2 FOSTERING R&D COLLABORATION – THE INTERPLAY OF TRUST, APPROPRIABILITY AND ABSORPTIVE CAPACITY

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Value creation in the present day markets demands new kind of managerial logic. One manifestation of this can be seen in relation to R&D collaboration: while importance of external knowledge and networks of relationships is undoubtedly increasing as a source of competitive advantage, collaborations still frequently fail. In order to avoid this, companies need to find ways to manage factors that have an effect not only on the outcomes of collaboration but on each other as well. Such important factors include trusting relationships, creating security through means such as contracts and intellectual property rights, and capabilities to absorb relevant knowledge. In this study we will examine these factors and their roles for R&D collaboration among 299 Finnish companies. Our results suggest that these factors are intertwined and that they are closely related to willingness to engage into R&D collaboration and the final outcomes.

1 INTRODUCTION

Due to various changes in the operating environment of companies, value creation in the present day markets demands new kind of managerial logic. One manifestation of this is related to operating in networks and collaboration: while importance of external knowledge and networks of relationships is undoubtedly increasing as a source of competitive advantage, collaborations still frequently fail (e.g., Heimeriks 2002). The difficulties that the parties face in getting what they seek from collaboration are caused by various issues and absence of essential success factors. Several studies cite the critical factors such as clear ground rules, communication and trust (e.g., Hoffmann et al. 2001, Mohr and Spekman 1994, Forrest and Martin 1992), which may be difficult to establish and maintain. Nature of knowledge and its role in R&D collaboration is also very special and may cause challenges. The more dense and connected networks, technologies and communications facilitate the diffusion of knowledge, thus improving the accessibility of knowledge and creating ground for learning. However, it is very difficult for collaborating parties to identify and control which type of knowledge should flow between the parties for increased collaboration performance, and which should be restricted to protect own core capabilities. Especially codified knowledge (or information) can be captured and copied relatively cost-efficiently by competitors (Nelson 1959), which easily creates an appropriability problem: the failure of an innovating firm to capture profits from its innovations (e.g., Arrow 1962, Winter 2006). Consequently, companies somehow need to be able to manage simultaneous knowledge protection and knowledge sharing so that the benefits sought from collaboration and networking are achieved.

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In this study knowledge sharing and protection is first discussed in the context of collaborative innovation, and especially R&D collaboration. Next, the dilemma of knowledge protection and sharing is considered through examination of absorptive capacity, appropriability issues, and trust. These issues are selected because of their relevant roles for R&D collaboration intensity, which surely is important considering collaborative innovation in more general, and their interactions. Section four presents the empirical evidence drawn from a dataset collected from 299 Finnish companies, and the final section summarizes the findings.

2 R&D COLLABORATION

Nowadays success in creating competitive advantage through innovation activities depends to a large extent on the effectiveness with which the firm can obtain, create, and transfer knowledge both within the firm and beyond its boundaries (Chesbrough 2003, Tyler 2001, Miles et al. 2005). R&D collaboration enables sharing the risks & costs and access to complementary resources and capabilities (Stuart 2000, Blomqvist 2002). Consequently, inter-organizational collaboration is becoming increasingly important (e.g., Jarillo 1988, Dyer and Singh 1998, Gulati et al. 2000, Ireland et al. 2002) and especially R&D collaboration can notably improve the innovation performance of the firms engaged in such activities.

Managing R&D collaboration requires various capabilities from managers, however. *Collaboration capability* is one of the most important ones. It has been defined as the firm's ability to build and manage relationships based on mutual trust, communication and commitment, and it has been argued to be critical for knowledge creation and R&D collaboration (Blomqvist and Levy 2006). Further, such a capability is needed in varying circumstances: The firm's *ability to leverage knowledge and resources from various actors* is critical for R&D collaboration as well – especially in contemporary and increasingly complex R&D environment where knowledge is dispersed (Tsoukas, 1996). The higher the variety in external relationships is, the higher the potential for getting access to relevant knowledge. In relation to variety, it is not only the quantity of relationships that is important, but also their quality: In addition to the volume of knowledge flows, also diversity of knowledge is central. Therefore, in this research we propose that a firm's ability to build relationships with asymmetric actors (firms of different sizes and with different competences, capabilities, power and cultures, for example; see Blomqvist 2002) is relevant for its R&D collaboration activities. Indeed, firms are seen to learn through partnerships, and those companies with experience with more various types of partnerships may perform better (Kale et al. 2002).

Summarizing the above discussion, we hypothesize that there is a relationship between the firm's R&D collaboration intensity and innovation performance:

H1: R&D collaboration intensity of a firm is positively related to its innovation performance.

3 SHARING AND PROTECTING KNOWLEDGE

Despite all the potential that R&D collaboration holds, collaborations frequently fail, which suggests that managing collaborative activities entails challenging areas. In order to be able to capture benefits from networking and cooperative activities, companies need to find ways to manage many dilemmas. One of them is the paradox

of knowledge protection and knowledge sharing. The potential of competitors to capture essential knowledge of a firm and the possibilities of a company to prevent it have an effect on the profit margins and incentives to invest in innovation (van Dijk 2000), which highlights the need to keep knowledge secret and proprietary. Similar needs may be present in R&D collaboration as well, in particular if the risk of opportunism emerges. In fact, prior research has shown that many firms that operate in collaboration with other organizations are worried about knowledge spillovers between the participants (e.g., Baughn et al. 1997, Norman 2002, Helm and Kloyer 2004). These concerns influence many things starting from the firms' propensity to engage in collaborative arrangements: in decision-making related to collaborative activities the benefits that can be captured from incoming knowledge seem to be outweighed by the ability of a firm to prevent out-bound knowledge spillovers (Bönte and Keilbach 2005). On the other hand, knowledge sharing is inherently needed for value creation in R&D collaboration (see also Miles et al. 2005; Blomqvist and Levy 2006).

One approach to dealing with this paradox is examining the interplay of trust, appropriability regime (i.e., the means to protect innovations and intangibles and their profitability), and absorptive capacity of firms and their partners.

3.1 Potential for knowledge flows – absorptive capacity

Being able to avoid the appropriability problem – or at least to diminish its effects – depends on both the firm's internal and external factors. The ability of imitating companies to extract information about the innovation and exploit it so that the relative advantage of the innovator is notably reduced is fundamentally determined by the combined effect of the ability of a firm to prevent imitation, and the absorptive capacity of other firms. (This combination is also called as expropriability; Willman 1992, Heiman and Nickerson 2004).

Cohen and Levinthal (1990, p. 128) define the firm's absorptive capacity as "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends." In R&D collaboration absorptive capacity is needed in order to obtain, incorporate, transform and exploit knowledge (see Zahra and George 2002) so that the collaborating organizations can create new products and services, or new intangibles. Therefore, we hypothesize that the scope of R&D collaboration with various partners and the volume of knowledge flows in such activities are related to absorptive capacity:

H2: Company's absorptive capacity is positively related to the R&D collaboration intensity of the firm.

3.2 Appropriability regime of a firm

The problem with competitors' capabilities is that a firm cannot really have a bearing on them as such. Thus, as noted above, one potentially efficient way to approach the appropriability problem is to pay closer attention to building barriers against imitation, i.e., to take notice of the formation of the firm's appropriability regime; the combination of available and effective means of protecting intangibles and innovations, their profitability, and the increased rents due to R&D.

Companies can benefit from having a strong appropriability regime considering that "a real possibility is that the value created by the collaboration from transferring

knowledge may be eclipsed by the value of the knowledge expropriated" (Heiman and Nickerson 2004, p. 402). Utilizing a range of mechanisms makes it possible for innovators to earn (temporary) monopoly rents and other quasi rents. Such appropriability mechanisms include the tacit nature of knowledge, lead time, human resource management, practical and technical means of concealment, and institutional protection consisting of intellectual property rights (IPRs such as patents, copyright, and trade secrets), contracts and labor legislation (see, e.g., Hurmelinna-Laukkanen and Puumalainen, 2007, for references). These mechanisms can be utilized effectively in managing knowledge protection. However, while preventing knowledge flows may be essential in some situations, in others, such as in R&D collaboration, loosening or giving up protection and sharing knowledge generates more value (see Pisano 2006). Therefore, the appropriability strategy of a firm needs to be build so that protection will not be overly emphasized (it may not be even needed if other's absorptive capacity is weak) and so that the appropriability mechanisms actually foster knowledge sharing when it is needed.

The appropriability regime can have an important role in relation to collaboration. Previous research indicates that when a firm is able to protect its knowledge, it more willingly engages in collaboration (Kuivalainen et al. 2003). Using contracts, for instance, enables companies to "minimize their external dependencies and protect themselves against opportunism" (Yli-Renko et al. 2001, 530), which provides a safer starting point for companies. Subsequently, we can formulate the following hypothesis:

H3: The strength of the firm's appropriability regime is positively related to its R&D collaboration intensity.

3.3 Trusting relationships

Despite the companies' efforts to protect themselves, knowledge leakages are bound to happen, and other firms are going to be able to absorb such knowledge, at least to an extent. Therefore, there is an inherent risk related to R&D collaboration. In such a situation trust and trusting relationships become essential. In a modern society trust may be increasingly important for actors to be able to make decisions and act. A comprehensive, consistent, transparent, integrated and legitimated institutional system has been seen to provide stability and predictability which makes trust relationships easier (Deakin et al., 1997 referred in Möllering 2006, 149).

Trust may not evolve without a trusting behaviour, open communication and some type of risk taking. An actor's willingness to trust may be related to perceived risk, his/her ability and willingness to risk-taking as well as the perception of the other party's trustworthiness (Blomqvist 2005). Trust can be seen as a social governance mechanism complementing, or even substituting legal governance (Blomqvist et al. 2005). Trust has a critical role in R&D collaboration, as it can increase the effectiveness and efficiency of collaboration through enhanced coordination, communication and commitment. Trust may enhance shared norms and knowledge protection through mutual interest for continuous cooperation.

Based on this, we hypothesize that trusting relationships are relevant considering firm's orientation towards R&D collaboration:

H4: Trust is positively related to the R&D collaboration intensity.

4 EMPIRICAL EVIDENCE

4.1 Sample and data collection

The hypotheses were tested using a data set drawn from a survey conducted in Finland in 2004. The data were collected by means of a structured questionnaire, using the key-informant technique. The initial population comprised Finnish companies from eight industrial sectors engaged in R&D. The sample used consisted of firms operating in different industrial sectors, which provides a fair degree of generalizability. All firms with at least 50 employees from selected industry sectors were included in the sample frame. A total of 1,140 firms were identified from the Blue Book Database, and 881 of them were found to be eligible. Of these firms, 200 refused to participate. The pretested survey questionnaire with an introductory letter was mailed to the 681 remaining companies, followed by a reminder e-mail. We received responses from 299 companies, representing a satisfactory effective response rate of 33.9% (299/881). Non-response bias was checked on a number of variables by following the suggestions of Armstrong and Overton (1977), and did not appear to present a problem.

4.2 Measures

Following the Oslo manual (1997), *innovation performance* was measured as the share of sales from new or substantially improved products that were launched during the past three years (percentage of total sales).

The measure for evaluating the *R&D collaboration intensity* was composed as a mean of 8 likert-scaled (1-5) items illustrating how much the firm conducted R&D activities with suppliers, customers, universities and competitors, and the volume of knowledge flows in joint R&D with other organizations and the firm. The composite measure showed a good reliability with Cronbach alpha value[1] at .73.

Absorptive capacity was measured as a combination of 4 items. Two of them described the extent to which companies gathered and exploited knowledge in terms of actively observing, adopting and exploiting the best practices in the firm's own industry and in other industries respectively, and two assessed how soon the firms became aware of other's R&D activities (alpha =.64)[2].

The perceived strength of *appropriability regime* in protecting innovation was assessed on the following question: "How significant have the following mechanisms been during the past three years in protecting product innovations from imitation by (potential) competitors?" A list of 17 different mechanisms followed, and the respondents rated the significance of each one on a five-point scale (1 = slightly significant, 5 = very significant). The Cronbach alpha value was .87.

Trust measure was composed as a mean of 4 Likert-scaled items describing the the importance of trust building for performance, ability to build fast trust, and the

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[1] Cronbach's alpha is an index of reliability associated with the variation accounted for by the true score of the "underlying construct". The higher the score, the more reliable the generated scale is. The value of 0.6 has been seen as an acceptable reliability coefficient.

[2] This measure was preferred since R&D intensity, which often is seen as sign of absorptive capacity (see, e.g., Tu et al. 2006, Cohen and Levinthal 1990), does not seem to be suitable indicator in every industry (e.g., Palmberg 2002).

role of trusting relationships as a factor diminishing harmful imitation of products and processes of a firm (alpha =.66).

4.3 Analysis and results

A correlation matrix was computed in order to identify the hypothesized relationships between the R&D collaboration intensity, Innovation performance, absorptive capacity, appropriability regime, and trust (see Table 1).

Table 1. Correlation matrix

Variable	*Mean (SD)*	*1*	*2*	*3*	*4*	*5*
1. Innovation performance#	23.78 (21.23)	1.00				
2. R&D coll. intensity	1.97 (0.59)	.183**	1.00			
3. absorptive capacity	3,91 (0.96)	.061	.164**	1.00		
4. Appropriability regime	2.43 (0.69)	.246**	.313**	.117	1.00	
5. Trust	3.80 (0.69)	.029	.230**	.182**	.365**	1.00

**=sig. < .01, *=sig. < .05, a =sig. < .10 (n = 299), # Logarithmic transformation

The relationship between the R&D collaboration intensity and innovation performance was the focus of the first hypothesis, H1. The results indicate a significant positive relationship between the variables. Therefore, support can be found for hypothesis 1.

We also found a direct positive association between the absorptive capacity and R&D collaboration intensity. Hence, our hypothesis 2 is supported. Similarly, the strength of the appropriability regime and the R&D collaboration intensity are positively related, supporting hypothesis 3. Finally, the correlation between trust and R&D collaboration intensity is positive and significant, providing support for our hypothesis 4.

5 DISCUSSION AND CONCLUSIONS

This study examined factors that foster R&D collaboration. We considered, in particular, the roles of trust, absorptive capacity and appropriability regime. Theoretical consideration suggests that they all are important factors behind the readiness and ability of companies to engage into R&D collaboration. In our empirical analysis we found that the more companies are able to protect their know-how and the more they can trust on their partners, the more willing they are to engage into R&D collaboration and to share knowledge through such activities (H3 and H4). Similarly, also the absorptive capacity is positively related to R&D collaboration (H2 was supported).

Considering, in particular, that R&D intensity is positively related to innovation performance, managers should pay special attention to the linkages of absorptive capacity, trust and appropriability regime. For instance, it seems that when trust resides in a relationship, knowledge can flow more freely, which may improve the absorptive capacity of participating firms. These interactions can be very relevant. In terms of consequences for R&D collaboration, for example, breaching a trusting relationship may be more costly than breaching a contract, infringing IPRs, or violating some other form of protection. On the other hand, abusing the partner's rights also damages trust. Thus, acknowledging the different elements is needed.

There are some limitations related to this study. Considering the empirical part, the measures used may not be fully optimal. Adding more variables might reveal various relationships that are now left out. In further research an in-depth analysis of the interplay of the key variables in inter-organizational relationships would also be valuable. The processes how firms balance contracts, intellectual property rights and trust, for example, could improve understanding of governance and outcomes of collaborative innovation. However, this study provides one point of view on the topic of R&D collaboration, and it certainly offers a point of departure for future studies.

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