

Collaboration for Innovation: A Longitudinal Case Study on How Social Capital Mitigates Collaboration Challenges in University-Industry Research Alliances

Abstract

Universities and public research organizations (PROs) are valuable sources of knowledge on innovation development for firms. Differences in goals and approaches between firms and PROs often create tension and lead to challenges that prevent achieving fruitful collaboration. This paper explores how the development of cognitive and relational social capital can mitigate such challenges and encourage fruitful collaboration between firms and PROs in research alliances over time and further lead to the development of innovations. By comparing three firms participating in a well-established research alliance with three firms participating in an emerging one, the development of both cognitive and relational social capital at the individual, organizational and alliance level is shown to be crucial for effective collaboration in research alliances over time. Common goals and understandings regarding the collaboration and the creation of personal relationships between the employees of firms and PROs contribute to mitigating collaborative challenges, to cohesion and to the achievement of goals to create innovation. Moreover, the presence of at least one of the dimensions of social capital appears to be necessary when entering a research alliance for the first time because cognitive and relational social capital are found to be mutually reinforced over time.

Key words: University-industry collaboration, tension, social capital, research alliances

1.0 Introduction

Universities and public research organizations (PROs) are important knowledge sources through which firms access new ideas and the knowledge resources required for investments in innovation development. PROs provide firms with knowledge and technological resources that contribute relevant expertise to enrich and expand a firm's technological resource base, which is important for innovation development (Dahlander and Gann, 2010). Although many firms recognize the importance of collaborating with PROs in innovation development, they are often reluctant to use these external knowledge sources because they find it challenging to achieve effective collaboration, as both firms and PROs must compromise their interests in the pursuit of collaboration. Firms and PROs can have conflicting goals in terms of organizational structure, management, goals and approaches to problems, which make collaboration between academic and commercial activities challenging and give rise to tension (Ambos et al., 2008).

A primary tension between firms and PROs when conducting typical R&D collaboration is that private firms are often driven toward short-term innovation outcomes to provide advantages to their customers, whereas researchers are primarily driven toward long-term outcomes and publication reputation in the international arena (Becker and Trowler, 1989). Firms in general tend to rank PROs relatively low as sources of innovation. However, firms that collaborate with PROs are much more innovative than firms without links to PROs (Howells et al., 2012). To realize the potential of PRO collaboration, greater knowledge is necessary concerning how firms can develop and sustain a fruitful collaboration in which the collaborative partners are able to learn from one another and develop innovations (Spithoven et al., 2011, Zahra and George, 2002, Inkpen and Tsang, 2005). Various dimensions of social capital are crucial for successful collaborations between firms and PROs. This paper develops a theory on how firms and PROs manage fruitful collaborations in which tensions are mitigated and knowledge is enhanced in research alliances relying

on two dimensions of social capital: cognitive and relational social capital. Cognitive social capital concerns the value of shared goals and a common understanding among collaborative partners, and relational social capital concerns the value of personal relations and trust; both lead to the achievement of effective collaboration (Nahapiet and Ghoshal, 1998, Adler and Kwon, 2002). The previous literature has primarily contributed by addressing the formal structures of social capital, whereas this study investigates the content of social capital and its interrelations, which are rarely investigated (Lee, 2009, Rass et al., 2013, Inkpen and Tsang, 2005).

Recently, studies have called for in-depth, longitudinal research on university-industry collaboration in research alliances (Lind et al., 2013, Smith, 2012). This paper contributes to the literature on university-industry collaboration by exploring how firms and PROs are able to achieve fruitful collaboration in research alliances over time, in the sense that the partners are able to create knowledge and innovation, by specifically exploring the role of relational and cognitive social capital. This study explores the following research question: *“How can firms develop cognitive and relational social capital in their relationship with PROs to mitigate tensions and build fruitful collaboration in research alliances over time?”*

To explore the research question, a longitudinal case study of six firms is conducted. Three of the firms participate in a well-established research alliance in which the collaborating firms and PROs are able to work well together. Notably, they have achieved goal alignment, and several innovation outcomes have developed. The other three firms participate in an emerging research alliance and struggle to create innovations and achieve common goals, and they lack mutual understanding of one another’s interests. The selected research alliances have different backgrounds but are similar in the sense that both have received public support and are pursuing environmental improvements to solve specific industry challenges. Interviews are conducted with several firms within each alliance, but for this study, the most heavily engaged firms within each alliance are selected as cases. Previous research on social

capital is typically conducted at a single level of analysis (Adler and Kwon, 2002) that focuses on individuals (Burt, 1992), organizations (Tsai, 2002), communities or nations (Putnam, 1993). The outcomes of collaboration within research alliances are likely influenced by social capital at three levels: individual, organizational and alliance. This paper explores the individual, organizational and alliance levels of analysis to fully understand the role of social capital in university-industry collaboration, as called for by several authors (Payne et al., 2011, Hitt et al., 2007).

This paper extends prior research on the use of external knowledge. Through a longitudinal study of firms within two research alliances in different phases of development, I find that the development of cognitive and relational social capital is clearly important for the achievement of effective collaboration between firms and PROs in research alliances and that social capital requires time to develop. The findings also make important contributions related to the levels of analysis considered. Social capital dimensions should not be regarded as characteristics of an individual organization but rather as capabilities developed over time in relationships between individuals and organizations. Firms should address the importance of developing both cognitive and relational social capital in their relationships with PROs at an individual, organizational and alliance level to create robust collaboration and reduce the vulnerability from having only individual social capital. Moreover, this study contributes to a better understanding of the interplay among the dimensions of social capital. Cognitive social capital leverages relational social capital because it is easier to create personal relationships between firms and PROs when they agree on the collaborative fundamentals. Conversely, relational social capital plays a role in developing cognitive social capital for firms that lack a common understanding and shared goals with collaborating PROs.

These findings have important implications for firms collaborating with PROs, illustrating that at least one social capital dimension should be developed when entering a new collaboration to allow for the development of the other dimension.

This paper is organized as follows. Section 2 presents the theoretical framework. Section 3 describes the methodological approach. Section 4 presents the findings and propositions. Finally, Section 5 contains conclusions and offers implications for future research and practice.

2.0 Theoretical framework

2.1 Collaboration between firms and PROs in research alliances

Although collaboration is important for learning and innovation, many firms face significant challenges when collaborating with PROs. These challenges are primarily rooted in tensions between firms and PROs, which can be defined as “*two co-existing contradictory forces with conflicting goals*” (Fang et al., 2011p. 774). A common tension between firms and PROs concerns dissimilarities between academic and commercial activities (Ambos et al., 2008). PROs perform fundamental research, whereas commercial firms address the cost activities of innovation, which makes firms more oriented toward the short-term and applied research that provides solutions to problems, whereas PROs are more long-term oriented (Spithoven et al., 2011, Perkmann et al., 2011). Moreover, different routines and cultures and a lack of trust between firms and PROs are factors that make university-industry collaboration challenging (Smith, 2012).

A large, primarily quantitative body of literature has contributed insights into the factors that determine firms’ ability to source external knowledge from R&D alliances and the consequences of such knowledge sourcing on firms’ innovative and economic performance. However, few studies examine how firms can actually benefit from external knowledge sourcing, especially when the dissimilarity between a focal firm and its PRO alliance partner is high. In such a case, qualitative research can provide a deeper understanding of the collaborative process (Smith, 2012). Certain firms are able to overcome this type of challenge and recognize, assimilate, and apply

novel information from dissimilar actors. This dilemma is likely to be particularly prominent in relationships between industrial firms and PROs, in which dissimilarity can be regarded as substantial due to the tension between academic and commercial activities (Ambos et al., 2008). Collaborative tensions and barriers between firms and PROs have been acknowledged in the literature; however, it is necessary to better understand the factors that mitigate or reduce these barriers over time (Bruneel et al., 2010). It is likely that further knowledge concerning how firms and PROs can mitigate collaborative challenges will contribute important implications for how collaborative firms and PRO partners can benefit more from university-industry collaboration and thereby increase their ability to create innovation capabilities. As university-industry collaboration concerns relationships between individuals and recent research has highlighted a need to examine personal relationships in collaborative performance (Bozeman et al., 2013), this paper relies on a theoretical concept useful for understanding social interaction between individuals: social capital (Nahapiet and Ghoshal, 1998). This study thus attempts to examine how the development of social capital between firms and PROs contributes to mitigating collaborative tensions and thereby enhances collaborative and innovative performance in research alliances.

2.2 Social capital

Social capital can be defined as *“the aggregate of resources embedded within, available through, and derived from the network of relationships possessed by an individual or organisation”* (Inkpen and Tsang, 2005, p. 151). Social capital is important for university-industry collaboration because it facilitates interaction and trust between collaborative partners (Inkpen and Tsang, 2005) and knowledge acquisition (Parra-Requena et al., 2013). Social capital can be regarded from a bridging perspective or a bonding perspective. The bonding view of social capital

focuses on the internal characteristics of collective actors; the border can reflect organizations, communities or nations. The bridging view, upon which this paper builds, relates to social capital as a means of enhancing network ties with external relations (Adler and Kwon, 2002). This study follows the *content* of network ties and thus the dimensions of cognitive and relational social capital (Nahapiet and Ghoshal, 1998).

2.2.1 Cognitive social capital

A mutual lack of understanding concerning working practices and expectations has been found to be a barrier to university-industry collaboration (Bruneel et al., 2010), and building *cognitive social capital* may be a way to overcome this challenge. Cognitive social capital refers to shared interpretations and systems of meanings (Cicourel, 1974), common language and codes (Monteverde, 1995), and shared narratives (Orr, 1990) among parties. When organizations have shared visions and systems, it is easier to learn from one another (Hult et al., 2004). Cognitive social capital has been divided into two categories: shared goals and shared culture (Adler and Kwon, 2002). Shared goals refer to a common understanding of and approach to network tasks (Inkpen and Tsang, 2005) and common perspectives on goals (Masiello et al., 2013). Previous research has demonstrated that successful collaboration between firms and PROs is closely associated with the parties possessing similar competencies and capabilities (Petruzzelli, 2011). Shared culture refers to rules and norms that determine appropriate behavior within the network. When the actors within a network have cultural links, this facilitates collaboration (Inkpen and Tsang, 2005). However, firms that are overly cognitively similar may reduce innovation in university-industry collaborations because there is an inverted U-shaped relationship between cognitive social capital and innovation in collaborative performance (Cowan et al., 2007).

2.2.2 Relational social capital

Relational social capital focuses on relational closeness and trust and refers to “*those assets created and leveraged through relationships*” (Nahapiet and Ghoshal, 1998). This term describes personal relationships formed through prior contacts (Granovetter, 1992) and concerns mutual respect and friendship, expectations and reputations (Adler and Kwon, 2002). Collaboration experience has been found to reduce barriers to university-industry collaboration (Hagedoorn and Schakenraad, 1994). Petruzzelli (2011) found that the existence of previous collaborations promotes trust between academic and industrial partners, illustrating the usefulness of building personal relationships when developing technologies. Relational social capital has been found to be the most important dimension of social capital as a driver of university-industry collaboration due to the effect of trust (Van Wijk et al., 2008). Because university-industry collaboration often involves collaboration between unknown partners and therefore involves a high degree of uncertainty (Bruneel et al., 2010), developing trust through personal relationships can reduce uncertainty among collaborative partners and increase their willingness to be open and share information and resources (Adler and Kwon, 2002, Tsai, 2000). Moreover, building trust with collaborative partners may reduce the risk of opportunistic behavior (Putnam, 1993). Conversely, (Yli-Renko et al., 2001) argue that when trust reaches a very high level, it can be detrimental to interorganizational collaboration. Actors experience a decreased need for control as conflicts and information decrease, which may diminish the creation of new knowledge (Masiello et al., 2013).

In summary, tensions in university-industry collaboration may be harmful to the successful collaboration of firms and PROs in research alliances and prevent innovative outcomes. This paper explores how different dimensions of social capital can mitigate challenges between firms and PROs and increase innovative performance in research alliances, relying on a longitudinal case study of six case firms representing two contrasting research alliances.

3.0 Methodology

3.1 Research design

A longitudinal case-study design is employed to develop theory on how firms and PROs collaborate in research alliances and how social capital dimensions develop over time to enhance fruitful collaboration (Yin, 2009). A multiple-case study is conducted to develop relevant theory as an extension of an existing theoretical framework (Yin, 2009).

3.2 Case selection

The research question was examined using data collected from two research alliances in Norway: one well-established research alliance (Alliance 1) and one emerging research alliance (Alliance 2). To understand how the collaborative process evolves in the research alliances, I drew on insights from six firm cases: three in each alliance. The research alliances were selected from a population of research centers that received public support and had objectives related to creating environmental innovation in collaboration with firms and PROs as illustrated in Table 1.

Table 1

Characteristics of the research alliances

	Objective	Participants	Funding	Establishment
Well-established research alliance (1)	To pursue environmental improvements and to increase the technological qualifications of industry employees.	All firms within the business sector and their external R&D partners as participants and hosts for each project.	Research grants from The Research Council of Norway (30%-50%) and participation fees from member companies.	Established by the industry in 1989.
Emerging research alliance (2)	To conduct high-level, long-term international research to solve specific challenges in the energy industry and identify new, innovative solutions.	A university, university college or research organization hosts each project that includes firm partners that cover large parts of each branch's value chain; occasionally, other research organizations participate.	Research grants from The Research Council of Norway and financing from the member companies and research partners.	Established by research organizations in 2009.

The two research alliances were selected based on theoretical codes (Eisenhardt, 1989) and research suggesting university-industry collaboration as a driver of innovation (Dahlander and Gann, 2010). Both research alliances supported firms that sought to innovate through long-term research and development activity in research alliances with PROs. Although there were differences related to their establishment (Table 1), the research alliances had comparable interaction processes between firms and PROs, which are explored by this paper.

As a first step in selecting the cases, I conducted initial interviews with some of the hosts, beginning with prior personal contacts in both alliances (Yin, 2009). This approach was used to collect information on the research alliances, receive advice on relevant firms and research partners to contact, and obtain assistance related to the subjects that were addressed in the interviews.

3.3 Data collection

Annual reports and secondary data pertaining to both of the studied research alliances, such as evaluation reports, were collected and read in preparation for the interviews to allow the design of effective questions before commencing the interview process (Yin, 2009). Table 2 illustrates the informants interviewed.

Table 2

Informants interviewed (number of interviews in parentheses)

	Well-established research alliance (1)				Emerging research alliance (2)			
	Firm 1	Firm 2	Firm 3	PROs and others	Firm 4	Firm 5	Firm 6	PROs and others
Informants (2011)	CEO (1) Policy manager (1)	CEO (2) Researcher (2)	Researcher (2)	2 other firms: CEO (3), Engineering (1), Firm researchers (2) 4 PROs (4) 1 Industry Federation (1)	R&D manager (1)	CEO (1)	Technology manager (1)	1 other firm (1) 8 PROs (8) 2 interest organizations (2)
Informants (2013-2014)	CEO (1)	Researcher (1)	CEO (1) Researcher (1)	2 other firms: CEO (2), researcher (2) 2 PROs (2)	R&D manager (1)	CEO (1)	Technology manager (1)	1 other firm (1) 8 PROs (8) 1 interest organization (1)
Total	3	4	4	17	2	2	2	21
Secondary sources	Firm presentation Press articles	Firm presentation Press articles	Firm presentation Press articles	Firm presentation Press articles	Annual reports Evaluation reports	Annual reports Evaluation reports	Annual reports Evaluation reports	Annual reports Evaluation reports

*The total number of interviews is less than the sum of the persons interviewed because some interviews were conducted with multiple individuals.

A research team collected the data, and a minimum of 2 interviewers attended each interview. In research Alliance 1, we began by observing a seminar arranged by the research alliance, at which projects were presented and discussed. A total of 55 interviews were conducted (Table 2), of which 28 represented Alliance 1 and 27 represented Alliance 2. The interviews were conducted during two periods: in both alliances, the initial interviews were conducted in 2011, and additional interviews were conducted during the period September 2013 – February 2014.

The interviews were intended to obtain an in-depth understanding of how the innovation process and interaction among the collaborative partners unfolded in each

of the research alliances. The research team conducted semi-structured interviews to create a fluid rather than rigid interviewing situation (Rubin and Rubin, 2011). As an overall interview guide, we sought to understand the interaction among participants within the research alliances retrospectively, which is a viable methodology for understanding important events in a collaboration (Miller et al., 1997). We began in chronological order with the background on how the research alliances were initiated, and then we discussed project planning in terms of the rate of involvement and the expectations for the collaboration. Finally, we asked about the innovation outcome achieved. To obtain relevant information, we began the interviews by stating that we sought to understand the process of collaboration between firms and PROs within the research alliances. This approach prevented the informants from discussing technical issues beyond our understanding. Moreover, we did not refer to theoretical concepts. During the interviews, we added follow-up questions such as “Why did you do that?”, “Who was involved?” and “How did you experience that?” The questions were asked to motivate the interviewees to reflect on their experiences related to events that were mentioned during the interviews and to enrich our understanding of the unique process of interaction within the collaboration in every case. At least two researchers conducted each interview, and the interviews were recorded and transcribed as part of the data analysis process (Yin, 2009).

Insights from both the case firms and collaborative PROs within the research alliances are enhanced to obtain a better understanding of firms’ interaction processes, tensions and the development of social capital for facilitating fruitful and viable collaboration.

3.4 Data analysis

The analysis is based on a cross-case comparison with the aim of identifying cross-case patterns (Eisenhardt, 1989) through a search of theoretical dimensions

(Eisenhardt, 1989) using the data, including critical characteristics and events that influenced how social capital was identified and developed during firm-PRO collaboration. First, challenges related to the collaboration were mapped. Then, following Inkpen and Tsang (2005), a distinction was made between cognitive and relational social capital with respect to the beginning, the process and the end of the collaboration by considering how the different levels of social capital facilitated improved collaboration between the partners over time and assisted in overcoming collaboration challenges. The transcribed data were read and reread to identify similarities and differences among the cases. After the analysis, propositions were developed for quantitative testing in future research (Yin, 2009).

4.0 Results and discussion

First, the overall findings are presented in relation to the firms' involvement in and the experienced outcomes of the research alliances. Then, key findings are presented and propositions developed concerning why certain firms experience better collaboration with PROs by relying on the concept of social capital. The findings and discussion below integrate the case findings with the scholarly literature.

4.1 Firms' involvement in and outcomes of the research alliances

Table 3 outlines the 6 cases' involvement in the research alliances, the alliances' influence on working objectives and the outcomes firms experienced due to the alliance.

Table 3

Firms' involvement in, influence on and outcome experienced from collaboration in the research alliances

Research alliance	Involvement	Influence	Outcome
1 Firm 1 Medium size Single plant within the process industry	The firm is very involved in the research alliance. <i>"We have always been involved in the [collaboration] and have become even more involved in it".</i> <i>"The [Firm] is very involved in several of the projects".</i>	High level of influence. <i>"It has been a very good process...we have avoided conflicts about the project tasks because, I believe, the [PROs] are very pragmatic".</i>	The firm experienced an increase in knowledge because of the collaboration. <i>"The cooperation within the [collaboration] and between the [PROs and partners] is very good and has resulted in many important projects... from which we have gained important knowledge".</i> <i>"I have seen the value of participating in the [collaboration] and the value of the knowledge created in the [collaboration]. We have used it in our operations".</i>
Firm 2 Large size, part of a larger international corporation with three Norwegian production plants, process industry	The firm is very involved in the collaboration. <i>"We are very involved in the things that the [collaboration] works with".</i> <i>"We are opening up our production plant and will therefore gain more information".</i>	High level of influence. <i>"Yes, we have a great deal of influence in the alliance".</i> <i>"We are active in stating the premises for the objects that we should work on".</i> <i>"We clearly set the frame of conditions for the projects".</i>	The firm benefited from substantial outcomes from the collaboration and has implemented results based on the outcomes of the collaborative projects. <i>"You exchange knowledge and come up with new ideas that help the project, but in the long run, the firms receive benefits from the ideas".</i> <i>"It would have been difficult, if not impossible, to solve the problems with the answers that we have found together with the [PROs]".</i>
Firm 3 Large size, part of a larger international corporation with three Norwegian production plants, process industry	The firm is highly involved in all aspects of the projects in the collaboration. It initiates projects and works effectively within them. Over time, the firm has become even more engaged and has expended more resources to work on the collaborative projects.	High level of influence. <i>"We are more engaged in influencing the project topics to assure the relevance".</i> (Researcher) <i>"It is very important to be engaged in an early phase so that our interest is influential".</i>	The firm benefits from substantial outcomes from the collaboration and has implemented results based on the outcomes of the collaborative projects. <i>"We aim to be a world leader in our field, and thus, the collaboration with the [PROs] is very important".</i> <i>"If we are curious about the results of one of the R&D projects, we assemble an industrial project in which the aim is to implement the results".</i>
2 Firm 4 Small- sized division of a larger Norwegian corporation in the heating industry	Low involvement. <i>"We don't prioritize putting many resources into the [collaboration]".</i>	Low level of influence. PROs decide the working tasks. <i>"The initiative comes from the [PROs] and we do not receive much benefit from the output".</i>	Experience limited outcomes from the research alliance. <i>"We do not have much benefit from the output".</i>
Firm 5 Medium-sized firm in the energy-recycling industry	Low involvement at the beginning of collaboration. <i>"We didn't have the time or the resources to be very involved in the [collaboration]".</i> Increased involvement during the collaboration. <i>"We have understood that we have to engage more in the [collaboration], demanding and attempting to formulate the strategies".</i>	Low level of influence. PROs decide the working tasks. <i>"The initiative mostly comes from the PROs)".</i> After collaborating for some time, the PROs stated that they wanted the firms to influence the research tasks.	The firm expected more results at the beginning of the collaboration. <i>"We had inappropriate expectations when we entered the collaboration. We don't get direct results, but a direction and some interesting things that we can further develop".</i>

Firm 6 Small-sized firm in the bio-energy industry	Low involvement at the beginning of the collaboration. Did not prioritize the time and resources of the collaboration. Gradually, the firm became more involved as it understood that the outcome had the potential to improve. <i>"I could have been more involved in the [collaboration], but I am not sure how much input they wanted from me... it is a possibility, but in that case, it is something I have overlooked in all of my daily tasks".</i>	Low level of influence at the beginning. After some time, they required more from the PROs. <i>"Actually, we should have been positioned to have influence... I remember I asked the [collaborative PROs] to work on a special task relevant to us. They answered that it was interesting but that it needed to be considered the following year. But that was never done".</i>	Low level of output experienced at the beginning of the collaboration. <i>"We had high expectations for the [collaboration] from the beginning. It took a long time before the work within the [collaboration] started, and we were very frustrated. It [the collaboration] didn't go very well".</i> Over time, the firm understood that it needed to become more involved to obtain benefits. <i>"We are not 'baby birds' sitting with open throats waiting to be fed by the [PROs]. Actually, we have to do something to achieve the benefit of the [collaboration]"</i> .
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*EU measures of firm sizes are used: large > 250 employees; medium 50-250 employees; and small <50.

A clear distinction is observed between the two groups of case firms related to the involvement and the level of output that they experienced from the PRO collaboration. The firms within Alliance 1 are highly involved in the collaboration with the PROs and stated that they had experienced a high-level outcome: *"We wouldn't have increased our knowledge so much if it had not been for the collaboration"*. Several of these firms also stated that collaboration is essential to developing the industry's overall knowledge base: *"If we look back to the knowledge achieved over the last 15 years, it is obvious that it comes from the collaboration"*. The Alliance 1 firms are able to implement innovations using knowledge achieved from the alliance. The firms within Alliance 2 do not experience a high rate of output from the PRO collaboration because it does not provide them with the desired rate of innovation: *"One always get new ideas from meetings that keep us "awake", but there is very little focus on our core activities"*.

The Alliance 2 firms are not highly involved in the research alliance and do not prioritize alliance meetings: *"They don't show up, they don't prioritize taking a day to come and discuss things with us and the other partners"*. Some of the Alliance 2 firms connect the low level of output with the low level of involvement in the collaboration: *"What we gain from it [the collaboration] relies on our own contribution. If we*

manage to structure our time in such a way that some of it contains the work with [the collaboration], we may gain much more out of it”.

To better understand why the firms within Alliance 1 experience better innovation outcomes and are more involved in the alliance than the firms within Alliance 2, the concept of social capital is explored.

4. 2 How firms collaborate in research alliances

How the case firms collaborate with PROs in the research alliances is explored through the development of cognitive and relational social capital over time. Table 4 summarizes the firms’ cognitive and relational social capital in their relationship with the collaborative PROs.

Table 4

The firms' cognitive and relational social capital

Research alliance	Cognitive social capital	Relational social capital
1 Firm 1	<p>The firm began with a different understanding of the PROs but achieved a better understanding, and the firm developed shared goals with the PROs over time. <i>"There have been very good communication and teamwork from the beginning"</i>.</p> <p><i>"The cooperation with them [the PROs] has worked very well, and good projects and clarifications have come out of it"</i>.</p>	<p>Firm employees and some of the collaborative PROs were previously acquainted, and over time, they have become familiar the PROs. <i>"We know the [PROs] very well"</i>.</p> <p><i>"Compared to other research partners and collaborations with people we do not know or have not worked with before, this collaboration functions very well"</i>.</p>
Firm 2	<p>There was a common understanding and shared goals with the collaborative PROs. <i>"It is not complicated to talk with the researchers. We understand each other. Of course, there are some very specialized people, but they are not the ones who we meet"</i>.</p> <p><i>"We have a common goal and are clear on what to examine... All of us are moving in the same direction and set the conditions for the collaboration"</i>.</p>	<p>The firm and the collaborative PROs know one another very well. <i>"We are like a family"</i>.</p> <p><i>"Acquaintances are important, as is having personal relationships to rely on"</i>.</p> <p><i>"We have close contact with them [i.e., the PROs]"</i>.</p>
Firm 3	<p>There are common understanding and good communication within the collaborative PROs. Occasionally, goals are mismatched, but that problem is solved through good communication. <i>"We have to be very clear at an early stage about what we want to achieve with the [PROs] to reduce the risk of letting the researchers work on things that they find interesting but that may not be interesting to us. If the working premises are based on their [the PROs'] manner, it is not good for any of us"</i>.</p> <p><i>"Usually, we have the same goals as the [PROs] with respect to the development of the industry, but sometimes we have different long-term goals and strategies to reach those goals. It depends on close interaction with the industry, and we work on projects in accordance with the industry"</i>.</p>	<p>The firm and the collaborative PROs know one another very well.</p> <p><i>"We have become closer and more able to communicate in a general way"</i>.</p> <p><i>"We know each other [i.e., the PROs] very well, and that makes the collaboration easy"</i>.</p> <p><i>"When we need specialized research, we have people who know about our industry and about our challenges"</i></p>
2 Firm 4	<p>The firm and PRO partners have different goals.</p>	<p>The firm and the PROs are acquainted.</p>

"The [PROs] are working to finish publications. That is good because it builds competence, but there is too little industry contact".

"I know them [the PROs] very well and know how the [PRO] system functions. I have been working there for 15 years".

*"There is a gap between our goals".
"I have an understanding of the [PROs]' goal, but I am not sure that they understand our goals... The [PROs] have lost contact with the industry".*

"There should have been closer contact between the firms and the [PROs] within the [research center]".

Over time and after feedback from the industry, the PROs have become more involved in engaging the firms in the collaboration. *"They [the PROs] have become much more proactive in involving the industry partners".*

Firm 5 There are different understandings and poor communication at the beginning of the collaboration. After feedback from the firm, the PROs have improved: *"We have pushed the [PROs] to be more concise when presenting, something that they have improved by becoming more 'to the point'".*

The firm and the PROs are acquainted. *"The trust has always been there; we are used to working with PROs, and they are used to working with us".*

"We have had previous projects with them [the PROs]".

"The challenge has been poor communication between us and the [PROs]".

"Understanding has become better during the collaboration".

Firm 6 The firms and PROs have had different goals since the beginning of the collaboration. The firms expected the PROs to be engaged in what the firm wanted to develop, but the PROs were disengaged.

Some within the firm and the PROs are acquainted. Several of the firm representatives in the collaboration were previously employees of the primary collaborative PRO.

"I don't believe that they don't want to have the same goals as us. It is all about their ability to complete things. That is the case for us, too. It is about time".

4.2.1 Cognitive social capital

When mapping the firms' cognitive social capital in their relationships with partner PROs, a clear distinction between the firms in alliances 1 and 2 was observed. First, when examining shared goals (Adler and Kwon, 2002), all of the firms within Alliance 2 experienced tensions, as they and the collaborative PROs had different goals. The

PROs primarily focused on publishing, whereas the firms were driven toward short-term value and innovative outcomes (Becker and Trowler, 1989). The tension between the collaborative partners was frustrating for many of the Alliance 2 firms' participants: *"I think there is very little focus on product development in [the collaboration]. They focus on research for the sake of research. The focus should have been much more commercially oriented and rooted in the industry"*. This example illustrates a lack of common fundamental goals for and a lack of a common understanding of the collaboration within Alliance 2. Although the PROs primarily focus on research and publishing, some of them are conscious of their lack of industry focus: *"Many of the firms have concepts that are not very interesting to the researchers. They are interested in products that they can sell and from which they can earn money"*.

Like the Alliance 2 firms, the Alliance 1 firms are concerned with short-term outcomes, but they are able to consider both their own and the collaborative PROs' goals when collaborating, which provides them with a common foundation for collaboration: *"It is important that we manage to see all of the partners' requirements"*. Occasionally, disagreements between the firms and the PROs in Alliance 1 arise regarding project objectives when the firms believe that the PROs are overly academically oriented, but the participants consistently appear able to resolve these disagreements. One of the firm representatives made the following observation: *"There are some fundamental conflicts between the industry and academia. The industry wants direct and applied results and development of the industry, whereas academics are more scientifically oriented and have to leverage articles. There are many discussions about that, but we always arrive at an agreement"*.

Both of the alliances address common challenges related to the collaborations' objectives, which the PROs and firms attempt to lead in somewhat different directions. However, the Alliance 1 firms appear to resolve such problems through

good communication: *“Sometimes when working with them [PROs], we see unsurprising results and acknowledgements of things that we already know. Then, we see the potential to become better, and we must turn them [the PROs] toward a better result orientation”,* and *“We are always seen and heard by the [PROs]”*. Although there is occasional tension between the firms and the PROs, the Alliance 1 firms appear to understand the importance of intra-alliance collaboration: *“Industry and research are like a symbiosis that is mutually dependent. We simply must find solutions through dialogue”*.

Another aspect of cognitive social capital relates to common culture (shared rules and norms) (Inkpen and Tsang, 2005). The two groups of firms have different cultures with respect to their collaborative PROs; the primary difference concerns different planning horizons. The firms have a short-term perspective and must address their operating activities quickly, whereas the PROs have a long-term perspective and do not seek exploitation to the same extent as the firms. It appears, however, that the Alliance 1 firms are more aware of the differences between them and the collaborative PROs than the Alliance 2 firms, which helps the former to steer the PROs in a direction that serves the firms’ interests. The firms and the PROs in Alliance 2 appear to lack a fundamental understanding of one another, which often leads to the PROs deciding the projects to be pursued in the research alliance. This understanding might have increased if the Alliance 2 firms had become more involved in the collaboration from the beginning (Table 2) and if the PROs had invited the firms to play a greater role in the collaboration.

Thus, insufficient firm involvement leads to a lack of cognitive social capital, which, in turn, makes it more difficult for such an alliance to develop innovations in a timely manner. However, after collaborating, understanding improved once the Alliance 2 firms understood that they had to be more involved in the research alliance and provide the PROs with clear feedback: *“We [the firm] have pushed them hard, which they have taken into account...They have become better and more to the point”*.

My longitudinal data clearly demonstrate that the Alliance 1 firms have, over time, managed to accumulate cognitive social capital in their relationship with the PROs at an individual, organizational and alliance level. A common understanding of the alliance's working objectives between the firms and the PROs is achieved over time, as their organizations have internally integrated the alliance work; they invest considerable resources in the collaboration (Table 2) and support the work of the firm's representative at the alliance. are backing the firm representative of the alliance in the work that they perform in the alliance. Cognitive social capital is also clearly observed at an alliance level in Alliance 1, which has commitment and a common understanding of the working objectives. Over 4 years of collaboration, Alliance 2 firms have increased their cognitive social capital but primarily at the individual level, as the firm representatives have achieved a greater understanding of the nature of the collaboration within the research alliance (Bruneel et al., 2010) and of the value of engaging in the collaboration. Individual cognitive social capital is valuable and likely provides a foundation for perceiving improved collaboration in the alliance over time, but the firm representatives in Alliance 2 should make an effort to develop social capital at the organizational and alliance levels to better integrate the work performed in the research alliance into firm objectives. A stronger organization and alliance level would likely decrease potential vulnerability stemming from relying on a few persons directly responsible for collaboration in the alliance, and this would likely increase the alliance's innovation outcome. This discussion suggests the following propositions:

Proposition 1: A higher level of involvement in a research alliance increases firms' cognitive social capital toward PROs.

Proposition 2: Cognitive social capital must be present at an individual, organizational and alliance level to achieve a fruitful collaboration between firms and PROs in research alliances over time.

4.2.2 Relational social capital

Over time, the firms within Alliance 1 have developed relational social capital at three levels: individual, organizational and alliance. All of the firm representatives within Alliance 1 have personal relationships with the collaborative PROs, which are rooted in acquaintances made during their school days or previous employment. Several of the PRO representatives have previously worked in the industry, and many of the firm representatives involved in the research alliance have worked as researchers. A factor that potentially contributes to personal closeness is that this industry is a relatively small group in Norway in which many individuals know one another. As a PRO partner stated: *“At some point, we have all been either classmates or colleagues”*. Because of the long-standing close contact among the collaborative partners in Alliance 1, the firms and the PROs have built trust and openness within the group over time: *“We trust each other”*. Through a high level of trust and openness, this group of firms is able to overcome barriers related to communication with the PROs. The firms within Alliance 1 rapidly resolve misunderstandings or conflicting ideas related to tasks: *“It is easier to come to agreements when we know each other and have worked together for years”*. This evidence clearly demonstrates that previous collaboration reduces collaborative challenges (Lhuillery and Pfister, 2009). Based on individual relational social capital, the Alliance 2 firms developed relational social capital at an organizational and alliance level over time. Participants within Alliance 1 experience the alliance as a “family” and a collegial community with solidarity and loyalty toward one another, which is important for achieving effective collaboration, as these qualities mitigate tensions and allow for the creation of new knowledge. As observed, the participants are active, engage in alliance meetings, and often have several firm

employees who responsible for managing the efforts of the alliance. Social capital is lost from employee turnover (Shaw et al., 2005); dimensions of social capital at both an organizational and an alliance level reduce vulnerability if employees connected to the research alliances resign because new alliance representatives will likely acquire social capital more quickly and be able to collaborate well in the alliance at an early stage.

The firms within Alliance 2 had some level of prior contact with the PROs at both an individual and an organizational level before entering the collaboration, but they had not yet achieved the same closeness with the collaborative PROs as the Alliance 1 firms. Some of the Alliance 2 firms experience a low level of trust toward the collaborative PROs: *“The [PROs] need to do something to build trust with their partners”*. A potential risk of a low level of trust is that the Alliance 2 firms lack important knowledge concerning how to make the research alliance successful (Inkpen and Tsang, 2005). It is likely that because of the Alliance 2 firms’ low level of involvement in the collaboration, they cannot achieve trusting personal relationships with the PROs. Alliance 2 also has low relational social capital at the alliance level: a lack of common goals, understanding and personal relations. The alliance participants are beginning to know one another but have not yet established a strong community represented by commitment and cohesion, as the following quotation from the Alliance 2 manager illustrates: *“We try hard just to force us to have annual meetings where we all need to listen to what we want. It is very difficult; it could have been a separate activity. It is very, very difficult”*. Notably, the Alliance 2 firms do not perceive the importance of developing social relationships akin to those developed in Alliance 1 and appear to focus often on “problems”: *“They [the firms] contact us [PRO partner], unless it is planned, it is typically because they have some problem”*.

Because of their low involvement in the alliance, the Alliance 2 firms have fewer opportunities to establish the framework conditions, typically because the PROs have already established them. Based on the close personal relationships developed over

time between the firms and the PROs in Alliance 1, the Alliance 1 firms appear to know how to exercise influence on behalf of their interests: *“They [the PROs] know that we will end the collaboration if they don’t pay attention to our interests”*. If the Alliance 2 firms invest sufficient resources into the collaboration by involving and creating more relational social capital, they will likely be more able to influence the alliance’s working objectives and thereby generate greater innovation outcomes.

A low level of firm involvement before the collaboration may also evolve into expectation tensions (Bruneel et al., 2010), as observed in all of the Alliance 2 firms. These firms expected short-term innovation outcomes, whereas the PROs had a long-term orientation: *“Our expectations have been somewhat different from those of the [PROs]. I had expected a more direct flow of results from the [collaboration]”*. The Alliance 1 firms accumulated a very high level of relational social capital in their relationship with the PROs over time, which taught them what to expect from the collaboration: *“Large portions of the R&D results are impossible to implement. The importance of these results is that they build knowledge, which again can generate good ideas”*. Through the accumulation of relational social capital at an individual, organizational and alliance level over time, the Alliance 1 firms obtained the knowledge necessary to consider both their own and the PROs’ interests (Bjerregaard, 2010).

The Alliance 2 firms and the PROs might need to strengthen their relational social capital to understand each of the collaborative partners’ expectations and frame working objectives that best satisfy both the firms’ and the PROs’ expectations. Following this argument, the PROs could assume a role in developing trust with the firms very early in the collaboration by involving the firms and taking their needs into consideration. To avoid misunderstandings, the PROs could frequently communicate the nature of a research alliance to the firm partners and how it will be coordinated. Increasing relational social capital has the potential to contribute to the ability to

consider both the firms' and the PRO partners' interests and prevent the PROs from exclusively focusing on their long-term goals (Putnam, 1993).

As argued concerning the cognitive dimension of social capital, relational social capital at an individual level alone is insufficient to create an effective collaboration between firms and PROs in research alliances. The development of relational social capital at the individual, organizational and alliance levels is essential for achieving a fruitful collaboration in which tensions are mitigated and knowledge and innovation are created. This discussion suggests the following propositions:

Proposition 3: Firms with a higher level of initial relational social capital are better able to influence the objectives of projects in research alliances and reduce collaborative challenges compared to firms with a lower level of relational social capital.

Proposition 4: A higher level of involvement in a research alliance increases firms' relational social capital in their collaboration with PROs.

Proposition 5: Relational social capital must be present at an individual, organizational and alliance level to achieve a fruitful collaboration between firms and PROs in research alliances over time.

4.2.3 Interplay between cognitive and relational social capital over time

An interdependency is observed between shared understanding and language (cognitive social capital) and personal relationships (relational social capital) (Ashforth and Mael, 1996) in both research alliances. Through longstanding close relations, the firms within Alliance 1 have forged a common understanding and shared goals with the collaborative PROs. Based on relational social capital at an individual level, the firms have also transferred the relational capital to an alliance level such that all

partners feel like a “family”. Further, the personal relations have been transferred to the organization, which experiences the alliance as an important aspect of its overall objectives.

Some of the Alliance 2 firms also began with a trusting relationship and built a common understanding over time: *“The trust has always been there, but the understanding of how to collaborate has become better over time”*. Another representative from an Alliance 2 firm stated: *“The process that runs at this time is more prudent in ensuring the firm’s requirements”*. Interaction among firm and PRO representatives appears to be fundamental to developing cognitive social capital over time in research alliances. Through interaction, the Alliance 2 firms have come to understand that involvement in the alliance is important to establishing the framework conditions for collaboration: *“Over time, we have understood it... especially after the midterm evaluation—that we have to engage more in the [research alliance] to influence the strategy”*. Some of the PROs in Alliance 2 also acknowledged that they need to interact more with their partner firms: *“You have to interact with the industry in practice, not just write a to-do list on paper. You must simply pick up the phone and be in regular contact with them [the firms]”*. It appears that the Alliance 2 firms have developed individual cognitive social capital through relational social capital over time, but it remains necessary to develop the relational and cognitive social capital at the alliance and organizational levels.

In contrast, the findings indicate that the presence of cognitive social capital develops relational social capital. When firms agree on collaborative fundamentals and have shared goals and expectations (cognitive social capital) concerning the research alliance’s objectives, as the Alliance 1 firms do, it might be easier to develop stronger relational social capital. The Alliance 2 firms and the PROs initially had different goals for the collaboration, which made it difficult for them to engage in the research alliance. Over time, the Alliance 2 firms became more engaged in the research alliance, as their organizations better understood the value of participating

in the alliance, and they increased the cognitive social capital dimension, thereby obtaining a greater ability to interact with the collaborative PROs and increase their relational social capital. In contrast to the relational dimension of social capital, which is found to develop from an individual level, cognitive social capital is found to develop from an organizational level. Consequently, when the organizations representing the research alliance share a common understanding of their goals and thereby invest sufficient resources in the collaboration, the cognitive social capital can be transferred to the alliance level that addresses what the alliance should work on. Further, the individual firm representative obtains capital if he or she receives support from both the organization and the alliance on what he or she should focus on in the collaboration.

It is likely that a lack of both cognitive and relational social capital is one reason that certain firms in Alliance 2 ceased participating in the research alliance. Thus, firms could develop at least one of the social capital dimensions to further develop the next dimension and improve the likelihood of mitigating challenges and achieving a fruitful collaboration in research alliances to create knowledge and innovation. This discussion suggests the following propositions:

Proposition 6: Firms with higher initial levels of relational social capital are more able to develop cognitive social capital in their relationship with PROs in research alliances over time compared to firms with lower initial levels of relational social capital.

Proposition 7: Firms with higher initial levels of cognitive social capital are more able to develop relational social capital in their relationship with PROs in research alliances over time compared to firms with lower levels of initial cognitive social capital.

Proposition 8: Relational social capital is likely developed from an individual level to an alliance level and finally to an organizational level.

Proposition 9: Cognitive social capital is likely developed from an organizational level to an alliance level and finally to an individual level.

5.0 Conclusion and implications

This study is a novel attempt to reveal how firms and PROs achieve fruitful collaboration in research alliances in which knowledge and innovation is created. It extends university-industry research by adopting the cognitive and relational social capital perspective to explore *how* firms can mitigate tensions and collaborate well with PROs in research alliances to create knowledge and innovation, as called for by previous studies (Spithoven et al., 2011, Bruneel et al., 2010). Relational and cognitive social capital are important for learning and innovation in collaborations between firms and PROs (Masiello et al., 2013, Van Wijk et al., 2008). By longitudinally studying six firms within two contrasting research alliances, this paper extend previous findings by demonstrating that the presence of cognitive and relational social capital at three levels is a crucial determinant of a fruitful collaboration between firms and PROs in research alliances to release the potential for firms to innovate. The development of the social capital dimensions is also found to be highly dependent on time.

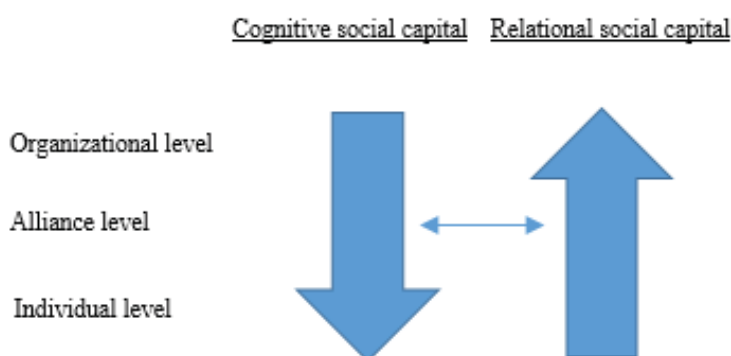


Figure 1. Fruitful collaboration between firms and PROs in research alliances over time.

Common goals and understandings concerning the collaboration and the creation of personal relationships between firms and PROs at the beginning of the alliance will lead to improved collaboration performance over time. The firms within the well-established research alliance are able to overcome tensions with the PROs as a result of their common understanding and good communication, which are products of their long-standing close relationships and the support that firm representatives receive from their internal organization. Thus, the firms within the well-established research alliance developed cognitive and relational social capital at the individual, organizational and alliance levels. They actively engage in open dialogue with the collaborative PROs that is characterized by a high level of trust and shared understanding. The data confirm that commitment, previous collaborative links, effective communication and trust are factors that influence the success of this university-industry collaboration (Mora-Valentin et al., 2004).

The key contributions concern the interplay among the dimensions of social capital (Rass et al., 2013). As the arrows in Figure 1 illustrate, cognitive social capital leverages relational social capital because it is easier to create personal relationships between firms and PROs when they agree on the collaborative fundamentals. Conversely, relational social capital plays a role in the development of cognitive social capital for firms that lack a common understanding and goals with their collaborative PROs. Reaching a common understanding and shared goals with the collaborative PROs clearly depends on the level of relational social capital.

Moreover, the findings indicate that cognitive social capital is first developed at an organizational level at which the alliance work is internally integrated, and then at an alliance level at which objectives and goals are consistent for all of the collaborative partners, and finally, at an individual level at which the firm representatives feel that they receive support and commitment in their alliance work. The relational social capital is first developed at an individual level by the collaborative partners engaging in a research alliance, then at the alliance level when all partners

perceive cohesion and engagement when participating in the alliance, and finally, at a firm level, which adapts the relational social capital created by the individuals in the alliance.

These ideas have important implications for firms collaborating with PROs in research alliances: at least one social capital dimension should be developed when entering into a collaboration to realize the other dimension. Contradicting previous findings that have found relational social capital to be the strongest driver of interorganizational collaboration (Van Wijk et al., 2008), this study thus observes that cognitive social capital acts as an equally strong driver. Moreover, developing one of the dimensions of social capital early in the collaboration is important for developing both of the social capital dimensions at the individual, organizational and the alliance levels, which is found to be essential for the achievement of a fruitful and viable collaboration in research alliances in which the partners create knowledge and innovation.

5.1 Implications

The findings of this study indicate that firms should develop cognitive and relational social capital with collaborative PROs to enhance viable and fruitful collaboration in research alliances and create knowledge and innovation; these findings have important implications both for firms and policy development. At the policy level, the most important implication for PROs seeking to establish a research alliance is the need to engage firm partners early in the process of establishing research alliances by requiring firm-partner involvement. Policies should be formulated to include a preliminary project in which partners from industry and PROs establish the framework conditions for the collaboration to ensure common understandings and shared goals before entering the collaboration. A preliminary project may lead to greater firm influence on project topics within research alliances, prevent firms from exiting the alliance because of a lack of focus on industry, and will

likely contribute to earlier effective collaboration for knowledge and innovation development.

Moreover, the government should encourage PRO partners to be proactive in contacting firm partners. Such contacts will foster the personal relationships and trust necessary for long-term, effective collaboration within research alliances. Because this study highlights the importance of effectively developing collaboration between partners within research alliances, policy makers should design publicly supported research projects with a long-term orientation and publicly demonstrate patience in developing new technologies. Furthermore, my study implies that the government should clarify how it defines the innovations expected from public research projects and specify that the outcomes could be either incremental or radical. This clarification may reduce expectation tensions between collaborative partners.

At the firm level, this study implies that firms must understand how to manage their social relationships with collaborative PROs to achieve the benefits of participating in research alliances, and this understanding is highly dependent of time. Firms should develop personal relationships with and a common understanding of PROs by actively engaging in research alliances from the beginning of the collaboration. Although active engagement is a costly strategy, firms will likely receive larger benefits from invested resources over time in line with their interests. Firms should also be aware of the importance of creating social capital at an individual, organizational and alliance level. In that sense, employees participating in PRO collaboration should be motivated to create social capital and transfer it to the organization. Conversely, the firm should develop social capital to internally integrate support mechanisms related to internal PRO collaboration. Participants should be aware of the value of creating strong social capital at the alliance level by developing common goals, commitment and cohesion within the collaboration, as this is found to be crucial for achieving a fruitful collaboration to develop innovation.

5.2 Limitations and further research

Although these findings on research alliances might be transferable to other research alliances, one cannot argue that they are universally valid. Future research should test my findings using larger samples to explore whether the findings are transferrable to other research alliances. The research alliances considered in this study primarily collaborate on environmental research projects. Future research should include research alliances that collaborate on other issues to explore whether and how the context affects the collaborative process. Moreover, future research is needed to study collaborative processes in research alliances in similar stages of development over time.

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