



Contents lists available at ScienceDirect

Technovation

journal homepage: www.elsevier.com/locate/technovation

R & D cooperation and unintended innovation performance: Role of appropriability regimes and sectoral characteristics

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ARTICLE INFO

Keywords:

Unintended innovation performance
R & D cooperation
High technology industry
Low technology industry
Appropriability regime

ABSTRACT

This research empirically examines the relation between R&D cooperation and unintended innovation performance. The effects of appropriability and sectoral conditions on the unintended innovation performance in the context of R&D cooperation were also tested. Binary logistic regression was used to analyze the manufacturing firms sampled from the Korea Innovation Survey (KIS) 2012. Our estimation results show that for the high-tech focal firms under strong appropriability regime, cooperation with competitors increases the likelihood of their unintended innovation performance. For the high-tech focal firms under weak appropriability regime, cooperation with customer and user firms and universities increases the likelihood of their unintended innovation performance. For the low-tech firms under strong appropriability regime, cooperation with the customer and user firms and advisory organizations increases the likelihood of unintended innovation performance. For the low-tech firms under weak appropriability regime, cooperation with competitors and government research institutes increases the likelihood of unintended innovation performance. As a whole, the significance of this paper lies in shedding a new light on approaching the innovation performance with the notion of unintended innovation performance, which is shaped by different partner types and environmental conditions.

1. Introduction

R & D cooperation is characterized by intensive knowledge exchange and organizational learning processes which requires lower transaction costs than in pure market-based transactions (Becker and Dietz, 2004; Dachs et al., 2008). Among the various motives of R & D cooperation, firms gain access to complementary technologies (Mohnen and Hoareau, 2003; Miotti and Sachwald, 2003), thereby improving the probability of success in their innovation projects (Becker and Dietz, 2004; Sampson, 2007; Abramovsky et al., 2009; Freel and Harrison, 2006). In fact, a large number of cross-sectional studies found that R & D cooperation helps boosting focal firms' innovation performance (Cincera et al., 2003; Belderbos et al., 2006). However, some scholars emphasize the inherently unstable nature of R & D cooperation which generates disappointing outcomes (Harrigan, 1988; Kogut, 1988; Kesteloot and Veugelers, 1995; Barkema et al., 1997; Mora-Valentin et al., 2004; Reuer and Zollo, 2005; Lhuillery and Pfister, 2009). Despite the unstable nature and unexpected risks inherent in R & D cooperation that may result in failure, such features may bring about unintended success in R & D cooperation.

As a whole, previous literature has left two important research gaps unfilled. First of all, existing studies failed to integrate the notion of unintended success, which exceeds the initial expectations based on established goals in R & D cooperation. Such unintended success needs more attentions from scholars, as the idea that unintended success or unpredictable outcomes create values within innovation processes has become well accepted (Diaz de Chumaceiro, 1995; Austin et al., 2012). A list of unintended success would include anesthesia, aspartame, cellophane, corn flakes, dynamite, lithium, nylon, PVC, photography, rayon, smallpox vaccine, stainless steel, Teflon, Viagra, vulcanized rubber, x-rays, and many more (Simonton, 2004; Austin et al., 2012). In the context of R & D cooperation, the collaboration between International Business Machines ("IBM") and Asea Brown Boveri ("ABB") in 1987 was originally aimed at developing an expert system for monitoring and guiding the maintenance of asynchronous electric motors. However, the cooperation not only increased IBM's reputation in the expert systems market as expected, but also produced some unintended technological success to be accrued to IBM's R & D project on the development of a broader 'shell' for personal computers (Tunisini and Zanfei, 1998). Accordingly, this study fills the gap of the unintended

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<http://dx.doi.org/10.1016/j.technovation.2017.03.002>

Received 17 March 2016; Received in revised form 14 March 2017; Accepted 17 March 2017

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dimension of the innovation performance by empirically testing the unintended innovation performance as the innovation outcome which exceeds the preset goals in R&D cooperation. Accordingly, the first objective of this study is to investigate the relation between R&D cooperation and unintended innovation performance.

Secondly, previous research has not paid adequate attention to the external environments that shape the relationship between R&D cooperation and unintended innovation performance (Bayona et al., 2001; Arranz and de Arroyabe, 2008; Wu, 2012). Scholars have argued that sectoral technological characteristics and appropriability conditions are two important environmental factors that influence a firm's resource-seeking behaviors (e.g. searching for similar or complementary resources). Likewise, both sectoral technological characteristics and appropriability conditions have been considered as key factors, as they brought important implications to organizational learning literature (Harrigan, 1988; Doz, 1996). In particular, investigating the R&D cooperation by low-tech firms has been limited to certain industries such as food processing, agribusiness, etc. which may not represent the general population of the firms engaged in low-tech industry (Van de Vrande et al., 2009; Maietta, 2015). However, it is important to note that even low-tech firms actively pursue and engage in R&D cooperation, as innovation is not a unique concern for high-tech firms, but also for the firms in low-tech industries (Zhao, 2009; Martinez et al., 2017). Hence, the second objective of this study is to examine the environmental factors that shape the unintended innovation performance in both high-tech and low-tech firms' R&D cooperation activities.

With the research objectives in mind, this study intends to contribute to the literature in three important aspects. First, research on R&D cooperation has mainly focused on identifying mechanisms through which strategic cooperation helps firms to enhance their innovation performance (Powell et al., 1996; Stuart, 2000; Bell, 2005; Ahuja, 2000). Despite the extensive literature in this area, the effect of R&D cooperation on unintended innovation performance has not been examined yet. In fact, the gap for unintended innovation performance in R&D cooperation has not feature in the empirical modeling or testing, despite its prevalent presence in conceptual and theoretical papers (Austin et al., 2012). Also, compared with general innovation performance, unintended innovation performance should require more attentions, as general innovation performance with its basis on a rational approach is only focused on reducing uncertainty and thereby precipitously killing a project that could result in unintended and valuable breakthroughs (Austin et al., 2012). Second, studies on inter-organizational R&D cooperation have addressed various types of partner relationships (e.g. firm-firm, firm-government research institute, firm-university, etc.). However, it is important to consider how different partner types may shape the outcome of R&D cooperation. Whereas, some collaborations focus on process innovation by incrementally improving the existing internal knowledge-base with an external partner's specific capabilities, others are aimed at product innovation by tapping external knowledge to investigate technologies that are new to the firm (Ahuja, 2000; Bercovitz and Feldman, 2007). Thus, this study investigates the impact of partner types on unintended innovation performance in process and product-oriented innovation activities. Lastly, research on R&D cooperation has mainly focused on addressing the cooperation initiated by high-tech firms. However, many low-tech firms are also pursuing innovation activities by forming R&D cooperation (Hirsch-Kreinsen, 2008; Zhao, 2009; Heidenreich, 2009). This study fills in the gap by making a comparison between high-tech and low-tech R&D cooperation.

Next section begins with the theoretical background by reviewing the streams of literature in R&D cooperation. Section 3 entails methodological approach and process along with descriptive statistics of our samples. Section 4 presents the results of the empirical analysis, which used binary logistic model and propensity score matching (PSM) approach. The last section provides the implications drawn from the findings and future directions of the research.

2. Literature review

2.1. Sources of unintended innovation performance in R&D cooperation

Unintended innovation performance in our study is defined as performing better than firms' initial performance goal. In fact, firms may gain unintended above-normal returns when they have superior information, when they are lucky, or both (Barney, 1986). It is argued that all other apparent sources of either quasi-rents or market power ultimately lead to the importance of either superior information or luck. Obviously, these arguments imply that even firms' endeavor for resource heterogeneity and imperfect mobility is present; it is still difficult for the firms to achieve above normal returns, which exceed the initial expectations or target goals. Likewise, utilization of in-house capabilities and resources is not sufficient to achieve above normal returns. This is why the competitive advantage of a firm is derived from recombination of its internal resources with external resources (Amit and Schoemaker, 1993; Sarasvathy, 2001). In this sense, R&D cooperation improves focal firm's internal technological capability by acquiring new technological resources from external partners. As a result, R&D cooperation provides opportunities for focal firms to achieve above normal returns, which go beyond their initial expectations and target goals.

According to the extended resources-based view, the sources of unintended innovation performance lie in a subset of shared resources and non-shared resources owned by each actor in R&D cooperation (Lavie, 2006) that are based on the willingness of participating firms to share or not to share their resources. On the one hand, when the intersection of shared resource sets between a focal firm and its partner in R&D cooperation is similar and substantial; both the actors pool their resources to achieve a greater scale and competitive position in their industry. The similarity in shared resources is increased when the R&D cooperation is formed with competitors. R&D cooperation between the firms with similar resources improve focal firms' efficiency-based performance (e.g. cost saving) which has its focus on "economies of sameness" (Larsson and Finkelstein, 1999; Bauer and Matzler, 2014). In fact, R&D cooperation with its emphasis on sharing of similar resources may offer both "appropriated relational rents" and "inbound spillover rents" for focal firms (Lavie, 2006; Gnyawali and Park, 2011). The former rents are intentionally and mutually transmitted between partners, since their related resources are shared via R&D cooperation. The latter rents are unilateral in nature, as they are acquired by focal firms' opportunistic behavior. Despite the fact that inbound spillover rents are derived from partners' both shared and non-shared resources, the rents are primarily derived from the acquisition of counterparts' resources that have not been intended for sharing. This is the reason why inbound spillover rents are usually associated with the competitors that collaborate strategically. Since both of the participating actors are likely to be confronted with similar set of problems in their end-product markets, R&D cooperation with the competitors results in lower levels of causal ambiguity and higher potentials of adoption that are derived from the utilization of similar resources (Ritala and Hurmelinna-Laukkanen, 2009). Furthermore, when the participating actors possess adequate industry-specific common knowledge, the focal firm not only improves their knowledge sharing activities for common benefit resulting in appropriated relational rents (Grant and Baden-Fuller, 2004; Cohen and Levinthal, 1990), but also absorbs counterpart's core capability through the windows of intended opportunities or unintended opportunities. Likewise, since cooperation grants focal firms to gain access to the shared resources of its partners, the leakage of knowledge associated with such resources from counterparts is inevitable. When a focal firm holds latent objectives to target the core assets of its partner, the focal firm exploits the cooperation for its private benefits with its opportunistic strategic action called "Trojan Horses" (Hennart et al., 1999; Kale et al., 2000). Thus, when similar resources are sought by the focal firms in R&D cooperation, common

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