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Reverse knowledge diffusion: Competitive dynamics and the knowledge seeking behavior of Korean high-tech firms

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Abstract This paper endeavors to enrich the existing knowledge acquisition literatures by specifically highlighting downsides of external ties of individuals. We introduce the concept of reverse knowledge diffusion (RKD) through external ties of individuals, and develop theoretical propositions to explain how the risks of RKD vary based on competitive dynamics and status of firms as innovation market leaders or market followers. We develop the construct of RKD to help explain why rivals may pursue contrasting knowledge seeking strategies with regards to leverage external ties of individuals, the timing of establishing these ties, and ex ante control mechanisms designed to regulate these relationships. We also discuss how our propositions advance the theory of knowledge seeking behaviors and generate future research opportunities.

Keywords Knowledge acquisition · Knowledge diffusion · Interpersonal network · Knowledge search · Reverse knowledge diffusion

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Organizational capabilities to exploit external knowledge have been a crucial component of innovation especially in high-tech sectors (Cohen & Levinthal, 1990; Teece, 2007). This is also explained through Chesbrough's (2003) "open innovation" model, which emphasizes the role of firms to increase the breadth and depth of existing knowledge by exploring diverse and useful ideas from the market. Most previous studies on external knowledge acquisition have suggested several methods mostly at the firm level, such as acquisitions (e.g., Ahuja & Katila, 2001), alliances (e.g., Mowery, Oxley, & Silverman, 1996), human mobility (e.g., Rosenkopf & Almeida, 2003), and inter-organizational collaboration networks (Powell, Koput, & Smith-Doerr, 1996). However, interpersonal ties are especially efficient to access non-codified and complex tacit knowledge (e.g., know-how and expertise) for which face-to-face interactions are often necessary requirements (e.g., Laursen & Salter, 2006; Menon & Pfeffer, 2003). Furthermore, by examining step-by-step procedures of knowledge seeking behavior through interpersonal ties, scholars may investigate detail processes of knowledge creation at the individual level.

Previous research on interpersonal ties emphasizes benefits of utilizing embedded knowledge in external experts and how to manage such external knowledge for better innovation performance. These studies empirically analyzed the relationship between number of external ties and innovation outcomes (e.g., Shan, Walker, & Kogut, 1994), how to design collaborative networks (e.g., Singh, 2005), impact of tie strength (e.g., Hansen, 1999), effect of network structures and positions on innovation (e.g., Ahuja, 2000), and governance mechanism of contracts versus trust (e.g., Levin & Cross, 2004). However, previous studies have not actively highlighted that interpersonal ties come with inherent downsides, such as unintended knowledge disclosure (e.g., Liebeskind, 1997), possible conflicts with potential partners (e.g., Nelson, 1989), and limited strategic flexibilities (e.g., Gomes-Casseres, 1996). These possible downsides of interpersonal ties may imply that academic researchers need further investigation on the topic of external knowledge acquisition at the micro level.

Our intensive interviews with R&D engineers in high-tech sectors further identified the need to investigate the knowledge seeking behavior at the individual level more deeply. We find that knowledge workers of Samsung Electronics Corporation (SEC) and Hynix Semiconductor Incorporation (Hynix) in Korea, a market leader and an obvious follower in the global dynamic random-access memory (DRAM) semiconductor industry respectively, deploy entirely different tactics to seek knowledge of external experts. When seeking external knowledge of experts, SEC is less aggressive than Hynix. Also when relying on external experts, SEC tends to seek experts outside of Korea. However, Hynix usually interacts with local experts in Korea. Even when these two firms face very similar technical problems, unlike Hynix, SEC is well known to selectively contact experts outside its home market. These contrasts between Hynix and SEC can be easily identified by our interview with an anonymous R&D engineer at SEC:

> When we look for specific technical expertise from external sources, we often suffer from significant disadvantage due to serious concerns about possible unintended loss of our internal knowledge and somewhat demanding internal security-check procedures. To minimize the possibility of such knowledge loss, we first have to develop a detailed plan about what, how, when, and where to

search knowledge. However, those document works are just beginning compared to various internal protocols of external knowledge search. It sometimes seems that our managers are too much cautious.

Indeed, these phenomena may require additional studies to investigate why even very similar firms in the same industry would pursue entirely different knowledge seeking strategies.

The strategic positioning literature focuses more directly on examining why rivals even in the same sector may have entirely different strategies and incentive alignments when seeking knowledge, new product development, or market entry (e.g., Chen, 1996; Chen, Smith, & Grimm, 1992). Previous studies have investigated various competitive dimensions of market leaders and followers, such as, how relative market status affects power balance (Ferrier, Smith, & Grimm, 1999), how market leaders respond to attacks (Ferrier, 2001), and how speed of execution differs (Hopkins, 2003). Other studies have examined different reactions to innovations (Charitou & Markides, 2003), impact of corporate reputation on competition (Chen, 1996), competition as game structures (Grimm & Smith, 1997), and sustainability of market leadership (Makadok, 1998). However, contrasting knowledge seeking behavior between market leaders and followers has not received sufficient academic attention.

The above paragraphs imply that there may exist a unique relationship between the strategic positioning of firms and knowledge seeking strategies utilizing external ties especially at the individual level. By integrating the research about market leader and follower dynamics with the knowledge acquisition literature, our study investigates meaningful research questions: Why and how does the strategic position affect knowledge seeking behavior through interpersonal ties with external experts? Our study investigating individual-level behavior of knowledge workers is further differentiated by the fact that we specifically highlight potential downsides of external ties: reverse knowledge diffusion (RKD). RKD occurs when external ties originally established for knowledge inflows facilitate pathways of unintended knowledge outflow.

We expect our study to make three meaningful contributions. First, this paper extends the existing knowledge management literatures by specifically highlighting the possible downside of external ties of individuals as a channel for possible outlets of sensitive internal knowledge and information. Second, we develop a conceptual framework of RKD and explain the conditions and factors that increase its likelihood. These theoretical efforts will provide a critical foundation for future research in the field of knowledge management and innovation. Third, through an intensive interview with high-tech firms in Korea, we suggest testable propositions about how RKD affects market leaders and followers differently in terms of knowledge seeking behavior.

External ties and reverse knowledge diffusion

External ties as channels to access external knowledge

Exploiting external knowledge either to passively respond to change or to actively address opportunities has often been critical to successful innovation (Cohen & Levinthal, 1990; Teece, 2007). External knowledge is especially beneficial when it

complements existing knowledge (Cassiman & Veugelers, 2006; Lavie & Rosenkopf, 2006), when firms can readily absorb it (Cohen & Levinthal, 1990), or when it is proprietary (Menon & Pfeffer, 2003). Mechanisms for acquiring external knowledge have drawn considerable attention, but mostly at the firm level, such as M&As, alliances, joint ventures, recruitments, and interpersonal or inter-organizational networks. For instance, Ahuja and Katila (2001) showed that 72 leading global chemical companies could increase innovation performance though M&As facilitating knowledge acquisition. Mowery et al. (1996) compared 792 alliances with a control sample of 858 firm pairs and found that equity joint ventures are more effective in knowledge acquisition than contract-based alliances. Rosenkopf and Almeida (2003) suggested that human mobility and alliances can facilitate inter-firm knowledge sharing even between firms in technologically and geographically constrained contexts.

However, the role of external ties of individuals as an external knowledge sourcing method has received less attention. We define knowledge seeking external ties as intentional efforts by knowledge workers to establish a formal or informal interpersonal relationship with independent experts outside their focal firm to acquire external knowledge including technology, know-how, information, advice, or feedback. External ties are a viable option when critical knowledge is non-codified and tacitly embedded in individuals (Kogut & Zander, 1992; Lam, 2000). Tacit knowledge transfer usually requires face-to-face interactions (Gray & Meister, 2004; Hansen, 1999). Also, compared to other intra-organizational arrangements, external ties are a meaningful method of gathering diverse, fresh, and valuable ideas for knowledge recombination (Ho & Chiu, 2012). Huston and Sakkab (2006) studied the innovation process of Proctor & Gamble (P&G), and highlighted its "YourEncore" system which connects about 800 high-performing retired scientists and engineers from about 150 companies. That system connects experts with deep experience and new ways of thinking from other organizations and industries to P&G. Nahapiet and Ghoshal (1998) emphasized the role of interpersonal ties in building social capital by leveraging resources embedded in relationships.

Individual-level external ties and reverse knowledge diffusion

Although external ties have much positive potential, there is high potential for these to cause serious problems and even financial damage by becoming pathways of unintended knowledge outflow. External knowledge is most valuable when there is a high level of fit between internal and external knowledge (Cassiman & Veugelers, 2006) or in the case when the environment is highly uncertain (Xu, Huang, & Gao, 2012). However, identifying compatible and complimentary knowledge in other firms requires knowledge workers to disclose sensitive internal knowledge to external experts. Indeed, developing a relationship that results in transfer of often tacit knowledge necessitates such information disclosures, which could result in knowledge workers inadvertently transferring proprietary knowledge and information. Consider two scientists discussing details of their firms' R&D projects. Although they must share knowledge to have an in-depth discussion, they simultaneously may wish to hold back some details because of the risk of knowledge expropriation. Similarly, knowledge workers at even competing firms may try to set up similar

arrangements for seeking knowledge. Once such scientists engage in external relationships, they often try to prove their expertise by discussing their firm's accumulated knowledge. Even well-documented contracts cannot be an effective ex ante measure to control unexpected knowledge disclosure. Indeed, market contracts for tacit knowledge exchange are typically "incomplete," leaving some terms and conditions of the expected exchange not clearly specified (Williamson, 1979, 1985). The incomplete nature of contracting creates incentives to engage in self-interested and opportunistic behavior even at the expense of other parties (Liebeskind, 1996). As an example, Hoecht and Trott (2006b) suggested that consultants are sharing proprietary skills and cutting-edge knowledge of existing clients to future clients.

As mentioned, RKD occurs when knowledge workers establish collaborative relationships with external experts, but then divulge critical proprietary knowledge to these external experts. Thus, rather than receiving new knowledge, RKD causes these external relationships to leak critical knowledge that jeopardizes a focal firm's innovation strategy by enabling competitors to imitate easily or hamper the focal firm's competitive advantage (Liebeskind, 1996).

RKD is distinctly different from information leakage (or spillover) in terms of actors' behavior, intentions, and outcomes (Jaffe, Trajtenberg, & Henderson, 1993; Marshall, 1920). First, RKD occurs in a context in which external experts are invited into collaborations such as consulting, advisory, or task-force teams that result in inadvertent knowledge transfer (Hoecht & Trott, 2006a, b). Alternatively, information leakage may not result from actions initiated by internal actors of the firm losing the knowledge advantage and more likely results from actions by unspecified third parties, we distinguish RKD from information leakage by focusing on actions of the agent of primary knowledge transfer. Second, since RKD involves disclosure of sensitive knowledge to specific individuals, there is the hope of confidentiality and that the knowledge is used to build the relationship rather than be expropriated for use by a competitor (Schrader, 1991). However, information leakage could occur naturally by non-specified entities over a longer period of time, and even by signaling effects by outsiders. Third, information leakage may result in beneficial outcomes, such as natural obtaining early feedback on up-coming new products in the future, signaling technological leadership to market, promoting new product launch, and/or establishing positive corporate reputation (Basdeo, Smith, Grimm, Rindova, & Derfus, 2006; Spence, 1973). However, we argue that RKD generates negative outcomes for the focal firm such as losing innovation edge, suffering subsequent financial damages, or yielding competitive advantages. Fourth, external ties are a precondition of RKD while information leakage may occur anytime without external ties (Liebeskind, 1996). Thus, RKD may be a critical byproduct of knowledge seeking behavior with external ties. Taken together these arguments clarify the conceptual distinction between RKD and information leakage, which helps to better understand risks associated with seeking knowledge through external ties (see Fig. 1 for the conceptual diagram).

Risks associated with external ties have become more important to both managers and researchers who recognize how difficult it is to protect proprietary knowledge even from inadvertent disclosure. To limit RKD ex ante, firms often use secrecy and legal protection mechanisms, but these have limited effectiveness (Liebeskind, 1996). As Hoecht and Trott (2006a) noted, innovation projects are often intangible and thus it is difficult to safeguard proprietary knowledge in contracts despite including

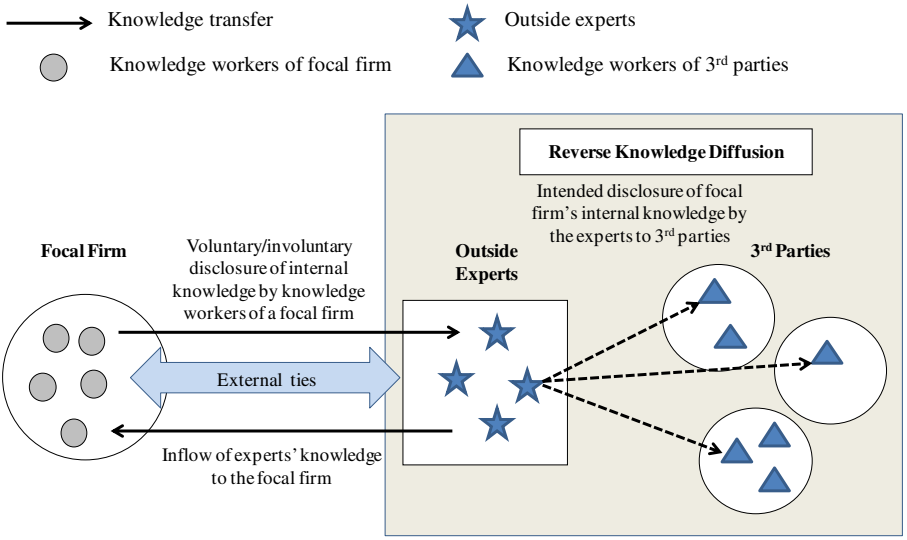

Fig. 1 Reverse knowledge diffusion conceptual diagram

detailed secrecy clauses and intellectual property agreements. The intangible nature of innovation hinders ability to detect and prove violations and misappropriations in a business context. Even if misappropriation is detected, it is often very challenging to secure compensation for damages. Once RKD occurs, firms often have limited recourse to recover damages. Indeed, previous studies have suggested that informal social control, such as mutual trust (Becerra, Lunnan, & Huemer, 2008) and professional reputation protection (Coleman, 1994), could be an effective alternative to legal contracts.

Factors and conditions affecting RKD

The theoretical construct RKD may provide a meaningful foundation to better explain risks associated with executing knowledge seeking strategies that rely on interactions between scientists and knowledge workers across organizations. Since many previous knowledge management studies have focused on knowledge acquisition strategies and strategy execution at the firm level, too little attention has been given to mechanisms and conditions that cause firms to lose sensitive internal knowledge. The RKD construct refocuses scholars on execution of knowledge acquisition strategies, in particular the roles of scientists as agents of knowledge diffusion. In this section, we revisit the knowledge management studies to develop a theoretical argument to explain mechanisms driving RKD. We identify the five factors that may increase the likelihood of RKD, specifically strength of ties, types of knowledge (explicit vs. tacit), timing of the involvement, industry context, and geographical distance.

Previous studies indicate that the strength of ties matters and we expect this to be the case for RKD. Strong rather than weak ties indicate that the interpersonal relationship is characterized by frequent interactions and proximity (Granovetter, 1973; Hansen, 1999; Levin & Cross, 2004). Hansen (1999) demonstrated that strong ties better facilitate transfer of complex and tacit knowledge between multiple project teams. Ghoshal, Korine, and Szulanski (1994) showed that intensive social interactions among

organizational actors positively affected the quantity of information transfer (Lane & Lubatkin, 1998; Zahra, Ireland, & Hitt, 2000). However, other studies argued that weak ties are more efficient in sharing diverse knowledge. Granovetter (1973) proved that weak ties provide novel and non-redundant information about new job opportunities. Levin and Cross (2004) emphasized different roles of strong and weak ties and found that strong ties help resolve demanding problems while weak ties transfer simple solutions. While disclosure of less information may occasionally cause serious problems, disclosing more sensitive knowledge is generally more likely to lead to more critical loss. Given the tacit nature of most proprietary knowledge, especially in high-tech industries, it will require a strong tie for an external expert to obtain critical information through interpersonal collaborations (Hansen, 1999; Uzzi, 1997). If we recognize strong ties as the more viable pathway to transfer tacit proprietary knowledge, then despite its effectiveness as a knowledge acquisition tool, a strong tie tend to increase the probability of RKD and is thus much riskier.

Previous studies also highlighted that the nature of knowledge, explicit versus tacit knowledge (e.g., Polanyi, 1966), may affect the probability of appropriability. Explicit knowledge is often easily codifiable and transferable even through formal procedures, but tacit knowledge is non-codifiable, difficult to communicate, and highly dependent on cognitive capability (e.g., Nonaka, 1994; Teece, 1977). Explicit knowledge being more easily understood and applied has a greater risk of appropriability because anyone acquiring it can generally resell or reapply it without losing the original value (Arrow, 1984). In addition, the marketing of knowledge, such as word of mouth, often attracts potential buyers (Arrow, 1971; Grant, 1996a). However, the less codifiable nature of tacit knowledge makes it more difficult to articulate and observe, thus it is mainly acquired through experience (Kogut & Zander, 1992; Lam, 2000; Nelson & Sidney, 1982; Von Hippel, 1994). This difference in the nature of knowledge helps explain why RKD is more likely to occur when primary discussions in external ties focus on explicit rather than tacit knowledge.

The stage of an innovation project may affect RKD when scientists form external ties. Previous studies advocated seeking knowledge from outside experts at an early stage of innovative projects to speed up development processes (Gupta & Wilemon, 1990). While potentially beneficial, establishing external ties early in an innovation project could be risky. When outsiders are involved in the early stages of innovation projects, they may have more time to access, understand, and absorb internal knowledge of a focal firm. Pucik (1988) showed that sufficient slack time and resources significantly help to identify and locate valuable knowledge. During early stages, scientists are more likely to openly discuss tacit and proprietary aspects of the project as they work to make sense of the knowledge trajectory. Conversely, in the later stages of a project as development and commercialization become clearer, scientists more easily recognize limits to place on interactions with outside experts. Thus, risks of RKD should be greater in earlier stages of innovation development.

As mentioned, industry context (high-tech vs. low-tech) also affects the amount and frequency of knowledge transfer (Teece, 2000). High-tech firms have stronger motives than low-tech firms for seeking external knowledge because they face shorter span of product life cycles (Kobrin, 1991) and highly volatile environment where proprietary knowledge is more important (D'Aveni, Dagnino, & Smith, 2010). Unlike existing studies, focusing on the concept of RKD affords theory development that

explicitly examines risks associated with knowledge seeking through external ties can be far riskier in high-tech rather than low-tech contexts.

Previous studies of knowledge management showed that geographical distance significantly increases communication costs and knowledge transfer since search activities are often constrained geographically and technologically (Jaffe et al., 1993). Rosenkopf and Almeida (2003) also suggested the physical relocation of knowledge workers as an alternative to overcome geographical distances. Alcácer and Chung (2007) showed that to minimize the cost of geographical distance and maximize colocation benefits, firms tend to mimic their leading competitors' location decisions. While existing studies recognized geographical distance as a barrier to knowledge search, the concept of RKD may advise managers to be more cautious about the external ties in local markets.

Impact of market position on knowledge seeking behavior

Although beneficial in many regards, the knowledge integration perspective does not offer a theoretical explanation for why firms in the same industrial sectors pursue different knowledge seeking strategies, especially in regards to external ties. Rather, this perspective suggests a similar strategy to create or sustain competitive advantages regardless of a firm's relative technological position, even technological leaders and followers (e.g., Fudenberg, Gilbert, Stiglitz, & Tirole, 1983). Previous studies on strategic positions and competitive dynamics provide theoretical arguments explaining contrasting behavior of market leaders and followers in the broad range of strategic actions such as innovation, new product development, market entry, and speed of execution (e.g., Chen et al., 1992). Competition for resources is an important driver of competitive dynamics (Barney, 1986). The significant gap between market leaders and followers in terms of resources, knowledge, and capabilities makes leaders more concerned about sustaining technological and market leadership, while it motivates followers to hasten to catch up (e.g., Harris & Vickers, 1987). Grant (1996b) argued that organizational capacity for creating and sustaining competitive advantage often depends on the ability to protect advantage against imitation. Due to its inherent nature of a public good, knowledge revealed to rivals cannot be fully restored to its prior status as purely proprietary (Liebeskind, 1997; Matusik & Hill, 1998). Thus, RKD likely poses a greater risk to market leaders rather than to followers. Therefore, we expect risks associated with RKD should subsequently differentiate knowledge seeking strategies of market leaders from market followers.

Risks associated with RKD may explain why rivals in the same segment and location, such as SEC and Hynix in Korea, have contrasting knowledge seeking strategies, especially leveraging external ties. Our interviews with knowledge workers of SEC repetitively showed the following:

> Our engineers are very proud of our standard-creating technological leadership, which has motivated on-going innovation efforts over the last two decades. However, such leadership often breeds caution when leveraging external knowledge since many of our managers are more interested in information security than technological breakthrough. Especially when the engineers develop

> initial concepts, managers often hide such projects. To work with external experts, engineers must go through three or four authorization and confirmation procedures with internal scientists in related fields. We engineers dream of working without such red tape. When we can manage such procedures, managers prefer us to work with foreign experts, such as IMEC (a world-leading research institute in nano-electronics technology in Belgium) rather than Korean experts.

The above statements illustrate that SEC has two competing goals of technology leadership and information security concurrently. Our subsequent interviews in other industries confirmed similar attitudes of knowledge workers toward external ties in technology leading firms. However, our interviews with scientists of Hynix and other technology followers, highlights an alternative approach:

> We are 2nd in the global semiconductor industry but always pay attention to what projects engineers of SEC plan and execute. Our primary R&D goal is beating SEC in terms of new technology developments and commercialization. To accelerate R&D projects, we will pursue internal development, hiring, outsourcing, buying, and often collaborations. Information security is always critical but is often secondary to speed. However, we never give up developing our own unique know-how and are driven to lead our field.

This Hynix engineer's statement is representative of how market followers in various industries approach R&D activities and technology competition. Engineers of market followers we interviewed were most concerned with catching up to market leaders. These insights from our interviews with knowledge workers reveal contrasting perceptions of possible benefits and risks of external ties that are driven largely by relative market position. While there are multiple ways to measure relative position of firms, we utilize the concepts of market leaders and market followers in terms of market share dominance (Ferrier et al., 1999), financial performance (Cool & Schendel, 1987), and technological leadership (Lieberman & Montgomery, 1988). We then use these interviews to develop theoretical propositions about how relative market position affects knowledge seeking strategy and its execution, in particular as these relate to the likelihood of RKD in external ties.

Why rivals behave differently?

The knowledge acquisition literature suggests that market leaders may have a strong incentive to sustain their knowledge leadership by investing in R&D and/or acquiring external knowledge. Hagedoorn (1995) argued that leading computer and microelectronics firms engage in more strategic alliances and collaborations. Due to relative advantages of advanced absorptive capacities and resources (Daneels, 2002; Nelson, 1991), leading firms generally seek to exploit more external knowledge (Wu & Chen, 2012). We interpret these arguments to imply that leading firms tend to utilize external ties more actively than market followers.

However, risks associated with RKD suggest different guidelines for market leaders and followers. For example, the external knowledge market leaders seek is often not well-known to the market and likely possessed by only a few scientists. Obtaining such tacit knowledge requires strong ties with outside experts. However, as

explained above, such strong ties increase the risk of RKD, and market leaders likely have a lot more to lose from RKD than market followers because it may give followers meaningful opportunities to narrow the knowledge gap with leaders. Since the increased risk and magnitude of loss from RKD is likely much greater for market leaders, they tend to be more cautious and less eager to commit to knowledge seeking through external ties. Even when developing external ties, scientists working for market leaders tend to take much longer to establish external ties due to many internal processes of red tape for internal knowledge protection (Liebeskind, 1996).

Conversely, market followers may perceive risks of RKD differently. First, risk associated with RKD may be deemed acceptable if these also hold some potential for market followers to narrow the knowledge gap with market leaders. The potential to quickly gain ground on a market leader likely encourages market followers to prefer external ties to internal R&D for knowledge development. Indeed, external ties are often recognized as more efficient in terms of time and costs than internal R&D in obtaining market leaders' tacit knowledge in knowledge intensive industries (Grant, 1996b). Second, since market followers' internal knowledge protection mechanisms may be less complicated and require less time for approval than market leaders, scientists working for market followers should face far fewer impediments to establishing external ties. Therefore, we generally predict the following:

Proposition 1 Market leaders are less likely than market followers to rely on external ties when seeking external knowledge.

When to rely on external ties?

The concept of RKD may also explain why firms seek to establish external ties during different stages in the development of their innovation projects. Previous knowledge management research has argued that involving external experts early better facilitates knowledge transfer and integration between entities (Doz & Hamel, 1998). However, risks associated with RKD suggest that market leaders may wish to delay seeking knowledge through external ties while market followers may prefer establishing these ties at early stages in the development of their innovation projects. Information exchange at an early stage will help project participants understand the overall picture of the knowledge development project (Kelly, Schaan, & Joncas, 2002), such as the project's ultimate goal, how the specific project will differentiate existing technology, where the technology will be applied, and the estimated economic value of the project. Such comprehensive understanding about a specific project provides a good foundation for external experts to identify which technology is most critical, and how to access or where to learn specific knowledge. In addition, early involvement provides external experts more time to absorb necessary knowledge, and allows them to interact with more internal engineers. Pucik (1988) suggested that early involvement of human resource staff in inter-organizational alliances is essential to precisely identify the critical value-added learning targets and the effective means to control them. Since establishing external ties at the early project stage increases knowledge sharing and exchange, market leaders may actually concerned be about established external ties during the early stages of an innovation. This is because if RKD occurs at the very early stage, knowledge leakage tends to cause market leaders

serious damage as rivals have more time to catch-up and/or imitate an innovation project that the leader is just starting. Indeed, one of our interviews with R&D engineers of several leading firms illustrates such concerns:

> We can always find ourselves in a fundamental dilemma at the very initial stage of new R&D projects. To avoid possibly wasting resources by heading in the wrong direction, we try to confirm our ideas with external experts or independent third parties. However, discussions or consultations with external players often concerned our internal control division. It seems to me that they would rather we not develop a new technology than risk disclosing knowledge to an outsider.

The possibility of RKD will be strongly affected by project evolution. As a new project evolves to the final stage, internal scientists gain a clearer understanding about what knowledge is needed from outside. More clearly identifying missing elements will subsequently reduce the scope of external knowledge sought. Attempting to fill a small knowledge gap should require much less disclosure of internal knowledge. Thus involving external experts in the project closer to the final stage minimizes the scope of knowledge disclosures and thus reduces risks associated with RKD. The possibility of RKD may be significantly attenuated at the later stage of innovation projects. Since market leaders usually have a knowledge "head start," they may not need to establish early project external ties.

Market followers may be less concerned with RKD risks even at the early stage since they are under pressure to close the knowledge gap with market leaders (Lambkin, 1988). Additionally, as followers, they may face less fallout from RKD. So market followers may prefer establishing external ties early because increased knowledge exploration may help market followers partially overcome the knowledge gap with market leaders (Lieberman, 1987). Additionally, increased risk of RKD posed by establishing early external ties may be offset by market followers having less proprietary knowledge to loose and thus a lower potential risk of RKD. (Lieberman & Montgomery, 1988). Diminished risk potential and greater pressure to quickly close the knowledge gap, may increase pressure on market followers to expedite establishment of external ties as early as possible in the development of innovation projects. Consequently, we predict the following:

Proposition 2 Market leaders will prefer establishing external ties in later stages of innovation projects than market followers do.

How do firms control the possible RKD?

Given the risks associated with RKD, we wondered how firms attempt to control or avoid it ex ante. The contrasting attitudes and incentive alignments to RKD suggest that market leaders and market followers may utilize different control mechanism. Some external ties rely on relational contracts established by two or more parties undertaking joint commitment and sharing sensitive knowledge (Park, 1996). The goals and expectations of prospective contract participants, either experts or knowledge seeking firms, are often incongruent or incompatible (Hamel, 1991; Mjoen & Tallman, 1997). Thus, external ties are often vulnerable to opportunism, asset specificity, and bounded rationality, which subsequently increase transaction costs

(Dietrich, 1994; Williamson, 1985). Because external ties often entail mutual commitment of critical knowledge in an uncertain and complex context, transaction costs during searching, formation, and subsequent operation are fairly high (Hennart, 1988). Detailed contract specifications are necessary for knowledge seeking firms to ensure control of their knowledge assets while maximizing possible benefits of external knowledge and future integration. In addition, when we come to cross-border arrangements, additional transaction difficulties arise from cultural, legal, economic, and geographical distances (Luo, Shenkar, & Park, 2002). Liebeskind (1997) specifically emphasized that ex ante controls are much more effective than ex post regulations to prevent possible residual leakage of knowledge.

The complexity and vulnerability of external ties requires strong control mechanisms between external experts and knowledge seeking firms to sustain successful relationships. Ring and Van de Ven (1994) emphasized the significance of control mechanisms to facilitate inter-partner learning and collaborations, because the norms of reciprocity and trust are often insufficient to control evolutionary relationships between multi-parties (Hamel, 1991; Kogut, 1988). Contracts are a major ex ante mechanism for controlling and minimizing conflicts. Contract completeness serves to reduce complexity, uncertainty, and transaction costs associated with external ties, and ex ante specifications controlling each party's rights, duties, and benefits can be reflected in various binding terms, clauses, and conditions (Kim & Sung-Choon, 2013; Schaan, 1983). Conversely, incomplete contracts often leave conceptual terms blurred or vague, and are insufficient in setting clear bounds and responsibilities of each party. Such contracts may provide a breeding foundation for shirking responsibility and shifting blame, which ultimately raises the possibility of RKD.

The knowledge management literature suggests that knowledge seeking firms should minimize transaction costs of external ties (Teece, 1977). However, it cannot predict why market leaders and followers will have entirely different perceptions of the level of detail and completeness of contracting. The RKD perspective can illustrate different incentives between market leaders and followers in this regard. As explained above, although control mechanisms are costly, compared to market followers, market leaders are more willing to pay such costs since RKD poses a greater risk to their leadership status. Market followers are willing to face the risks of RKD if the potential benefits increase the possibility of quickly obtaining external knowledge to close the knowledge gap. In terms of searching, forming, and operating external ties, market followers seek to accelerate knowledge acquisitions rather than spend significant time and resources completing contracts to better control possible RKD. Thus, we predict:

Proposition 3 Market leaders will prefer more complete contracts as an ex ante control mechanisms in external ties more than market followers will.

Discussion

Contributions

Studies in knowledge management have focused more on utilities of external knowledge than protection of one's own knowledge (Liebeskind, 1996). Although firms

often resort to legal/non-legal protective mechanisms to protect their knowledge, the incomplete nature of contracts as control mechanisms always leaves rooms for outsiders to appropriate sensitive internal knowledge for self-interest (Hoecht & Trott, 2006b). In knowledge intensive industries where possession of core knowledge directly influences corporate performance, knowledge protection is a key concern. The attractiveness of internal knowledge protection as a research motivation surfaced in our interviews with R&D engineers in multiple industries.

Our paper makes several theoretical contributions to the existing literatures. First, building on the broad concept of knowledge protection in previous studies (Cheung, 1982; Liebeskind, 1996), we contribute by highlighting the concept of RKD as intentional knowledge disclosure by external experts in the context of knowledge management and market leader/follower dynamics. We posit that costs and benefits trade-offs from external ties are different for market leaders and followers, which ultimately drives them to pursue different knowledge seeking strategies. Our study enriches existing literature by emphasizing how knowledge workers can be problematic agents of intentional knowledge disclosure while they are the very agents of knowledge transfer, exchange, and sharing. Compared to patent citation studies that analyzed explicit and intended knowledge transfer, the concept of RKD suggests that implicit and unidentifiable knowledge transfer may also become a research focus. The human mobility literature focuses on knowledge transfer with physical relocation of knowledge workers (Rosenkopf & Almeida, 2003), while our study identifies the phenomenon of unwanted knowledge transfer without physical relocation of scientists.

Second, a major contribution of our study relates to the introduction of a new concept that opens up many interesting avenues of theory and research that are yet explored. We first proposed that market leaders are less likely to rely on external ties than market followers. We argued that in spite of significant need and potential benefits for critical external knowledge, market leaders have more to lose with RKD than market followers do. Much of the previous research on knowledge management either simply highlighted benefits of external knowledge or distinguished different type of knowledge seeking activities, such as local search for incremental innovation and boundary spanning search for radical inputs (Rosenkopf & Almeida, 2003; Rosenkopf & Nerkar, 2001; Tushman, 1977). To refine the above knowledge seeking behavior we distinguish strategic market positions. This type of theoretical implication may be applied to other strategic management issues, such as why or under what conditions some firms pursue more active benchmarking activities, outsourcing strategies, new product development, absorptive capacity enhancement, market intelligence strategy, organizational structure design, or M&As. For instance, in terms of M&As, our study can explain that high-tech firms, such as Cisco, may prefer acquiring the entire target rather than horizontal collaborations that run the risk of RKD. In terms of buyer-supplier relationship management, it is always necessary for component suppliers to share detailed design of a new product with a final assembler, and vice versa, to reduce costs and improve quality (Clark & Fujimoto, 1991). However, both scholars and managers need to recognize that even this kind of productive knowledge sharing is not free from the risks of RKD.

We also argued that market followers are more likely to exploit external ties at early stage of innovations than market leaders. Previous studies mostly investigated

how managers can accelerate knowledge transfer between independent entities, or how the amount, type, and contents of external knowledge affect innovation outputs in the post-knowledge acquisition period (Cassiman & Veugelers, 2006; Cohen & Levinthal, 1990; Menon & Pfeffer, 2003; Zander & Kogut, 1995). However, they did not specify how timing of knowledge acquisition is moderated by strategic market positions. We suggested that, at early rather than later stages, the probability of RKD and subsequent damages may become especially serious basically due to more time for both knowledge learning and RKD. In addition, market followers are under more pressure to speedy catch-up and less constrained by potential RKD. Thus, we argue that the best timing of knowledge acquisition strategies especially for the market followers tend to be at the early stage of innovation projects while that for market leaders at the later stage. Our study may expand the current theoretical implications to various research questions, such as when the best timing to imitate, acquire, and/or integrate external knowledge may be for a specific type of firms, why the best timing of M&As or strategic alliances for knowledge acquisitions is different across competitors, or when the best timing for make or buy decisions is for a group of firms. For a specific example, considering the purpose of exploitation vs. exploration, we may investigate how the best timing of external knowledge acquisition may be affected by the inter-relationship between strategic positions and learning types.

Our third question asked how control mechanisms of RKD differ between market leaders and market followers. We argued that due to the high potential of severe damage from RKD, market leaders are rather willing to rely on a strong ex ante tool of highly complete contracts, as an effort to avoid opportunism, goal incongruence, and inherent uncertainty at the significant cost of time and financial resources. However, market followers may tend to take a simplified and less complete contract at the risk of possible RKD. Most previous studies on the knowledge management focused how to speed up knowledge acquisition and minimize the related costs of transactions (Grant, 1996a; Zander & Kogut, 1995). Specifically, the contract completeness is an intertwined result of factors at the multiple levels, such as goal differences between partners, cross-country effects, and cross-cultural components (Ding, Huang, & Liu, 2012; Luo et al., 2002). However, our study basically advises that by relying on a rather complete contract, it could be beneficial to intentionally increase the protection measures for the knowledge acquisition processes of market leaders. Our thought on the control mechanism of RKD may be relevant with other knowledge acquisition methods, such as what the best protection mechanism could be for M&As, alliances, and agreements with third parties in the ex ante and ex post perspectives, how to design the best contracts between partners under different contingencies, and how to deal with damage of RKD ex post.

In addition to the theoretical contributions above, our study also contributes to practice by providing new insights for managers. Conceptual framework and propositions of this study draw managers' attention by examining the benefits of external knowledge sourcing through outside individuals and the possible damages from RKD. Managers need to understand the inevitable trade-off between the efficiency of knowledge acquisitions and costs of knowledge protection. They often try to increase the protection mechanism of internal knowledge, such as enhancing monitoring procedures, establishing rules and regulations, and redesigning compensation packages. However, such efforts will subsequently face direct conflict with speedy

acquisition of external knowledge. This calls for a cautious cost-benefit analysis for the managers when seeking knowledge from external ties with a special attention to their market status, specifically market leaders and followers. In addition, there exists another trade-off between establishing efficient external ties and securing high level of trust between contract participants. While the high level of trust can be an effective alternative to control possible RKD especially for repetitive collaborations with the same partners (Ring & Van de Ven, 1994), it usually takes a significant amount of time to build up and is less cost-efficient. In addition, the informal control mechanism of trust may not be a reliable solution for market leaders due to their high concern about RKD. The trust-based relations, which often require some forms of trusting actions, such as exclusion of binding terms, less detailed agreements, less safeguards, and less monitoring, cannot be an effective ex post control mechanism since they do not often include how to compensate possible damages between partners. In summary, while the previous literature mainly focuses on how to develop and expand the knowledge base, our study suggests that considering their strategic market positions, managers need to find optimal solutions to the trade-off between the methods to acquire external knowledge and the protection methods of internal knowledge.

Limitations and future research

Our study provides further critical implications for theory building, future research, and managerial implications on the knowledge management and competitive dynamics. First, the simple combination of the two literatures can provide us better theoretical predictions of knowledge transfer and intentional diffusion of someone else's knowledge. For example, while the existing human mobility research focus on the relocation itself (Almeida & Kogut, 1999; Rosenkopf & Almeida, 2003), the integration of market status into the knowledge management allows researchers to investigate a more refined issue: How the human mobility from market leaders to market followers may affect innovation outcomes differently, compared to that from market followers to market leaders. The concept of RKD can further redesign the above question such as, under what conditions the human mobility may causes the knowledge reverse flows from market leaders to market followers and vice versa.

Second, the integration of knowledge management literature into the competitive dynamics studies can also be enriched if researchers may creatively consider the concept of RKD in their future research. For example, previous studies have shown that the first-mover advantages are meaningfully sustainable across a wide variety of industries (Ketchen, Snow, & Hoover, 2004) and identified internal and external contingencies associated with the sustainability of such advantages (e.g., Nehrt, 1998; Schoenecker & Cooper, 1998). Strongly motivated scholars can examine how the sustainability of leading firms' competitive advantages may be affected by possible RKD through various channels of knowledge transfer, such as M&As, alliances, and human mobility.

Third, the roles of control mechanism may be further examined when researchers take into account the different types of controls and their differential impact on knowledge creation. Unlike our study that investigated only contract completeness, controls on inputs may have entirely different impacts on innovation than those on outputs. For instance, in a sample of 57 pharmaceutical firms, Cardinal (2001) found

that the use of input, behavior, and output control mechanisms have significant impact on radical innovations but only input and output control on incremental innovation. Other studies found that types of controls also affect input decisions in global contexts. Chen, Park, and Newburry, (2009) showed that output and process controls are more associated with property-based contributions in international joint ventures while process and social controls with knowledge-based contributions.

Fourth, beyond the national context of Korea, our study can be applied to innovation issues in other Asian countries including China and India. It is also meaningful to pay special attention to the differences in institutional contexts across countries, since it can help scholars to draw more practical insights and managerial implications on corporate behavior (e.g., Meyer, Estrin, Bhaumik, & Peng, 2009). Asian economies are often recognized as emerging markets where intellectual property right is subject to weaker legal protection than most Western economies and informal networks tend to be more critical than formal relationships (e.g., Ahlstrom, Chen, & Yeh, 2010). For example, people in East Asian economies easily build up strong ties based on their educational background, kinship, and hometown (Hitt, Lee, & Yucel, 2002). In addition, social control processes rather than formal controls are more often used as corporate control mechanisms (Lu, Tsang, & Peng, 2008). These Asian characteristics may effectively make RKD fairly critical in countries such as Korea, Japan, and China. Therefore, future studies may need to examine firms in other Asian countries such as China, India, and Vietnam, where innovation and technology development becomes one of the most important critical drivers for economic growth and social welfare (Ahlstrom, 2010).

Lastly, there definitely remains a need to test our propositions with the aid of further empirical tests either qualitatively or quantitatively. Future research can design in-depth qualitative studies about under what conditions the probability of RKD increases, and what factors affect the probability most significantly among knowledge types, strength of ties, timing of the involvement, and structure of ex ante control mechanism. Also, empirical or case studies in different industry contexts will provide a better understanding about dynamics of RKD in various industries. While we take into account high-tech industries in the manufacturing sectors, this context was an intentional choice due to its well-known reputation for active sourcing of external knowledge. However, the service sectors, such as the consulting, hospitality, logistics, IT and software solutions, are an obvious target for further investigation. Lastly, researchers may investigate the roles of RKD as a moderating or mediating variable in various fields, such as organizational capability management, internal R&D process, or organizational structure design.

Conclusion

A major motivation of this study is to explain why some firms choose or not choose to use external ties of individuals to seek knowledge. While the benefit of sourcing external knowledge has received much attention in previous literatures, potential costs of external knowledge seeking has not received comparable academic attention. Thus, we focused on a new concept of RKD and the conditions that increase the probability of RKD. RKD specifically helps us to better understand how firms may lose their sensitive internal knowledge to competing firms. Relying on this unique

concept of RKD, we posit that the possible trade-offs between upsides and downsides of external ties of individuals may deliver different impacts on market leaders and followers respectively. We argue that RKD may ultimately influence them to make entirely contrasting choices in terms of knowledge seeking methods, timings, and protection mechanisms. In particular, we suggested that, compared to market followers, market leaders are less likely to utilize external ties of individuals due to the high potential risk of losing its core knowledge. We expect our work to shed additional light on the knowledge management and innovation, and provide a new foundation for future studies.

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