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Abstract

M&A is a popular strategy for pharmaceutical industry due to high R&D risk and costs. Prior research related to post-M&A performance mainly focused on the financial and technology resource perspectives. This study aims to provide a new perspective of innovation strategy which is inspired by the research of March (1991), who noted the difference between exploration and exploitation. Moreover, we build the bridge between M&A and innovation strategy by applying the resource-based view theory. We argue that the acquirer's exploration strategy will negatively influence the post-M&A innovation performance and the innovation strategy similarity between the acquirer and the target is beneficial for future innovation. Furthermore, we hypothesize that there is a negatively moderating effect caused by the acquirer's exploration strategy on the effect of innovation strategy similarity. On the basis of 89 M&A deals in the pharmaceutical industry, our empirical results suggest two important findings. First, post-M&A innovation performance is influenced by acquirer's innovation strategy, more specifically, acquirer's exploration is harmful for post-M&A innovation. Second, the similarity effect is moderated by acquirer's innovation strategy. Precisely, acquirer's exploration will diminish the positive effect of similarity.

Keywords: Mergers and acquisitions, Pharmaceutical industry, Innovation performance, Innovation strategy, Exploration and exploitation, Resource-based view.

1 INTRODUCTION

Innovation is a major source of competitive advantages (Chen et al., 2009). Innovation may happen in any part of business operations, such as manufacturing process, product design, customer service, and business process. Through innovation, firms are able to renew their assets (Schumpeter, 2013), thus leading to new abilities or improved performance. Facing a changing and intensively competitive business environment, firms need innovation to maintain or strengthen their survival competence.

There are several strategies that help firms develop innovation, including internal R&D (Hall and Bagchi-Sen, 2002), alliance (Sampson, 2007), and merger and acquisition (M&A) (Bertrand and Zuniga, 2006; Cassiman et al., 2005). While both alliance and M&A allow firms to access external knowledge (Hagedoorn and Duysters, 2002), M&A provides stronger control right to external resources (Yin and Shanley, 2008), thus leading to greater innovative potential. By performing M&As, companies are able to obtain desired resources, for example, market channel, market share, economies of scale, technology, or knowledge (Datta and Roumani, 2015; Hagedoorn and Duysters, 2002; King et al., 2008). The Wall Street Journal reported that 2015 was the biggest M&A year ever, according to data from a financial service firm Dealogic (Farrell, 2015). Global M&A value reached a peak of $4.304 trillion and refreshed the 2007 record of $4.296 trillion. The new record for M&A value indicates that M&A is prevalent and is considered an effective business strategy.

M&A has received widespread attention from both business managers and academic researchers. Prior studies examined post-M&A performance mainly from the financial perspective (Halpern, 1973). Recently, a stream of research highlights technological M&As and their resultant innovation performance due to the increasing need for innovation. M&A is effective for technological innovation. Developing new knowledge or technology incurs high risk and tremendous costs. For example, it costs on average $2.6 billion for pharmaceutical companies to develop a new prescription drug that receives market approval, reported by Tufts CSDD 2014 Cost Study (CSDD, 2014). Under such circumstance, M&A has several merits, including spreading R&D risk, diversifying knowledge input, eliminating potential competitors, creating economy of scale of R&D projects, applying existing knowledge to new market, and accessing to exclusive technology from target firms (Cassiman and Veugelers, 2002; Lerner et al., 2003). In generally, M&A allows firms to reorganize and refine their R&D resources and projects (Bertrand and Zuniga, 2006).

Focusing on technological M&As, prior studies have found some significant factors affecting post-M&A innovation performance, such as knowledge base (Ahuja and Katila, 2001; Cloodt et al., 2006), knowledge similarity (Jaffe, 1986; Makri et al., 2010), and knowledge complementarity (Makri et al., 2010). While the effects of knowledge on post-M&A innovation performance have been widely examined, we noticed that innovation strategy is not considered yet in the literature. Innovation strategy concerns about how firms align their resources to develop knowledge or technologies. Here we adopt prior studies and define innovation strategy from the view of organizational learning (March, 1991). To learn and use knowledge, two opposite strategies, exploration and exploitation, are defined by March (1991). Exploration involves distant search, accessing novel knowledge, and thus taking higher risk. In contrast, exploitation involves local search and existing knowledge reuse. Prior studies argued that deciding the orientation of innovation strategy could be critical for firm performance (He and Wong, 2004; Quintana-García and Benavides-Velasco, 2008). These research emphasized that the two innovation strategies require different structures, processes and even cultures. In the context of M&A, two organizations must pay efforts on integration and resolving conflicts. Besides affecting how the organization designs their process, innovation strategy also influences the process of integration. However, little is known about the role of innovation strategy in technological-driven M&A, especially the effect on post-M&A innovation performance.

In this paper, we explore the impact of the acquirer's innovation strategy and the effect of innovation strategy similarity between the acquirer and target on post-M&A innovation performance. Furthermore, we consider the moderating effect of the acquirer's innovation strategy on the similarity of innovation

strategy. We aim to provide a new perspective to the literature and build the linkage between M&A research and innovation strategy literature through the resource-based view (RBV) theory.

Our study makes several contributions to the M&A literature. First, we show evidence for the effect of innovation strategy on post-M&A innovation performance. Second, we further examine the effect of the innovation strategy similarity and the interaction effect of the acquirer's innovation strategy and the innovation strategy similarity. Third, this study builds a linkage between M&A literature and innovation strategy research by RBV. Fourth, we obtain several practical and academic suggestions that can inspire more managerial methods and research in the future.

2 THEORY AND HYPOTHESES

Our study focuses on how innovation strategy influences post-M&A innovation performance. Prior studies had investigated post-M&A performance from different perspectives. Most traditional research focused on the financial perspective (King et al., 2008). Despite the financial perspective, some studies have transferred their research attention to technological performance and factors (Ahuja and Katila, 2001; Datta and Roumani, 2015; Makri et al., 2010), due to the increasing importance of technological M&As. Rapid changes in technologies force firms to maintain their innovation ability to meet new challenges and requirements. Innovation is especially critical for high-tech industries, and M&A seems to be a popular strategy for companies to maintain their innovation through gaining external resources (Hagedoorn and Duysters, 2002). The main research question from the technological perspective is similar to that from the financial perspective: what factors influence post-M&A innovation performance? Prior studies which applied the technological perspective provide several inspiring technological factors such as knowledge base (Ahuja and Katila, 2001; Cloodt et al., 2006; King, 2008; Datta and Roumani, 2015), technology similarity or relatedness (Jaffe, 1986; Cassiman et al., 2008; Makri et al., 2010) and R&D abilities (King et al., 2008). These studies provide evidences for the importance of knowledge resources on post-M&A innovation performance. For example, Ahuja and Katila (2001) showed the size of the acquired knowledge base has a positive effect on post-M&A innovation performance. All these studies aim to reveal the important technological resources which affect post-M&A innovation performance; however, limited studies paid their attention to innovation strategy in the M&A literature (Van Deusen and Mueller, 1999).

According to March's (1991) research in organizational learning, R&D innovation is a process of searching and recombining knowledge. Two opposite innovation strategies have been commonly studied: exploration and exploitation (Atuahene-Gima, 2005; Benner and Tushman, 2003; Quintana-García and Benavides-Velasco, 2008). Exploration involves novel knowledge, distant search, uncertainty, and return variation. It usually generates stronger and longer competitive advantage than exploitation due to its novelty and rarity. Nevertheless, exploration bears higher risk and variance (March, 1991). In contrast, exploitation seems to be more stable and predictable because it is relevant to routines and existing knowledge reuse. However, it might be harmful for firms in the long-term due to the lack of novel knowledge and novel chances. As March (1991) mentioned, exploration and exploitation compete for resources, thus leading to a resource allocation issue. Firms need to balance their innovation strategy between exploration and exploitation. What is the best strategy for a firm to reach a balance between exploration and exploitation has invoked another stream of research (Andriopoulos and Lewis, 2009; He and Wong, 2004; Jansen et al., 2005). We bring this notion into M&A literature by asking how different innovation strategies influence post-M&A innovation performance. In order to build the bridge between innovation strategy and M&A, we adopted the theory of resource-based view (RBV) in this research, following Greve's (2007) research on innovation strategy.

The RBV theory (Barney, 1991; Wernerfelt, 1984) concerns resources as essentials of any activity in a company. According to RBV, firm innovation is supported by knowledge resource. In other words, a different level of knowledge resource leads to a different level of innovation performance (Bierly and Chakrabarti, 1996). Moreover, some researchers argued that slack resources are influential to a firm's innovation performance (Nohria and Gulati, 1996; Schoonhoven et al., 1990). A possible explanation is

that slack resources allow firms to perform slack search or conduct projects that are not derived from market expectations but hold scientific potential (Levinthal and March, 1981; March and Olsen, 1976). While most of the research argued that there is a positive relationship between the amount of slack resources and innovation performance (Majumdar and Venkataraman, 1993; Zajac et al., 1991), Greve (2007) extended March's (1991) study and further examined the relationship between slack resources and innovation strategy. The arrangement for resources on exploration and exploitation not only affects resource allocation, but also influences the administration, structure, and culture. For example, an exploratory firm may spend more resources to organize knowledge from different fields, more time to collect novel knowledge or hire more inventors from different backgrounds. When M&A occurs, these arrangements between firms may cause synergy or impediment. It is worth noting that we mainly discuss the effect of innovation strategy in view of exploration since exploration and exploitation are opposite concepts and discussing them separately is trivial.

2.1 Acquirer's innovation (exploratory) strategy

We argue that the acquirer's exploratory strategy will negatively influence post-M&A innovation. Unlike an alliance or joint venture, M&A is an unbalanced deal between acquirer and target. The acquirers usually have greater power than targets thus being dominant in M&A. Therefore, the acquirer has stronger influence on the post-M&A performance than the target in most cases. According to March (1991), exploration is closely associated with slack resources. Sufficient slack resources allow firms to perform experiments and more lax performance monitoring, both of which are critical to exploratory innovation (Lounamaa and March, 1987). Greve (2007) also pointed out that even though both exploration and exploitation are promoted by slack resources, exploration is more sensitive to slack resources because exploration needs to bear a long-term horizon study, distant search, and extra experiment cost.

M&A can be a difficult challenge for firms (Haspeslagh and Jemison, 1991). Before the acquirer can create competitive advantages through M&A, it needs to integrate the target's resources, such as human resources (Buono et al., 1989) and incompatible culture (Nahavandi and Malekzadeh, 1988). Therefore, all processes in M&A consume the slack resources from both firms. Since there is a positive relationship between firm resources and firm performance (Zajac et al., 1991), conducting M&A activities may harm the post-M&A innovation performance due to the consumption of resources. Moreover, exploration demands more resources than exploitation. Therefore, a firm with a higher level of exploration strategy should have fewer slack resources than a firm with a lower level of exploration strategy. We thus hypothesize:

H1: The acquirer's innovation (exploratory) strategy will influence post-M&A innovation performance. That is, the more exploratory strategy the acquirer has, the worse the post-M&A innovation performance is.

2.2 Similarity of innovation strategy between acquirer and target

Prior studies have demonstrated the effect of similarity between acquirer and target on post-M&A innovation performance. For example, Ahuja and Katila (2001) studied the relative size of the knowledge base between acquirer and target, and the relatedness of the knowledge base between acquirer and target. Jaffe (1986) and Makri et al. (2010) examined the technology scope similarity between acquirer and target. Following these research studies, we take a dyadic perspective and examine the effect of innovation strategy similarity between acquirer and target.

As mentioned in the previous section, innovation strategy is relevant to knowledge search and resource allocation. Different innovation strategies between two firms may cause conflict and require additional coordinating resources. Gomes et al. (2013) summarized important factors in the pre-merger phase (e.g., choice and evaluation of the strategic partner) and in the post-merger phase (e.g., integration strategies), and suggested that the existing literature for partner selection can be classified into two perspectives: "strategic fit" (Lubatkin, 1987) and "organizational fit" (Angwin, 2000; Haspeslagh and Jemison, 1991;

Weber et al., 1996). Moreover, the research concludes that fitness in strategy and fitness in organization are helpful for firms' integration or cooperation. For example, if the acquirer is more exploratory while the target orientates toward exploitation, their dissimilar strategies may create conflict among inventors and administrators of the two firms and thus incur higher costs for integration (Lubatkin, 1983) because of different organizational structures and cultures. Organizational culture has been widely studied (Cooper and Cartwright, 1992; Weber and Pliskin, 1996; Weber et al., 2012), concluding that distant culture may cause conflict, which leads to a negative effect on firm performance. The R&D culture in each firm is shaped by its innovation strategy. Therefore, we argue that a higher similarity of innovation strategy between acquirer and target is beneficial for later integration, thus leading to greater post-M&A innovation performance. Note that if the similarity of innovation strategy between acquirer and target is relatively high, it means their level of exploration (or exploitation) is similar.

H2: The similarity of innovation strategy between acquirer and target will positively influence the post-M&A innovation performance. That is, the more similar the innovation strategy between acquirer and target is, the higher the post-M&A innovation performance is.

2.3 Moderating effect of acquirer's innovation strategy on the relationship between similarity of innovation strategy and post-M&A performance

After considering the innovation strategy of the acquirer and the similarity of innovation strategy between acquirer and target, we now take a further step and look at the interaction between these two effects. While both exploration and exploitation are susceptible to risk and resource variation, exploratory innovation is more resource-consuming and riskier, therefore, it is more sensitive to the lack of resources or variation. Moreover, M&A consumes many kinds of resources, including administrative resources and capital resources to coordinate and integrate the M&A process.

As we mentioned before, the acquirer has more power in most M&A deals, that is, the acquirer needs to bear more risk and responsibility because the acquirer must coordinate and integrate the innovation resources acquired from the target and its own resources. It means that the acquirer suffers from spending slack resources including capital and administrative resources on M&A. Under such circumstances, a higher-risk innovation strategy seems to be more harmful for post-M&A innovation. Thus, we argue that when the acquirer is more exploratory, the positive effect of the similarity of innovation strategy between itself and the target on post-M&A innovation performance will diminish because the acquirer has less slack resources to coordinate and integrate the innovation resources from the target firm. Thus, we propose:

H3: The acquirer's innovation (exploratory) strategy will negatively moderate the effect of the innovation strategy similarity on post-M&A innovation performance.

3 METHODOLOGY

3.1 Sample and data

Our research focuses on technological M&As, that is, an acquirer conducts a merger or acquisition to collect external knowledge or existing technology. To construct a general definition of technological M&A, we adopt the definition made by Ahuja and Katila (2001) as: "acquired firms obtaining even a single patent in the 5 years prior to the acquisition are classified as technological acquisitions." This definition is suitable for our study, because we use patent data to measure a firm's innovation strategy (i.e., the extent of exploration) and its innovation performance.

3.1.1 Merger and acquisition data

We followed prior studies and collected from the Securities Data Corporation's (SDC) Platinum database M&A deals, which were announced between 1990 and 2009. The SDC database is owned by

Thomson Reuters and collects announced mergers and acquisitions, joint ventures, and alliance data worldwide valued at one million dollars or more (Frey and Hussinger, 2006).

To ensure that the M&A deals included in our study involve technology innovation, we followed previous studies and chose M&A deals from a high-technology industry, i.e., the pharmaceutical industry (SICs: 2833, 2834, 2835, 2836) (Paruchuri et al., 2006; Zaheer et al., 2010; Zhang et al., 2007). We chose the pharmaceutical industry for several reasons. First, technological or scientific innovation is a vital ability for firms in the pharmaceutical industry (Morton, 2002), and firms in this industry have a propensity to patent their innovation (Levin et al., 1987). Second, M&A is popular in the pharmaceutical industry (Graves and Langowitz, 1993). Third, most M&As in the pharmaceutical industry are conducted for technological assets rather than other business resources (Thompson, 2001).

We filtered the data by two constraints. First, because we focus on how external factors influence post-M&A innovation performance, self-acquisition should be excluded. We removed all deals where the acquirer and target belong to the same company. Second, to make sure that the acquirer has sufficient power to access the target's knowledge resources, we limited the percentage share acquired after the transaction to greater than 50 percent.

Since the technology resources are at firm-level, we cannot decompose them into the subsidiary-level, therefore we excluded all M&A deals that involved a subsidiary, department, or branch. The advantage of such an approach is that the effect of M&A will not be disturbed by the innovation of other units and the measurements of technology resources can be completed. To exclude M&As involving subsidiaries, departments and branches, we manually inspected each M&A case collected from the SDC database. As the SDC database provides a brief description of each M&A case, our coders had enough information to distinguish the unit level of acquirer and target. The coders were separated into two groups for a process of cross-validation. All unmatched results were manually checked by a third coder.

3.1.2 Financial data

Following previous research, we need to control alternative effects by adopting financial variables. We collected financial data of the acquirer from COMPUSTAT database. This database collects financial data of publicly traded firms in many countries, including the U.S.

To ensure these variables are controlled in our model, we excluded M&A cases where the financial data of the acquirers are missing. In terms of target firms, we were not concerned with their financial variables since we only focused on technological-driven M&As, meaning that the acquirer buys or merges a target for its technological assets. This assumption also helps us extend the sample size by including M&As which involve private target companies.

3.1.3 Patent data

To measure the technological variables, we followed prior studies and adopted patent as a proxy for assessing company innovation characteristics (Ahuja and Katila, 2001; Jaffe, 1986). Since the U.S. is the largest and primary market, many companies applied their inventions for patents in the U.S. Therefore, we chose USPTO (United States Patent & Trademark Office) as the patent data source. For each company, we searched for its granted patents from 1985 to 2012 based on their application date, and excluded deals where the acquirer or target has no patent applications in the five years before the M&A.

We faced the challenge of matching assignees' names when searching patents. A company may use different names when applying patents. For example, Bayerische Motoren Werke AG has patents with the abbreviated name "BMW," and the Taiwan Semiconductor Manufacturing Company has a mistyped assignee name "Taiwan Seimconductor Manufacture Company." Furthermore, the name of a firm taken from the SDC database and COMPUSTAT may not be the name used in the firm's patents. To solve the name matching issue, we first used the truncated name extracted from COMPUSTAT for the acquirer and from the SDC database for the target.

The truncated name is formed using the following algorithm: For each company name, we segmented the name by spaces. For example, Apple Computer Company was segmented into "Apple," "Computer," and "Company," then we dropped the last word generic to most of companies (i.e., we deleted the "Company" from the name). Subsequently, we used "Apple Computer" to perform a fuzzy search in the patent database. However, many irrelevant names may be retrieved by the search engine, for example, "Apple Computer Communication Cooperation." Therefore, for each focal company, two coders inspected possible names retrieved by the fuzzy search to find the names that really refer to the focal company, i.e., Apple Computer Company in this case.

We were able to find all granted patents of each company following the name matching process. Finally, we aggregated the alliance data from SDC, financial data from COMPUSTAT and patent data from USPTO to form our research sample. We collected 89 M&A cases as our final sample.

3.2 Model

Following a previous study (Zhang et al., 2007), a negative binomial regression was employed in this research for two reasons. First, our dependent variable is a count, non-negative variable. Second, the mean and variance are far beyond similar in our data set, which means the Poisson regression is not suitable for our study. For robustness check, we also applied the Poisson regression model and found no difference.

3.3 Variable definition and operationalization

3.3.1 Dependent variable

Post-M&A innovation performance. We assessed the innovation performance of acquirer by counting the forward citations received by the acquirer's granted patents applied after M&A (Valentini, 2012). It is widely agreed that the number of forward citations implies the quality or impact of a patent. In this study, we only consider acquirer's patents since acquiring external knowledge by acquirers is the main reason of technological M&As. That is, to measure the post-M&A innovation performance, we take into consideration only acquirer's patents after M&A. While an older patent may receive more forward citations because it has existed for a longer time, the impact of the patent is also decreasing because new technologies may replace older ones. Therefore, we followed Ahuja and Katila (2001) and collected all forward citations for every successful (i.e., granted) patent application filed within four years after M&A.

3.3.2 Independent variables

Acquirer's innovation (exploratory) strategy. Exploration is an innovation strategy that a firm creates novel or radical knowledge beyond its existing knowledge base (Benner and Tushman, 2002; Rosenkopf and Nerkar, 2001). We followed prior research (Benner and Tushman, 2002; Katila and Ahuja, 2002; Phelps, 2010; Rosenkopf and Nerkar, 2001) and used patent citations to measure the level of an acquirer's exploration. Patents cite prior relevant patents or scientific articles to prove their technological novelty and advance. These cited patents or articles are recognized as the source of knowledge base (Ahuja and Katila, 2001; Cloodt et al., 2006). Since innovation is a process of searching prior existing knowledge and combining or transforming them into a new knowledge, we used backward citations to measure the level of exploring knowledge from novel sources.

Specifically, if an acquirer is involved in an M&A in year *t*, then we collected all the patents applied by the acquirer within 5 years before the focal M&A and eventually granted.[1] That is, patents applied from year *t*-4 to year t were collected. Then we traced these patents' backward citations as their knowledge source. Our notion following Phelps (2010) is that exploration tends to perform distant search thus leading to novel knowledge source. For each backward citation, if it was cited by the acquirer's other

[1] We also changed the time window of independent variables to 4 and 6 years, and the results are mostly consistent with the main model.

patents in the past seven years or it belongs to the acquirer, we labeled it as an "old citation." However, an "old citation" may turn to a "new citation" if the acquirer does not access this knowledge for some period of time and becomes unfamiliar with it. Phelps (2010) chose a 7-year window because the median age of backward citations in the telecom technologies industry is 6.5 year (Hicks et al., 2001). We applied the same time window to determine the novelty of a backward citation. For example, if a backward citation was cited in year *t*, we traced back to year *t*-6. If any other patent of the acquirer within this specific time window cited the same citation, then this citation was marked as an "old citation." On the other hand, the condition of new citation will last for three years, that is, a new citation cited in year *t* can be cited again in year *t*, *t*+1, and *t*+2 and will still be labelled as a "new citation." After labeling all backward citations, the exploration is measured by dividing the number of new citations by the number of total citations:

$$Exploratory_{it} = [\sum_{t-4}^{t} \left(\frac{new\ citations_{it}}{total\ citations_{it}}\right)]/5$$

This measure is bounded between 0 and 1. A higher value implies more exploratory and less exploitative.

Innovation strategy similarity between acquirer and target. To compute this variable, we first used the method mentioned in the last section and computed the exploratory strategy for acquirer and target separately. Since the exploratory strategy is bounded between 0 and 1, we measured the similarity between two firms by the following formula:

$$Similarity_{at} = 1 - \frac{|E_a - E_t|}{E_a + E_t + \delta}$$

where E_a is the level of exploration of the acquirer, and E_t is the level of exploration of the target. We added a very small number δ (in this study, we set δ as 0.00001) to prevent the hazard of a zero denominator. The similarity is bounded between 0 and 1, and a higher similarity implies that the acquirer has a similar innovation strategy to that of the target.

3.3.3 Control variables

To control for possible confounding effects, we included several control variables. First, in terms of financial influence, we included *acquirer's firm size* (Ahuja and Katila, 2001), which is measured by the number of employees, *acquirer's current ratio* (Singh, 1986), *acquirer's R&D intensity* (Griliches, 1990), *year dummies* and *SIC dummies*.

Second, in terms of technological influence, commonly examined by prior studies, we added three technological variables as our control variables. *Pre-sample size* was added to control the original innovation ability of the acquirer (Silverman, 1999). While prior research has argued that the technology similarity between acquirer and target might influence the post-M&A innovation performance, *technology similarity* was added as another control variable. To measure technology similarity, we tabulated the technology fields of the acquirer and target by the 4-digit IPC class of their patents that were filed in the preceding 5-years. Then we computed the cosine similarity of the vectors representing their technology fields (Ahuja and Katila, 2001).

Some research has also examined the technology diversity of a firm (Cohen and Levinthal, 1990) and argued that the firm's technology diversity may have a relationship with its absorptive ability, which has an effect on innovation performance. Therefore, we added *technology diversity of acquirer* and *technology diversity of target* to control for the influence from the two firms' absorptive ability. We constructed the technology diversity of a firm according to the Herfindahl index using the following formula:

$$Technology\ Diversity_{it} = 1 - \sum_{j}^{J} (\sum_{t-4}^{t} \frac{N_{ijt}}{N_{it}})^2$$

where N_{it} is the total number of successful patent applications filed by firm *i* in year *t*. N_{ijt} is the number of successful patent applications in IPC class *j* by firm *i* in year *t*. In addition, *J* is the number of all classes obtained by firm *i*. A higher value indicates that the firm has a more diverse technology stock.

Third, Ahuja and Katila (2001) performed a longitudinal study on technological M&As and found that the attributes of the knowledge base are important factors. Thus, we included their measurements as control variables. The *absolute size of knowledge base of the target* is constructed by the following procedure. First, we collected the successful patent applications of the target that were filed in the preceding 5 years. Then we combined these patents and their backward citations into a set (denoted as the knowledge base of the target firm), whose size represents the absolute size of the knowledge base of the firm. The *relative size of knowledge base* is the ratio of knowledge base size between acquirer and target. Specifically, if the size of the acquirer's knowledge base is greater than that of the target's knowledge base, the relative size of knowledge base is computed by dividing the size of the target's knowledge base by the size of the acquirer's knowledge base. However, when the size of the acquirer's knowledge base is smaller than that of the target's knowledge base, the relative size of knowledge base is computed by dividing the size of the acquirer's knowledge base by the size of the target's knowledge base. Finally, the *relatedness of knowledge base between acquirer and target* is constructed by computing the cosine similarity of the knowledge base grouped by 4-digit IPC class of the acquirer and target.

4 RESULT

Table 1 presents the descriptive statistics and correlations of the variables adopted in this research. The average number of received forward citations in 4 years after M&A is 742.92 and the standard deviation is 1731.01, indicating that in the pharmaceutical industry several firms are much more dominant in innovation performance due to the high deviation compared to the mean. On average, the technological diversity of the acquirer is 0.69, higher than the average of the target (i.e., 0.41). While acquirers usually possess more resources, it is reasonable that acquirers have a higher average technological diversity, i.e., a better absorptive ability, than targets have. The average cosine similarity of the technology portfolio between acquirer and target is 0.49 and deviation is 0.34. This number indicates that in most M&A, acquirers seek targets with relevant technology or knowledge to the acquirers themselves.

Hypothesis 1 proposed that the acquirer's innovation (exploratory) strategy will negatively influence the post-M&A innovation performance. As shown in Model 2 of Table 2, "Acquirer Exploration" is negative and significant ($\beta = -2.5118$, $p < 0.01$), thus providing support to Hypothesis 1. Hypothesis 2 posited that the similarity of innovation strategy between acquirer and target will positively influence the post-M&A innovation performance. As shown in Model 3 of Table 2, the variable "Similarity of Exploration between Acquirer and Target" is positive but not significant ($\beta = 0.2975$), thereby providing no support to Hypothesis 2.

Hypothesis 3 examined the interaction effect between the acquirer's exploratory strategy and the innovation strategy similarity between acquirer and target. Our result provides support to Hypothesis 3, where the interaction "Acquirer exploration × Similarity of exploration between acquirer and target" is negative and significant ($\beta = -9.0269$, $p < 0.05$). In summary, the level of acquirer's exploration seems to be harmful for post-M&A innovation performance. There is no support for the positive effect of innovation strategy similarity on post-M&A innovation performance. However, we found the interaction effect between acquirer's exploratory strategy and the innovation strategy similarity. Acquirer's exploratory strategy negatively moderates the effect of innovation strategy similarity on post-M&A innovation performance.

Table 1. Means, standard deviations and bivariate correlations for all variables

Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12
1. Acquirer's post-M&A innovation performance	742.92	1731.01												
2. R&D intensity	1.51	4.04	-0.14											
3. Current ratio	4.27	4.41	-0.23	0.27										
4. Firm size	22.51	35.02	0.36	-0.22	-0.39									
5. Pre-sample size	2070.49	3558.09	0.67	-0.18	-0.27	0.52								
6. Technology similarity	0.49	0.34	-0.10	0.10	0.16	-0.05	0.00							
7. Acquirer technology diversity	0.69	0.20	0.29	-0.40	-0.26	0.43	0.36	-0.07						
8. Target technology diversity	0.41	0.29	-0.03	0.11	-0.09	0.13	0.02	0.17	0.10					
9. Relative size of target knowledge base	150.94	367.84	0.15	-0.10	-0.13	0.44	0.19	0.16	0.07	0.30				
10. Absolute size of target knowledge base	0.25	0.30	-0.15	0.27	0.38	-0.15	-0.22	0.13	-0.17	0.31	0.37			
11. Relatedness of target knowledge base	18.17	38.35	0.05	-0.06	-0.03	0.25	0.18	0.20	0.17	0.32	0.56	0.35		
12. Acquirer exploration	0.59	0.20	0.06	0.05	-0.10	-0.01	-0.04	-0.08	0.00	-0.07	0.05	0.04	-0.06	
13. Similarity of exploration between acquirer and target	0.77	0.18	0.14	0.13	-0.06	0.20	0.13	0.13	0.25	0.14	0.13	0.20	0.15	0.53

Table 2. Effect of innovation strategy on post-M&A innovation performance: Negative binomial regression			
Variable	1	2	3
N	89	89	89
Constant	-1.5667†	-0.5189	-3.3044*
	[0.9287]	[0.9723]	[1.4747]
R&D intensity	-0.0597	-0.0369	-0.0413
	[0.0403]	[0.0398]	[0.0404]
Current ratio	-0.0259	-0.0330	-0.0386
	[0.0356]	[0.0349]	[0.0333]
Firm size	0.0064	0.0083†	0.0092*
	[0.0045]	[0.0045]	[0.0045]
Pre-sample size	0.0002***	0.0001**	0.0001**
	[0.0000]	[0.0000]	[0.0000]
Technology similarity	1.9731***	1.1791**	1.0410**
	[0.9682]	[0.3844]	[0.3950]
Acquirer technology diversity	0.3331*	1.6400†	1.6346
	[0.4333]	[0.9630]	[1.0613]
Target technology diversity	-0.0006	0.5485	0.3958
	[0.0004]	[0.4073]	[0.4067]
Relative size of target knowledge base	-0.0818	-0.0001	-0.0003
	[0.6705]	[0.0004]	[0.0004]
Absolute size of target knowledge base	0.0100	-0.8430	-0.5497
	[0.0036]	[0.6416]	[0.6233]
Relatedness of target knowledge base	1.5907***	0.0099**	0.0099**
	[0.4075]	[0.0034]	[0.0033]
Acquirer exploration		-2.5118**	4.2937*
		[0.8566]	[2.8784]
Similarity of exploration between acquirer and target		0.2975	4.3438*
		[0.8291]	[1.7927]
Acquirer exploration · Similarity of exploration between acquirer and target			-9.0269*
			[3.5818]

Note. $^{\dagger}p < 0.1;\ ^{*}p < 0.05;\ ^{**}p < 0.01;\ ^{***}p < 0.001$

Standard errors are in brackets. Year dummies and SIC code dummies are included, but not shown.

To explain the significant interaction effect, we plotted the results of interaction effect following Makri et al. (2010). In Figure 1, the effect of innovation strategy similarity for high and low level of acquirer's exploration was demonstrated. We computed the high and low level of acquirer's exploration by adding one standard deviation from its mean and subtracting one standard deviation from the mean, respectively.

As shown in Figure 1, when acquirer's exploration is low (i.e., acquirer being exploitative), the innovation strategy similarity between acquirer and target has a positive effect on post-M&A performance. However, when the acquirer's exploration is high (i.e., acquirer being exploratory), not only does the innovation strategy similarity have a lesser effect, but it also shows that the effect of this similarity even becomes negative. It is worth noting that the upward slope of effect of exploitative acquirers is larger than the downward slope of effect of exploratory acquirers. This indicates that if the acquirer's innovation strategy is fixed, an exploitative acquirer has better effectiveness than an exploratory acquirer in the context of merging/acquiring targets with different orientations of innovation strategy.

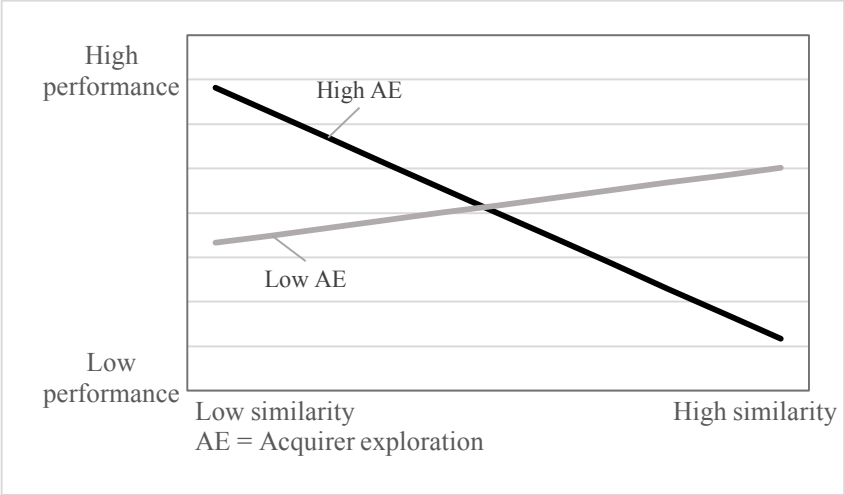

Figure 1. Interaction effects of the acquirer exploration with innovation strategy similarity on post-M&A innovation performance.

5 DISCUSSION AND CONCLUSION

In an effort to understand how the innovation strategy influences post-M&A innovation performance, we proposed a novel perspective that applies exploration and exploitation into M&A literature. The result for H1 is supported. Through examining the effect of acquirer's innovation strategy and the effect of innovation strategy similarity between acquirer and target, we concluded that before performing M&A deals, a high level of exploration of the acquirer seems to be harmful to its post-M&A innovation performance, as we expected. However, our findings did not support H2, which means the similarity of innovation strategy between acquirer and target does not significantly influence post-M&A innovation performance. The surprising result indicates that only focusing on this dyadic factor between acquirer and target is not sufficient for explaining innovation performance resulted from post-M&A or any other forms of inter-firm cooperation. There are two possible reasons for this insignificant result. First is that our data is limited to the pharmaceutical industry, thus leading to a bounded sample size. Second, prior research focusing on similarity of knowledge concluded that the best strategy is balance, which means too similar or too dissimilar are both harmful for innovation (Cloodt et al., 2006). Following this notion, the similarity of innovation strategy could be more complex and needs to be examined by generalizing or improving the model. Even though H2 is not supported, the effect of similar innovation strategy still influences post-M&A innovation performance under the moderating effect of acquirer's innovation strategy, which is proved by examining H3. Our research does provide some theoretical contributions to the literature and several managerial implications, highlighted in the following subsections.

5.1 Theoretical contributions

We are contributing to the stream of M&A literature by investigating a new technological perspective. Most of the previous studies have adopted a financial perspective and confirmed the effects of different financial variables. For example, Elgers and Clark (1980) found that a merger is beneficial to a firm's stock value; Healy et al. (1992) found that cash flow is significantly improved after mergers, resulting from increases in asset productivity. On the other hand, relatively few studies have examined the M&A performance in terms of technological factors. Most studies in technological M&A literature focused on knowledge characteristics including size of knowledge base, relativeness of knowledge base, etc. Yet no M&A research has considered the effect of innovation strategy. The innovation strategy of companies has been considered as influential to innovation performance, especially in high-tech industries. Our study broadens the horizon of M&A literature by investigating the innovation strategy and the innovation strategy similarity between acquirer and target. In addition, we further examined the interaction effect and found a significant moderating effect from the acquirer's exploration strategy. Moreover, we built

the linkage between the M&A literature and innovation strategy by the RBV theory. RBV and related research help us to explain how innovation strategy affects post-M&A innovation performance, and also create a framework for applying RBV into M&A or other forms of inter-firm cooperation literature.

5.2 Managerial implications

This study provides some meaningful insights for practical management in M&A. For those firms who want to carry out M&As, we suggest that they should rearrange their innovation resources before performing M&A deals. Our result shows that a high exploitation is helpful for post-M&A innovation performance. To achieve exploitation, firms can take the following strategies. First, the administration of the firm should encourage its inventors to reuse existing knowledge whenever possible, and promote cooperation between employees to increase knowledge reuse. Second, R&D managers should focus on improving existing projects or core abilities rather than develop radically novel knowledge or innovation. Third, in terms of human resource management, an employee whose background or expertise is relevant to the core abilities should be more preferred. Fourth, a knowledge management system is considered helpful for intra-firm knowledge sharing and transfer, thus promoting knowledge reuse and increasing exploitation.

Furthermore, the interaction between the acquirer's innovation strategy and similarity of innovation strategy indicates that compared to searching for exploitative targets, the acquirer should pay more attention to organizing its own strategy toward exploitation. That is, we suggest that when a firm is looking for M&A opportunities, it should first focus on coordinating its own innovation resources. When the cost of coordinating the innovation resources is too high, the firm can further consider the innovation strategy of the target.

Finally, following prior studies, we employed technological similarity as one of our control variables and this also gave us a practical management hint. For companies who mean to acquire external resources through M&As, a target with a similar technology portfolio is more preferable and should be placed at higher priority.

5.3 Future work

There are several limitations in this study, which represent directions for future research. First, our study is bounded in the pharmaceutical industry. Even though the pharmaceutical industry is recognized as a high-tech industry (Zaheer, 2010; Paruchuri, 2006, Zhang et al., 2007), there are still many possible high-tech industries remaining, such as the aero industry or chemical industry. We hope this study can be generalized by testing our proposed hypotheses on a variety of industries, thus increasing the external generalizability.

Second, our study is anchored on patent analysis, thus leaving room for other analysis techniques. Patent quality is adopted in this research to measure post-M&A innovation performance. However, many other measurements such as profit (Jaffe, 1986), market value (Jaffe, 1986) and time to patent (Datta and Roumani, 2015) are also relevant to innovation performance from a different angle.

Finally, this study focused on M&As. However, many other types of inter-firm cooperation should be considered in the future, such as alliance and joint ventures. Despite the essential difference, any technology-oriented cooperation seems to be suitable to be examined under the notion of innovation strategy. We look forward to future research extending our research model to other types of inter-firm cooperation.

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