R&D can enhance not only its internal capability to innovate, but also its internal knowledge pool as well as the skills of its technological staff and facilities. These accumulated capabilities can then be used to translate external flows of knowledge into actual benefits and add value to the firm (Todorova and Durisin, 2007).

However, the reality is that the valuable resources of firms are unique and extremely difficult to access before an acquisition or alliance. Particularly, high-tech firms' resources have always been kept a secret as knowledge is its core profit driver. Therefore, the acquirer tends to only get a glimpse of what the knowledge may be, but not an understanding to an extent that it can actually be used to create value. This leads to strong difficulties for acquirers in benefiting from external knowledge that abruptly flows in after an acquisition takes place (Kstopoulos et al., 2011; Cassiman and Veugelers, 2006; Escribano et al., 2009). In such context, the knowledge pool and the technological staff already available will play a significant role in creating value after acquisition. With such, existing internal R&D of buyers can act as a complement to the new knowledge from acquisitions. Therefore, absorptive capacity is a factor that is likely to have a positive influence on post-acquisition performance and generate higher shareholder value.

**Hypothesis 1a**: Acquisitions involving high-tech targets generate higher shareholder value for acquiring firms with higher R&D intensity

### 2.3 Knowledge accessing

Acquisition of a firm with higher level of technology has long been a strong strategic move for a company to enhance its R&D capacity (Al-Laham et al., 2010; Beule and Sels, 2016; King, Slotegraaf and Kesner, 2008). Knowledge accessing, technological acquisition, M&A as R&D are all types of ways in which a firm can access new information and knowledge from an external source rather than developing it from within. Especially for firms that does not even have the basic capability to innovate in an organic way, it might be much efficient for them to acquire knowledge from an external source than to start from a scratch (Vanhaverbeke, Duysters and Noorderhaven, 2002; Chesbrough and Crowther, 2006).

The intention to access external knowledge source becomes more clear as it is applied to acquisitions involving high-tech targets. This is because the high-tech targets tend to have specific and unique resources on a subject that is itself the firm's competency in the fast-paced market (Lin, Lin and Lin, 2010). Without sufficient degree of absorptive capacity, the benefits from an acquisition might not come from learning and utilizing the knowledge of the high-tech target. Rather, the value of acquisition can come from gaining the access to the business itself and its vital assets. These assets include access to not only knowledge but also to skilled employees, internal routines, brand names, value chains, intellectual property and management expertise (Maritan and Peteraf, 2011). By acquiring such assets, which otherwise would have been inefficient to develop from within, acquisitions of high-tech firms in this case can act as a substitute for internal R&D (Barkema and Vermeulen, 1998; Cassiman and Veugelers, 2006).

This paper views that the firms which benefit from the knowledge accessing theory are mainly firms with limited absorptive capacity for higher-level analysis, rather wanting the access to target's resources. Building up and developing the capabilities that previously was not present nor possible is the main purpose of acquisition for these type of firms (Bell and Figueiredo, 2012). With such, acquisition of high-tech targets will bring in the resources that can provide a basis for future profit creation. Hence, acquirers with low R&D intensity can create value from acquisition of high-tech firms by gaining access to the resources that can substitute their internal R&D efforts.

**Hypothesis 1b**: Acquisitions involving high-tech targets create higher shareholder value for acquiring firms with lower R&D intensity

### 2.4 Non-high tech acquirers in the trend of Open Innovation

According to Chesbrough (2006), open innovation is a paradigm claiming that firms can and should use both internal and external knowledge to advance technology. Recently, the idea was modified to mean 'an innovation process that is based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms' (Gabison and Pesole, 2014). According to Gabison and Pesole (2014), open innovation process is becoming more open, collaborative, widespread and rapid. According to them, acquisitions are a way of acquiring resources through the market place which allows the firms to obtain licenses or expertise from outside.

Another characteristic of open innovation is that it first started and spread within the high-tech industry, but is now proliferating to other industries and firms as well (Chesbrough and Crowther, 2006). According to BCG 2017 M&A report, 70% of tech related acquisition in 2016 involved non-high-tech buyers which shows the spread of the paradigm. To further examine the trend of open innovation, this paper aims to focus on the non-high-tech acquirers of the trend which are the relatively new performers of open innovation. According to Nunes, Serrasqueiro and Leitão (2012), non-high-tech firms tend to have relatively lower levels of investment in R&D and lack economies of scale effects in R&D. In this group, unlike the high-tech firms, R&D investment does not directly lead to the growth of firms while R&D investments does not function as an effective barrier to new firms entering the market. Therefore, it is important for non-high-tech acquirers to choose a target with technology that is competent in the market and is capable of driving future values.

Consequently, this paper aims to focus on the factor related to the target's technology and knowledge which is one of the significant key success factors of an open innovation (Chesbrough ,2006). According to Chesbrough (2006), if a target owns a technology which is competent in the market while being able to add value to the acquirer, it is highly likely that the open innovation will end up in a success. In order to determine the quality of the target's technology, this paper uses the R&D intensity of the target as a proxy. Despite some limitations, existing literature confirm that R&D expenditures can effectively represent the complex concept of current level of technology the firm holds along with its innovative capability (Lin, Lee and Hung, 2006; Zhang et al., 2007; Hoffman et al., 1998). With such context, it can be said that a decent level of research capability and resource are required from the target side in order to create post-acquisition value for the acquirer. Hence, higher R&D intensity of the target can have positive influence on the post-acquisition performance and generate higher shareholder value for non-high-tech acquirers.

**Hypothesis 2**: For acquisitions involving non-high-tech acquirers, higher shareholder value is generated for targets with higher R&D intensity.

## 3. Data and methodology

### 3.1 Models, data collection and sample

To test the three hypotheses mentioned above, this paper constructed two separate models. The first model, which aims to test hypotheses 1a and 1b, is formed by dropping acquisitions which did not involve a high-tech target. On the other hand, model 2 is constructed by dropping deals that involves high-tech acquirers to test the impact of target's R&D intensity on non-high-tech acquirers. Separate models were constructed to test the hypotheses mainly to maintain a sufficient sample size and to control for possible correlations between variables. If all restrictions were to be imposed while combining the two models, only a few samples would survive and threaten the internal as well as the external validity of the model. Furthermore, high correlation between variables of interest (mainly acquirer R&D intensity and target R&D intensity) were observed when the models were performed together. The VIF (variable inflation factor) between some variables were well over 10, which indicates that there is high chance of bias in the results of the model.

To test aforementioned hypotheses, this paper used completed public acquisitions within US (both acquirer and target being an US firm) for recent 15 years from 2003 to 2017. The main reason for only gathering data of acquisitions within US is first to effectively control for cultural impacts which pose significant impacts (Chatterjee and Lubatkin, 1992) and for the practical efficiency of the analysis. Deal specifics were collected from ThomsonOne database which initially started as 14218 deals without any other restrictions imposed. The ThomsonOne database provides the name of the acquirer, the name of target, date of announcement, macro industries of acquirer and target, value of deal, percentage of shares acquired, recent 1-year return on asset (ROA) as well as firm-specific identification codes such as Sedol, Ticker and Standard Industrial Classification (SIC) codes.

To calculate the impact of acquisitions on (shareholder) value creation with relation to R&D intensity and high-tech category, this paper uses the event study method. The method was introduced by Fama, Jensen and Roll (1969) and was further developed by MacKinlay (1997). It uses CAR (Cumulative Abnormal Returns) as a proxy of shareholder value creation and is currently a standard method in measuring security price changes in relation to an event (Beule and Sels, 2016).

Stock return data that is required as a dependent variable was retrieved using Thomson Reuters Datastream. If the stock returns were not available for the period this paper aims to test, according deals were dropped. The remaining CAR was merged with the dataset using Sedol codes and announcement dates of deals.

In order to assign the R&D intensity of firms, firms' R&D expenditures as well as its sales were

collected from WRDS (Wharton Research Data Services) Compustat North America. Compustat database provides a firm's expenditures on R&D as well as its past sales which this paper used to calculate the firm's R&D intensity. Ticker symbols retrieved from ThomsonOne was used to identify a firm in the database. Then the recent two-year data were collected in in accordance to the announcement date also provided by ThomsonOne. Again, the deals that did not have either the target's information or the acquirer's information were dropped from the sample.

Finally, with the aforementioned restrictions, this paper further dropped deals that had problems in the retrieved numbers, such as a negative number in deal value, percentage acquired or R&D intensity. Then extreme outliers were also dealt with for cases such as deal value being less than 1% or more than 1000 times of its original value as well as cases where R&D expenditure was well over a few multiples of the firm's sales revenue. Lastly, the models dropped deals for which the acquiring firm's individual identifier was same as the target. This means dropping acquisition within a single company that might result in high correlations between variables of interests. As a result, the remaining numbers of sample were 65 deals for the first model and 115 deals for the second model after all above restrictions were imposed.

### 3.2 Dependent variable

The models in this paper uses a market-based performance measure of stock returns and event study method (Beule and Sels, 2016; Schoenberg, 2006). Cumulative abnormal returns (CAR) of acquiring firms are calculated around the announcement date of acquisition to derive the value creation potential of deals. According to Beule and Sels (2016), this method has two underlying assumptions. The first one is that the market is semi-strong form efficient (Sinha and Srinivasan, 2012). According to the efficient market hypothesis, security prices in a semi-strong form efficient market incorporates all information that is publicly available at that time as well as past history of prices (Jensen, 1978). Any new information that becomes publically available also becomes incorporated in the security's price instantaneously. In this analysis, the announcement of a deal is a public information becoming available. The second underlying assumption of the event study method is that the market did not expect the event to occur while there are no confounding events close to the event of interest so that the market valuation of the firm does not get influenced (McWilliams and Siegel, 1997).

Taking this market efficiency into account, choosing the appropriate length for the assessment window is an important factor in the event study method. This is because the length of the window can portray one's perspectives towards the market's efficiency. With the information efficiency assumed in the semi-strong form efficient market, the value creating potential as well as the costs of an acquisition is factored into the stock prices of the acquirer around the time of announcement. A short window would

indicate a fairly high trust in the capital market's efficiency while a long window indicating one's view that the market will take some time to realize and incorporate the acquisition's benefits and costs. Some might argue that an acquisition's performance cannot be measured in a short time period since there can be unidentified variables that can significantly influence the post-acquisition performance (King et al., 2004). However, lengthening the event window can also lead to problems. Since the information is collected from a wide range of dates, longer windows will be more vulnerable to other events that might be related to the acquirer but not to the study. Such noises can influence the valuation of the buyer and lead the analysis into a wrong direction. Furthermore, according to Sudarsanam (2010), longer windows can raise questions about the efficacy as well as the reliability of the statistical procedures and its results. Adding onto these, Beule and Sels (2016) mentions that market performance measures analyzed with event study methods are relatively unbiased and invariant to differences in firms' characteristics than other measures (Cording, Christmann and King, 2008).

Furthermore, stock price movements due to announcements of acquisitions have been extensively used as a proxy of shareholder value creation by scholars in finance and strategic management (Markides and Ittner, 1994; Campa and Hernando, 2004; Moeller et al., 2003; Moeller et al., 2005; Gubbi et al., 2010; Singh and Montgomery, 1987). According to Campa and Hernando (2004), short-term CAR reflects changes in the expected future cash-flows to shareholders resulting from future synergies or shareholder value creation. Such event study method was also extensively used in studies of value creating potential of acquisitions involving high-tech classifications (Kohers and Kohers, 2000; Porrini, 2004; Benou and Madura, 2005).

With aforementioned contexts, this paper believes it has sufficiently justified the validity of using cumulative abnormal returns to shareholders as a measure of value creating potential of a deal. This paper uses cumulative abnormal returns calculated over a window of 21 days (from 10 days prior to announcement to 10 days following the announcement) which are obtained from the event study analysis. The detailed technical method of calculating of the cumulative abnormal returns used in this paper is provided in Appendix A.

### 3.3 Explanatory variables

The first explanatory variable of the analysis is the internal innovative capability which will be measured with the firm's R&D intensity. R&D intensity is a concept formed by dividing a firm's research and development expenses by its sales. This paper uses the recent two-year R&D and sales data to calculate a firm's R&D intensity. R&D intensity is commonly used in literatures to measure a firm's focus on its internal innovative capacity development as well as the relative importance of R&D for the company (Hirsch and Bijaoui, 1985; Baysinger and Hoskisson, 1989).

Using this concept, this paper aims to use R&D intensity as a proxy to a firm's adaptive capacity in hypothesis 1a. After the initial usage by Cohen and Levinthal (1990), R&D intensity became a popular proxy to represent adaptive capacity (Stock, Greis and Fischer, 2011). The logic is that research and development can generate a firm's ability to identify, capture, assimilate and utilize knowledge while generating internal innovations. Some even argue that R&D can generate such abilities even without any direct intention of doing so. R&D does not only generate a better knowledge basis of a firm, but it also accompanies enhancements in human and physical resources as well. According to Kim (1998), a firm's active investment in maintaining strong R&D programs lead to attracting and preserving talented professionals who can directly influence the firm's capability to assimilate new knowledge. Furthermore, active R&D investments in maintaining a structured facility allows for the company to better engage in knowledge transfers and alliances with external sources. Such outcomes will lead to broadened and deepened insights of the company that will help the company identify and assimilate knowledge.

In hypothesis 1b and hypothesis 2, R&D intensity will be mainly used to measure the quality of the resources and knowledge a firm possesses. Scholars confirm that R&D is indeed the main input for innovative efforts and the firm's technological level (Bogliacino and Pianta, 2012). Albeit the consensus among scholars that R&D cannot solely be relied as the only proxy for innovative capability, there are evidence that R&D intensity is positively correlated with the probability of reporting innovations (Baumann and Kritikos, 2016). According to Jalles (2010), R&D had a direct influence in a firm's patents and Intellectual Property Rights Index. In his study, these two technological progress proxies showed a positive effect on innovation and growth.

For the case of hypothesis 1a, a positive impact of R&D intensity on the value creation potential of acquisition is expected through the absorptive capacity theory. On the other hand, this paper expects a negative impact of a firm's R&D intensity on the market response of an acquisition as firms with lower levels of research capability can benefit from the inflow of knowledge and research basis. To effectively integrate the two hypotheses that might seem contradictory at a glance, this paper includes a quadratic term for R&D intensity along with the linear term (Beule and Sels, 2016). As such, this paper tries to dissolve the possible non-linear relationship that might exist between a firm's R&D intensity and the value creation potential of acquisitions. Should both hypotheses 1a and 1b be correct, there would be a U-shaped relationship observed in model 1.

The second independent variable of interest is the high-tech classification. In order to accurately filter high-tech firms, this paper followed the benchmark industry classification study from Kile and Phillps (2009). Using the three-digit SIC codes, they found a matching procedure with 95% accuracy in matching high-tech industries. With this method, they reduced sampling errors as well as increased the accuracy rate compared to their existing benchmark. Furthermore, this paper also applied a second

filter that high-tech firms should have a R&D intensity higher than 2%. Inspired by the method used by King, Slotegraaf and Kesner (2008), this threshold enables the model to conservatively and objectively filter high-tech firms with reasonable level of R&D expenditures. The 2% threshold is a rounded up number of the overall industry average R&D intensity figure of 1.5% (Cohen and Klepper ,1992; Ravenscraft and Scherer, 1987). Using this methodology, this paper created a dummy variable 'High-tech' for targets and acquirers in order to filter and control for the constructed models. For model 1, which is used to test hypothesis 1a and 1b, non-high-tech targets were dropped in order to examine the relationship between acquirers' R&D intensity and the market response to the deal in relation to absorptive capacity theory and knowledge accessing theory. For model 2, that is used to test hypothesis 2, high-tech acquirers were dropped to analyze the relationship between targets' R&D intensity and acquiring firms' CAR.

### 3.4 Control variables

Along with aforementioned dependent and explanatory variables, this paper includes a number of control variables. The first variable that is included is how 'good' the deal was. The variable 'Good Deal' was constructed by dividing the total transaction value by the market value of the portion of firm acquired. Since the market value of the acquired portion of target was not reported in the database used in this paper, the variable was formulated by multiplying the market value of the target at the time of acquisition by the acquired percentage of target. Variable 'Good Deal' represents a concept of relative price the acquirer had to pay compared to its actual market price. Consequently, a lower value indicates that the acquirer had a good deal which is expected to bring a better market reaction.

Secondly, the previous performance of the target might influence the value creating potential of the joint firm (Markides and Ittner, 1994). The variable 'EBITROA' was created to add the return on asset of earnings before interest and tax (EBITROA) which was retrieved from ThomsonOne. The variable is calculated by dividing target's EBIT by total assets for the recent 12 months. Better post-acquisition performance is expected for acquisitions including targets with high levels of EBITROA.

The third variable this paper controls for is whether the acquirer and target comes from the same macro industry. A dummy variable 'Same Industry' is added to account for the impacts of within-industry acquisitions. If the acquisition was made within an industry, it is highly likely that there would be significant portions of shared technology as well as culture between the acquirer and the target. Kitching (1973) empirically confirmed that acquisitions within a same industry can have significant effects in the post-acquisition performance.

Fourth, a dummy variable 'Full Acquisition' is made to control for deals that acquire the entire

share of the target. According to Beule and Sels (2016), partial acquisitions enables the existing important shareholders to continuously provide required resources and know-hows to the joint firm. Such resources can become more significant for acquisitions that intends enter a new industry, market, or technology. On the other hand, partial acquisitions might have some drawbacks such as decreased efficiency in promoting a single objective within the joint firms.

Finally, this paper controls for the fiscal years of transaction by including year dummies. This controls for any variation over time that might influence the models. On the other hand, any influence from cultural, linguistic or historical factors are not controlled for as the deals only include firms based in in US.

The hypotheses in this paper are tested through the event study method. Acquisition performance and the shareholder value creation potential are calculated using the CAR according to the event study method. Then, the calculated market responses of deals are regressed on the explanatory variables and the control variables listed above using ordinary least squares method.

## 4. Results

### 4.1 Descriptive results

Table 1 shows the descriptive statics for model 1 which is used to test hypotheses 1a and 1b. The statics indicate that CAR of acquirers on average was 2.5%. This indicates that acquirers of high-tech targets in general faced a decent market response surrounding the announcement date. As the targets only include high-tech firms while acquirers include both high-tech and non-high tech firms, the average R&D intensity of target was higher than that of acquirers. The average R&D intensity of firms showed a relatively high number of over 10%, yet this can be considered acceptable as most of the firms are classified as high-tech firms while also excluding firms with low levels of R&D intensity. Deals on average paid slightly more than the actual market value of what acquirers received. Majority of the acquirers of high-tech targets were also classified as high-tech while majority of the acquisitions were from the same industry and were full acquisitions.

**Table 1**
Descriptive statistics of model 1.

| Variable | Observations | Mean | Std. Dev. | Minimum | Maximum |
|---|---|---|---|---|---|
| CAR | 65 | .0259955 | .1574445 | -.3262211 | .5046891 |
| Acquirer R&D int | 65 | .1000815 | .0807008 | 0 | .3308922 |
| Target R&D int | 65 | .1936746 | .1970949 | 0.0239537 | .7605578 |
| Acquirer High-tech | 65 | .8307692 | .3778736 | 0 | 1 |
| Target High-tech | 65 | 1 | 0 | 1 | 1 |
| Good Deal | 65 | 1.136059 | .2759407 | .5067061 | 1.922674 |
| EBITROA | 41 | .1159512 | .109844 | .006 | .577 |
| Same Industry | 65 | .7692308 | .4246039 | 0 | 1 |
| Full Acquisition | 65 | .7846154 | .4142881 | 0 | 1 |

**Table 2**
Descriptive statistics of model 2.

| Variable | Observations | Mean | Std. Dev. | Minimum | Maximum |
|---|---|---|---|---|---|
| CAR | 115 | .0155046 | .1195099 | -.3173806 | .6346493 |
| Acquirer R&D int | 115 | .022171 | .0442684 | 0 | .3668141 |
| Target R&D int | 115 | .0407209 | .0679361 | 0 | .3778845 |
| Acquirer High-tech | 115 | 0 | 0 | 0 | 0 |
| Target High-tech | 115 | .1652174 | .3730019 | 0 | 1 |
| Good Deal | 59 | 1.018838 | .7366312 | .2385646 | 6.156234 |
| EBITROA | 84 | .1100595 | .095913 | .007 | .69 |
| Same Industry | 115 | .5478261 | .4998856 | 0 | 1 |
| Full Acquisition | 60 | .75 | .4366669 | 0 | 1 |

On the other hand, Table 2 presents the descriptive statics of model 2 that is used for hypothesis 2. For the case of non-high-tech acquirers, CAR around the announcement was on average 1.5% again indicating a decent response from the market. Majority of the targets of non-high-tech acquirers were also classified as non-high-tech, hence showing a low level of R&D intensity for both acquirer and target compared to Table 1. Deals on average paid less than the acquired share of target's actual market value. Slightly more than half of the deals were performed within the same industry while majority were full acquisitions.

### 4.2 Regression results

In order to figure out whether there are any significant effects from adding explanatory and control variables, model 1 was ran with 4 different sub-models. The results are provided in Table 3. Model 1-1 includes only the independent variables of interest. More variables are added in models 1-2, 1-3 and 1-4 to verify the robustness of the independent variables. There are small differences in the models, yet the models in general seems robust regarding the explanatory variables of interest.

Table 3 shows that acquirer's R&D intensity has a negative coefficient in all models whereas the quadratic term for acquirer's R&D intensity has a positive coefficient for all models. This means that deals with lower acquirer research intensity has a better market response than medium intensity firms when acquiring a high-tech firm, while buyers with higher research intensity also faces better stock market responses than medium firms. These results denote that the acquirer's R&D intensity and

cumulative abnormal returns can have a quadratic U-shaped relationship. With such, the results support hypothesis 1a that acquirers with higher level of adaptive capacity realize higher value creating potential when acquiring a high-tech target. Furthermore, the analysis also supports hypothesis 1b that acquirers with lower level of research intensity can realize higher cumulative abnormal returns. Taken together, the results also indicate that the effects based on knowledge accessing theory can have a stronger influence compared to that of adaptive capacity as overall coefficient of acquirer R&D intensity has a significant negative coefficient. The results for acquirer R&D intensity seems mostly robust excluding model 1-1. Regarding the high-tech classification of acquires, the result show that such factor does not have significant impacts on the value creating potential of the deals.

Model 1-2 adds the Good Deal variables to show significant and positive results which seems robust across the sub-models. This indicates that the relative price acquirer pays in buying a high-tech target can be a significant factor in realization of shareholder returns. Since the coefficient has a positive value, it can be said that the market prefers deals that paid high premiums compared to its actual value. Model 1-3 adds EBITROA which does not have a significant result. This indicates that the past performance of the target does not significantly affect the market's view on the post-acquisition performance. Model 1-4 added a dummy variable to control for any effects coming from acquiring a target that was in the same industry classification as the buyer. The results showed that there was not much significant impact from acquiring a target within an industry. Lastly, model 1-4 also included a dummy variable for full acquisition which showed a positive significant coefficient. This indicates that the market prefers a full ownership over the target in creating post-acquisition value.

**Table 3**
Results of the OLS regression for model 1 with 21-day window CAR as dependent variable

| Variable | Model 1-1 | Model 1-2 | Model 1-3 | Model 1-4 |
|---|---|---|---|---|
| Acquire R&D int | -1.411414 | -1.767422* | -2.893153** | -3.095791** |
| | (0.152) | (0.075) | (0.044) | (0.046) |
| Acquirer R&D int$^2$ | 4.488605 | 5.571465* | 8.54651** | 9.021356** |
| | (0.144) | (0.066) | (0.030) | (0.066) |
| Acquirer High-tech | .0461756 | .07315 | .1210798 | .1472763 |
| | (0.523) | (0.312) | (0.195) | (0.153) |
| Good Deal | | .1227014* | .1784015* | .1481955** |
| | | (0.064) | (0.059) | (0.066) |
| EBITROA | | | -.0139989 | .0959119 |
| | | | (0.935) | (0.483) |
| Same Industry | | | | -.1013102 |
| | | | | (0.418) |
| Full Acquisition | | | | .1785955*** |
| | | | | (0.001) |
| Constant | .1499085 | -.0142377 | -.0875462 | -.1410551 |
| $R^2$ | 0.3568 | 0.3898 | 0.5512 | 0.6474 |
| N | 65 | 65 | 41 | 41 |

* $p < 0.10$ significance levels based on two-tailed tests.
** $p < 0.05$ significance levels based on two-tailed tests.
*** $p < 0.01$ significance levels based on two-tailed tests.

In model 2, as shown in Table 4, cumulative abnormal returns were regressed on targets' R&D intensity and control variables for deals including non-high-tech acquirers. Same as model 1, model 2 gradually added control variables. The results show that targets' R&D intensity has a negative and significant coefficient. This indicates that the market responds better to acquisitions of lower research intense firms when non-high-tech acquirers are involved. With this, hypothesis 2 which expected a positive relation between target research intensity and non-high-tech buyer's value creating potential is rejected. This indicates that there can be some other explanation other than that inspiring hypothesis 2.

In model 2-2, variable Good Deal is added and shows a positive significant result which is similar to model 1. However, the result does not seem to be robust in other sub-models with more variables. EBITROA was added in model 2-3 and showed insignificant results. Same as model 1, this denotes that the market does not see the target's past performance as a significant factor in determining a deal's performance. Lastly, variables Same Industry and Full Acquisition are added in Model 2-4. Both show insignificant results indicating that the market does not view the variables as important factors influencing post-merge performance.

**Table 4**
Results of the OLS regression for model 2 with 21-day window CAR as dependent variable

| Variable | Model 2-1 | Model 2-2 | Model 2-3 | Model 2-4 |
|---|---|---|---|---|
| Target R&D int | -.1141057 | -.5946349** | -.6835526** | -.8925356*** |
| | (0.621) | (0.012) | (0.026) | (0.009) |
| Target High-tech | .0156167 | .0709086 | .0816234 | .1062785 |
| | (0.768) | (0.282) | (0.380) | (0.332) |
| Good Deal | | .0257651*** | .0761963 | .0282189 |
| | | (0.001) | (0.379) | (0.761) |
| EBITROA | | | -.0775448 | -.1635179 |
| | | | (0.540) | (0.280) |
| Same Industry | | | | -.0481393 |
| | | | | (0.253) |
| Full Acquisition | | | | .1125667 |
| | | | | (0.122) |
| Constant | -.0787163 | -.0691214 | .1499381 | .2370887 |
| $R^2$ | 0.1307 | 0.4549 | 0.4284 | 0.5387 |
| N | 115 | 59 | 45 | 45 |

* p < 0.10 significance levels based on two-tailed tests.
** p < 0.05 significance levels based on two-tailed tests.
*** p < 0.01 significance levels based on two-tailed tests.

## 5. Discussion and conclusion

This paper was carried out to analyze the relationship between R&D intensity of firms and the shareholder value creating potential of the acquisition with context of high-tech classifications in US M&A market. With the analysis peformed, this study aims to contribute to the academic literature in finding out what and how R&D related variables can be used to analyze and estimate the post-

acquisition performance of acquisitions.

In hypothesis 1a, the theory of adaptive capacity was looked into to analyze how the acquirer's research intensity can relate to value creation in acquiring a high-tech target. Rooted on the resource-based theory and the organizational learning theory, adaptive capacity theory suggests that acquirers with higher levels of research expenditure can generate more value from acquisition. This is because a firm with higher levels of adaptive capacity can better exploit and utilize the inflow of knowledge from the acquired high-tech target. Results from model 1 confirms hypothesis 1a that higher R&D intensity acquirer generate higher shareholder value for acquisitions of high-tech targets. This indicates that existing internal R&D and external flow of knowledge through acquisition can act as complements, further backing up the resource-based theory.

On the other hand, the relationship between the acquirer's R&D intensity and post-acquisition performance was tested with the basis of the knowledge accessing theory. The theory suggests that there are benefits of low research-intense acquirers in merging a high-tech target not by the exploiting the incoming knowledge to the full extent, but by simply gaining access to the research basis and resources of the high-tech target firm. According to Beule and Sels (2016), the intention of such type of acquisitions is in that the buyer is trying to upgrade the lacking innovative capabilities by acquisition rather than by internal development. In such case, the acquired research resources can act as a substitute of internal R&D which also backs up the resource-based theory.

Combining the two results, this paper found that there is a quadratic U-shaped relationship between the acquiring firm's research intensity and the acquisition's value creation potential. In other words, both low and high research-intense firms are expected to create more value to shareholders than medium-leveled firms. Specifically, it was more likely for a low research-intense firm to yield higher value than high research-intense firm. This indicates that a low research intense firm's benefits from gaining access to knowledge basis can be stronger than the benefits earned by a research intense firm from exploiting the new knowledge with the already existing capabilities.

Furthermore, the analysis from model 2 showed a rejection of hypothesis 2; that higher levels of R&D intensity of target will yield higher shareholder value to non-high-tech buyers. This hypothesis was motivated from the open innovation paradigm and was expected that non-high-tech acquirer's search for innovative source would benefit more if targets with higher R&D intensity was acquired. However, the results from model 2 showed a significant negative correlation between target's R&D intensity and the market's reaction to the acquisition. Such result can be interpreted in three aspects. The model might be improperly constructed from the side of the acquirer or the target or it might just be that the market values acquisitions of less research intense targets.

First, from the acquirer's side, regardless of the impact from the inflow of quality knowledge, there

can be other factors having stronger impact in creating shareholder value. Since the acquirers in model 2 are all non-high-tech firms with relatively low levels of R&D intensity, there might not be much variation in impact from accessing quality information. Rather, other variables such as absorptive capacity might have more significant impacts. According to Gabison and Pesole (2014), in the method of open innovation, internal expertise is vital in order for acquirers to be able to assess the value of solutions offered to them and innovate with it. That is, the quantity of R&D is not important but the quality of R&D that can be well assessed and used is more important. Such factors that are based in characteristics of the acquirer were not fully captured in model 2.

On the other hand, the model might have chances of improvement from the target side. For example, the variable R&D intensity might not be an accurate proxy for the quality of technology that will be flowing in as a result of acquisition. That is, as not all firms and industries innovate in a formally recognized way, using R&D intensity as a proxy for innovative capability might be flawed. In such cases, additional or more adequate variables can be added to the model in order to capture the concept of quality technology. Lastly, the model might not be improper. It might just be the market not valuing target's R&D intensity for non-high-tech acquirers as their main business and profitability is less dependent on research expenses compared to high-tech firms.

In conclusion, this paper attempts to contribute to the research on the determinants of successful acquisitions involving high-tech and non-high-tech acquisitions in the context of research and development. The study revealed a U-shaped relationship between the absorptive capacity of US acquirers and its CAR after acquiring a high-tech target. This result suggests that acquirers with high absorptive capacity has higher chances of generating value through the acquisition. On the other hand, firms with lower levels of absorptive capacity and low research expenditures can also benefit from acquisitions of high-tech firms by gaining access to the research infrastructure itself. Furthermore, the study also found a negative significant relationship between a US target's research intensity and the stock reactions of US a non-high-tech acquirer.

### 5.1 Managerial implications

With the global trend of acquiring knowledge from external sources, the results of this paper provides meaningful managerial implications. The first implication to managers that aims to acquire a high-tech target is that the of absorptive capacity or the R&D intensity can be a significance driver of stock market response. The findings in this paper suggest that acquirers who have a low or high levels of research intensity have a higher chance of realizing value from acquiring high-tech firms compared to buyers with middle-level research intensity. Such finding can be a meaningful message to mangers planning to acquire a high-tech target with the main purpose of acquiring new knowledge from the

target. Firms with high research intensity can strategically plan the acquisition to maximize gains from the high absorptive capacity while firms at the lower end can plan the acquisition in the direction of accessing the basic resources for further research. Meanwhile, the acquirers located at the middle of the spectrum should clearly plan their purpose and method in acquiring a high-tech firm as they will likely realize less value creation potential compared to the acquirers at each end of the spectrum.

Furthermore, the finding from model 2 also provides meaningful implications to non-high-tech acquirers. Albeit the constructed hypothesis was rejected, significant negative coefficient of target firm's R&D intensity was found. Managers from non-high-tech firms that are looking for a target with the purpose of knowledge should not simply value firms with higher level of research intensity. Rather, acquirers should be thorough in the due diligence procedure in determining whether the target's technology can derive an acquirer-specific value. The biggest caution the manager should take into account is differentiating a general high level of knowledge with a specific knowledge that can directly act as complement, supplement or substitute the already existing knowledge of the acquiring firm.

### 5.2 Limitations and future research

As with all studies, this paper also has some limitations. One shortcoming of this paper is that it focuses on a quite vague concept of knowledge and technology. Knowledge is a factor that is extremely subjective to what environment a firm is situated while a concept that can be influenced by so many factors. Even though R&D intensity is commonly used in literatures as a proxy of knowledge, there has always been debates in which the validity of the representativeness was questioned. Furthermore, the procedure with which knowledge is actually interpreted and utilized in creating value after acquisition is not clear in this paper. It would be an assignment for future research to take into account this procedure and model it as different methods in utilizing knowledge can significantly impact the results of the acquisition and the values created from it. By completing such studies, a deepened analysis will be possible which not only identifies significant variables that impact the value creation of acquisitions but also the method with which a firm can maximize the performance after a merger.

Furthermore, there also can be more improvements regarding hypothesis 2. This paper found a significant negative effect of a target's R&D intensity on the market response of a non-high-tech acquirer with which hypothesis 2 was rejected. As mentioned above in the discussion section, three ways of structured approaches can be taken in order to disentangle the reason why such negative coefficient was found. With such, it would be possible to improve the insights towards the current trend of open innovation especially the actively expanding sector of non-high-tech acquirers seeking for external sources of innovation.

Another scope in which there can be further research is the generalization of the findings. As this paper only included within US deals, future studies conducted in a global scale or any other environment can help generalize the finding of this paper. In addition, the deals used for the analysis only included acquisitions that are publically listed in the ThomsonOne US database. Therefore, deals involving non-listed firms or privately conducted deals were not included in the sample.

Finally, there can be rooms of improvements regarding practical issues. As deals that satisfy the both the conditions and the filters of the models were not abundant, the sample size of model 1 and model 2 were limited. More reliable analysis can be conducted if more samples could be collected. Moreover, more flexible and diverse approaches in constructing a model could be taken. For example, a model that could not be tested in this paper due to the lack of samples were deals that involve both high-tech targets and non-high tech acquirers. With more samples, such research would have been possible as model 3. Another practical limitation is that the event study method using cumulative abnormal returns assumes a semi-strong-form efficient market. As this method focuses on short time adaptation of the market to events, many studies prefer a shorter window period. However, with the same logic from Beule and Sels (2016), this paper used the 21-day window to take a cautious approach as shorter time periods tend to show overreactions of the market responses.

## Appendix A. Calculation of cumulative abnormal returns

This paper applied the event study method using the cumulative abnormal returns to measure the market's response towards an acquisition (Fama, Fisher, Jensen and Roll, 1969; MacKinlay, 1997). Cumulative abnormal returns are calculated by largely four steps in this paper. First, the actual realized return ($R_{it}$) of firm i at time t is derived by dividing the firm i's share value of time t by that in time t-1, then subtracting 1. Then, the function below is constructed to model the security returns in the market.

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$$

As the second step, predicted return is estimated based on the market model constructed above. A predicted return ($\hat{R}_{it}$) of firm i at time t is the return the firm would be expected to yield if an event of acquisition would not have taken place. Parameters $\hat{\alpha}_i$ and $\hat{\beta}_i$ are estimated by regressing the excess stock returns on the excess market returns of the estimation period. The market model provided above is used as a benchmark in deriving the predicted returns. According to Beule and Sels (2016), this method is the most predominant measure and takes into consideration the riskiness of the firm compared to that of the market. The calculation in this paper is performed with clean estimation period of 120 days prior to the announcement to 11 days before the event. In total, the clean estimation period includes 110 days. The prediction is done by regressing the firm's return series against the Standard & Poor's (S&P) 500 market index. This procedure yields the parameters $\hat{\alpha}_i$ and $\hat{\beta}_i$ as below.

$$\hat{R}_{it} = \hat{\alpha}_i + \hat{\beta}_i R_{mt}$$

$\hat{\alpha}_i$ represents the mean return over the period that is not explained by the market ($R_{mt}$), while $\hat{\beta}_i$ represents the sensitivity of the firm i to the market. $\hat{\beta}_i$ can also be interpreted as the firm-specific risk that is bore by firm i. $R_{mt}$ is the return on the market index in time t.

The third step is calculating the abnormal return ($\mathrm{A}R_{it}$) by subtracting the predicted return from the actual realized return.

$$\mathrm{A}R_{it} = R_{it} - \hat{R}_{it} = R_{it} - (\hat{\alpha}_i + \hat{\beta}_i R_{mt})$$

This yields the abnormal return which is the disturbance term of the market model due to an event and is calculated with an out of sample basis with the clean period mentioned above (MacKinlay, 1997).

Finally, the cumulative abnormal returns ($\mathrm{CA}R_i$) for each firm i is calculated by summing up the abnormal returns for dates within the window period. This paper used a 21-day window of plus and minus 10 days from the event which is shown as below.

$$\mathrm{CAR}_i = \sum_{t=-10}^{10} ARi_t$$

If the outcome of $\mathrm{CAR}_i$ is positive, the market views that on average there will be value created from the acquisition where as a negative value indicates that the market does not see that a value will be created due to the acquisition.

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