Cooperating with external partners: the importance of diversity for innovation performance

Beck, Mathias ; Schenker-Wicki, Andrea

DOI: https://doi.org/10.1504/EJIM.2014.064604

University of Zurich[UZH]

Department of Business Administration

UZH Business Working Paper Series

Working Paper No. 331

Cooperating with external partners: The importance of diversity for innovation performance

Mathias Beck and Andrea Schenker-Wicki

March 13

University of Zurich, Plattenstrasse 14, CH-8053 Zurich,
http://www.business.uzh.ch/forschung/wps.html

University of Zurich[UZH]

UZH Business Working Paper Series

Contact Details

Mathias Beck

University of Zurich

Department of Business Adminstration

Plattenstrasse 14, CH-8032 Zurich, Switzerland

mathias.beck@business.uzh.ch

Tel.: +41 44 634 45 41

Fax.: +41 44 634 49 15

Cooperating with external partners: The importance of diversity for innovation performance

Mathias Beck*

University of Zurich, Department of Business Administration, Performance Management, Plattenstrasse 14, CH-8055 Zurich, Switzerland. Tel: 0041 44 634 4541, Fax: fax: +41 (0)44 634 49 15, E-mail: mathias.beck@business.uzh.ch

Andrea Schenker-Wicki

University of Zurich, Plattenstrasse 32, CH-8055 Zurich, Switzerland.
E-mail: andrea.schenker@business.uzh.ch
* Corresponding author

Abstract: Innovations are rarely generated in complete isolation. Due to inherent uncertainty, high knowledge requirements, and high financial investments, many firms search for external partners to develop new products and processes. However, there is an ongoing debate as to whether firms who cooperate with diverse external partners such as suppliers, customers and governmental research institutions see increased innovation performance as compared to firms who cooperate with a less diverse range of collaborators. This paper investigates how diversity in cooperation networks affects firms' innovation performance output as measured by sales share of innovative products. To address this question, the authors analyze a large-scale sample of microdata from Swiss firms from four waves (1999, 2002, 2005, and 2008) of the Swiss innovation survey using panel data analysis. The findings suggest that firms with greater diversity in their cooperation network benefit by generating new product innovations, and that small firms benefit more from diversity of collaborators as compared to other firm sizes. The study further detects a curvilinear relationship between diversity of collaborator types and innovation performance, and emphasizes the importance of appropriate HRM and knowledge management policies and practices to provide firms with an effective mechanism for maximizing benefits from a diversified cooperation network.

Keywords: Collaboration for innovation; cooperation strategies; diversity; innovation performance; human resource management policies and practices; knowledge management strategies; technological capabilities; multinational corporations; small firms.

Acknowledgements: We are grateful to the comments and suggestions of Spyridon Arvanitis, William McKinley, Mary-Yoko Brannen, Florian Stahl, and Ulrich Kaiser as well as to the seminar and conference participants at ISPIM 2012 (Seoul), and University of Zurich. We also thank the KOF Swiss Economic Institute at ETH Zurich for providing the data.

1 Introduction

This paper focuses on firms' openness in cooperation networks with external partners and analyzes how diversity in types of collaboration partners influences firms' innovation performance. In highly industrialized countries, firms need to be innovative to compete in their markets. For many enterprises, generation and successful market introduction of new innovative products are crucially important to secure future business. However, to become and to remain innovative is difficult, especially considering technological and market environments characterized by high knowledge intensity and uncertainty (Teece, 1986). Sources of knowledge and competences, necessary to create new products and new processes, are dispersed widely and are difficult to locate. Additionally, since the 1980s, globalization has led to a more competitive and dynamic environment; at the same time product and technology life cycles have become shorter. Both effects have challenged firms to redefine their innovation search strategies and to widen their technological base (Nijssen, Van Reekum, & Hulshoff, 2001).

Aware of these circumstances in which innovations are created, firms need to develop new knowledge-appropriating architectures, or as Teece (1992, p. 22) argues "successful technological innovation requires complex forms of business organization". Contrary to the Schumpeter-oriented lonely entrepreneur, today's innovations in firms are rarely generated in complete isolation. Instead, innovating firms have started to search for other partners and increasingly build on external knowledge sources in their innovation activities (Katila, 2002; Katila & Ahuja, 2002) in order to complement their own capabilities (Becker & Dietz, 2004). Thus, firms should interact with their external environment to gain access and to acquire new ideas for the generation of innovations (Caloghirou, Ioannides, & Vonortas, 2003). In this context, cooperation and other means of collaboration among partners provide firms with an attractive mode of organizing innovative activities in a market and technological environment that is dynamic and characterized by high uncertainty and complexity (Doz, Santos, & Williamson, 2001). In the words of Teece (1992, p.22), innovating firms establish "linkages, upstream and downstream, lateral and horizontal."

Cooperation activities with external partners such as other firms, suppliers, customers or institutions can facilitate access to complementary assets and opportunities to exploit synergies (Becker & Dietz, 2004; Dachs, Ebersberger, & Pyka, 2008). Cooperative agreements with external partners can contribute to a better exploitation of external knowledge, and can initiate intensive learning processes. Consequently, the decision of a firm to cooperate with external partners can contribute to a broader base of technological opportunities (Caloghirou et al., 2003; Mowery, Oxley, & Silverman, 1998), and hence can confront problems relating to path-dependency (Dosi, 1997). Various works (Ahuja, 2000; Cassiman & Veugelers, 2002) suggest that cooperation with external partners enables firms to get access to complementary resources and markets, to foster the development of innovations, to benefit from economies of scale and scope, and to share costs, risks, and investments. This perspective takes a resource-based view in which a firm aims at maximizing its profits by complementing its own existing resources and capabilities through the use of external sources of knowledge (Mowery et al., 1998; Penrose, 1959; Tsang, 2000).

The construct of innovation performance can be linked to Schumpeter's classification (Schumpeter, 1939; Schumpeter & Opie, 1934) of innovation as the successful introduction of new products, new production processes, new means and sources of

supply, new exploitation of markets, and new ways to organize business. Following the Oslo innovation manual (OECD & Eurostat, 2005), product innovations include the invention and commercialization of entirely new products or services, whereas process innovations represent new methods of production of products or services through the implementation and adoption of new technology and innovations. This study focuses on innovation output and considers only product innovations, measured by the sale shares of new or significantly improved products in total turnover. This measure is used in much empirical work and is seen as an adequate indicator of innovation performance (Engqvist, Edlund, Gomez-Ortega, Loof, & Hermansson, 2006; Roberts, 1988).

Management literature (Coombs, 1996; Hagedoorn, 2002; Nooteboom, 1999) has also recognized the importance of cooperative inter-firm alliances and now focuses more on these intermediate organizational forms between hierarchical and market organization (Teece, 1992; Williamson, 1985). As Teece (1992, p.1) states, "such alliances can facilitate complex coordination beyond what the price system can accomplish, while avoiding the dysfunctional properties sometimes associated with hierarchy." As reported by literature (Hagedoorn, Link, & Vonortas, 2000; Rosenfeld, 1996) since the mid-1990s, large multinational companies as well as small and medium sized firms began to build up more and closer relationships with other companies. These formal or informal joint activities help firms achieve economies of scale, gain market access, and exchange resources, knowledge, and technology. Some scholars argue that with the establishment of cooperation activities in the innovation process, the situations in which firms generally generate innovations have moved from an internally focused perspective to a situation which corresponds to a more open model of innovation, with inter-firm R&D collaborations (Chesbrough, 2003a; Chesbrough, 2003b; Chesbrough, Vanhaverbeke, & West, 2006; Lichtenthaler, 2008), mass customization and personalization (Tseng & Piller, 2003), and external sourcing of knowledge (Laursen & Salter, 2006).

Despite the opportunities brought by cooperation, this organizational form requires special capabilities and an appropriate organizational structure (Teece, 1992; Wallin & von Krogh, 2010). Reciprocally, cooperative activities can influence corporate structure and affect how business is run between partners. Therefore cooperative organization addresses the core of a firm, shapes future business activities, and is generally seen as a major change in management (Drucker, 1995).

Various empirical studies have addressed the effects of different open search strategies for firms' innovation outcomes (Chiang & Hung, 2010; Henttonen, Ritala, & Jauhiainen, 2011; Katila & Ahuja, 2002; Laursen & Salter, 2006; Leiponen & Helfat, 2010; Sofka & Grimpe, 2010). Most of these studies build on the concept of *external search depth* and *external search breadth* initiated by Laursen & Saulter (2006), which differentiates between the intensity of the use of external knowledge sources (*depth*) and the number of external sources used (*breath*). The results of the various studies indicate that the use of both search strategies—specialized (depth) and more inclusive (breath)—are important factors for innovation outcomes. However, there is still a lack of understanding about the specific effects of different search strategies for innovation performance. More precisely, little is known about the effects of focused versus diversified cooperation strategies and about the potential implications of an over-diversified cooperation strategy in the firm's external partners network. In this area, more empirical studies are needed to determine practical implications for firms as well as for policy makers in terms of the formulation of appropriate technology policies.

In order to gather more empirical evidence for the aforementioned open questions, this work conceptualizes different cooperation strategies by distinguishing between different degrees of diversification strategies using external cooperation partners for collaborative innovation. Specifically, this study wants to contribute to a more concise understanding of which cooperation strategies are more beneficial for innovation outcomes by taking firm characteristics, sector affiliations, and technological capabilities into consideration. The goal of this work is to examine the potential for decreasing returns with an over-diversified cooperation network. In a nutshell, the authors want to contribute to the literature by achieving a better in-depth understanding of how collaborative innovation with external partners leads to better exchange of capabilities and knowledge, and therefore affects innovation performance.

A more concise understanding of the cooperating behavior of firms and its impact on innovation performance is still needed (Chesbrough et al., 2006; Lichtenthaler, 2011). More insight into this relationship would allow the formulation of appropriate technology and innovation policies, as well as, as initiating appropriate knowledge management and human resource management (HRM) policies and practices. Management scholars have already recognized the relevance of HRM and knowledge management for fostering innovation activities and creating an innovative culture inside the firm (Jimenez-Jimenez & Sanz-Valle, 2005; Laursen & Foss, 2003; Nonaka & Takeuchi, 1995; Schuler & Jackson, 1987; Wozniak, 1987). In this regard, HRM has launched various initiatives in the areas of (global) talent management, compensation and reward management, recruitment and selection, job design and work arrangements, performance management, training and development, and has further worked to build up competences in corporate leadership (Aguirre, Post, & Hewlett, 2009; Kesting, Mueller, Jorgensen, & Ulhoi, 2011; Schuler & Jackson, 2007). These HRM approaches have mainly focused to promote and facilitate innovation activities inside the firm. Less attention has been paid to how HRM and knowledge management can contribute to better integration of external knowledge, capabilities and technology located outside the firm and better management of the firm's external cooperation network. This is especially valid in the early stages of innovation, including idea creation and idea conversion together with partners outside the firm (Jaruzelski, Loehr, & Holman, 2012).

Regarding policy implications, economic policy makers have already realized the importance of cooperation arrangements for knowledge transfer and have established several support initiatives.[1] However the impact of these cooperation arrangements on innovation performance is still not clear and future research is also required. In particular, this study focuses on the relationship between the diversity of cooperation partners and the innovation output performance of firms. This analysis uses data from four waves (1999, 2002, 2005, and 2008) of the Swiss innovation survey—which corresponds to the Community Innovation Survey (CIS)— and employs a Tobit panel data regression method to estimate the impact of diverse cooperation partners on innovation output performance.

The paper is structured into five sections as follows. The next section introduces key underlying theoretical arguments and presents related literature with respect to the relationship between cooperation behavior and innovation performance. Section two elaborates on the conceptual framework for the effect of diversity in cooperation partners on innovation performance, and formulates the main hypotheses for empirical analysis. Section three presents the data and the methodological approach. Results are discussed in section four. Finally, section five concludes and gives an outlook for future research.

2 Overview of the theoretical background and previous studies

In the following section, the relationship between cooperation activities in the innovation process and the subsequent innovation performance of firms is elaborated from a theoretical and empirical perspective. Different streams of previous research can be found in the academic literature examining the effect of cooperation activities and innovation success. Section 2.1 collects key theoretical arguments for the effect of cooperation on innovation performance. Section 2.2 focuses on the relationship between cooperation and innovative activities. Section 2.3 evaluates the impact of specific types of cooperation partners on innovation performance, whereas section 2.4 considers the effect of diversity in cooperation partners used by an individual firm on innovation performance. Finally, section 2.5 elaborates the moderating effects of firm size and R&D expenditures.

2.1. Key theoretical arguments

From a theoretical perspective, three main branches of literature deal with the effect of inter-firm collaboration on the innovation process. The first branch of literature is allocated in the "neoclassical" field of inter-firm arrangements, capturing mainstream industrial organization (D'Aspremont & Jacquemin, 1988; Dasgupta & Stiglitz, 1980; Jaffe, 1996; Martin, 1994; Martin, 2002; Spence, 1984) and transaction cost economics (Jaffe, 1996; Williamson, 1975, 1985). The second stream incorporates strategic management approaches to inter-firm cooperation. Here, the role of cooperation is emphasized in improving the firm's competitive position (Hagedoorn, 1993; Porter, 1980, 1990), its exploration of complementary external resources and capabilities (Richardson, 1972; Teece, 1982, 1986, 1992), and its creation and acquisition of new knowledge and technology (Dodgson, 1991; Granstrand, Oskarsson, Sjoberg, & Sjolander, 1990; Pavitt, 1988).[2] Management literature argues that in addition to the avoidance of duplicative research, cooperating firms are able to benefit from synergies and therefore profit from economies of scope and learning.

According to transaction cost theorists, cooperation may be seen as an efficient hybrid coordination mechanism between markets and internal organization that reduces transaction costs. While markets, and therefore prices, are expected to allocate resources in a efficient way to generate optimal outcomes, there are considerable doubts that prices are sufficient signals in an technological environment characterized by high uncertainty (Teece, 1992). Williamson (1975) argues that market imperfections not only arise from difficulties in discovering the relevant information about prices and quality (Coase, 1937), but also from the difficulties of managing economic activities within incomplete contracts (Williamson, 1975). Full integration has also its weaknesses, for example in the form of providing appropriate incentives and compensation. Full integration of R&D can also narrow the view of workers on changes in technology (Dosi, 1997). Therefore, from a transaction cost perspective, cooperation may reduce transaction costs through improved flexibility and rapid adjustment to industrial changes and demand (Das, Sen, & Sengupta, 1998).

Another perspective to consider the firm's decision to cooperate or not is the trade-off between incoming and outgoing flows of knowledge. A firm should aim to maximize incoming spillovers while minimizing outgoing spillover. The more effective and efficient a firm is in their own R&D, the higher the so-called internal capacity of the firm (Cassiman & Veugelers, 2002), and the more the firm is able to take advantage of

external sources of knowledge. This is related to the concept of "absorptive capacity" established by Cohen & Levinthal (1989, 1990), who argue that absorptive capacity is crucial for benefitting from externally generated knowledge.

The third main stream, evolutionary economics emphasizes the importance of openness in the search strategy of a firm to detect new innovative opportunities. Through its access to external technological sources, a firm is able to choose among a greater variety of technological opportunities (Metcalfe, 1994). This provides the firm with the possibility creating or combining new technology and knowledge, increasing the probability it will become a successful innovator (Levinthal & March, 1993; Nelson & Winter, 1982). However, it may be difficult to combine many types of knowledge, and the possibility of gaining benefits from external sources is related to industry technology characteristics, particularly inherent technological opportunities (Klevorick, Levin, Nelson, & Winter, 1995).

2.2 Cooperation and innovative activities

When considering the increasing importance of cooperative activities in the innovation process (Hippel, 1988), most previous studies focus on determinants and motives for cooperative behavior with different partners (Belderbos, Carree, Diederen, Lokshin, & Veugelers, 2004a; Fritsch & Lukas, 2001; Kaiser, 2002; Miotti & Sachwald, 2003; Tether, 2002). As a result, the effect of cooperative behavior on the input and output of innovation performance (Belderbos et al., 2004a; Miotti & Sachwald, 2003) remains under-examined and requires further research (Amara & Landry, 2005; Lichtenthaler, 2011). In general, firms' behavior in innovative activities is substantially shaped by firm characteristics such as R&D intensity, firm size, etc., and environmental factors such as technology intensity, access to external available resources, market and industry structure, etc. (Fritsch & Lukas, 2001; Martin, 1994). Absorptive capacity seems to be an important factor in innovative activities. While internal capacity and absorptive capacity are crucial for getting access to externally-generated knowledge and for being a successful innovator (Negassi, 2004), they also positively affect the decision to cooperate with external partners (Abramovsky, Kremp, Lopez, Schmidt, & Simpson, 2009). Firms which are engaged in formal collaborative research have generally higher R&D expenditures (Becker & Dietz, 2004) and are more profitable from R&D (Belderbos et al., 2004a). With respect to input innovation performance, collaborating firms seek to increase resources and capabilities by combining their resources and utilizing complementarities (Gulati, 1995; Kogut, 1988).

2.3 Type of cooperation partners and innovation performance

The choice to cooperate with a certain type of partner is a trade-off of expected gains against expected risks (Katila, Rosenberger, & Eisenhardt, 2008; Powell, Koput, & SmithDoerr, 1996). Different types of partner show specific characteristics which can affect the way a cooperation is managed (Whitley, 2002). In presence of specific partner characteristics, we suggest that the type of cooperation partner influences innovation performance.

Attalah (2002) analyzes how overall R&D performance and welfare is affected by the nature of the cooperation partner. He states that overall R&D performance and welfare are more positively affected by vertical spillovers in the form of suppliers and customers,

as opposed to horizontal spillovers coming from universities, research institutions, and competitors. Freel & Harrison (2006) find empirical evidence that product innovations are positively influenced by joint activities with customers and public sector institutions, whereas process innovations are fostered by cooperations with suppliers and universities. In an empirical analysis of Dutch firms, Belderbos et al. (2004a) argue that increased labor productivity is related to cooperative activities with suppliers and competitors, whereas increased sales with new-to-market products are linked to cooperation with universities, research institutions, and competitors.

In recent studies analyzing the relationship between the type of cooperation partner and output innovation performance in form of increased product or process innovations, no clear-cut results can be found. However, some tendencies can be drawn. Cooperation with clients and suppliers provides knowledge about technology and markets (Whitley, 2002), reduces time to market (Liker, Collins, & Hull, 1999), and favors both process as well as product innovations (Miotti & Sachwald, 2003). To improve product innovations, a firm can benefit from cooperation with clients due to better market information (Fritsch & Lukas, 2001) and direct involvement in R&D teams (Atuahene-Gima, 1995). Cooperation with suppliers can reduce lead time and risks and increase flexibility, quality of products, and market adaptability (Chung & Kim, 2003). Cooperation activities with competitors includes the "hold-up" problem, making cooperation more beneficial for both parties if common problems and/or activities are beyond the competitor's sphere of influence (Tether, 2002). Cooperative activities in basic research or establishing new standards are potential areas of common interest (Amara & Landry, 2005; Gemünden, Heydebreck, & Herden, 1992), as are activities in the presence of a regulatory change (Tether, 2002). Cooperation with research organizations provides access to scientific and technological knowledge (Drejer & Jorgensen, 2005; Lundvall, 1992), and plays an important role in technological innovations (Bozeman, 2000; Vuola & Hameri, 2006) and the opening of new markets (Belderbos et al., 2004a).

The benefits of joint innovative activities will increase as the external partner's resources and capabilities better complement the firm's own resources available. However, these benefits must be weighted against transactions costs (Pisano, 1990; Williamson, 1989) caused by coordinating, managing, and controlling the activities of the involved partners (Nieto & Santamaria, 2007). The specificity of assets, asymmetric information, opportunistic behavior of the involved partners, and uncertainty about the appropriability of the innovation returns are important factors associated with these costs. As an integration of diverse partners creates better exploitation of complementary resources and capabilities, it would be interesting to analyze—considering the above mentioned costs—the relationship between diversity in cooperation partners and innovation performance.

2.4 Impact of diversity in cooperation partners and innovation performance

Evolutionary economists (Nelson & Winter, 1982) point out that a wide range of external partners and sources is crucial for increasing the variety of knowledge in a firm. Further, this variety is linked with the opportunity to create new combinations of knowledge and technology and to generate innovations (Chesbrough, 2003b; Laursen & Salter, 2006). Laursen & Salter (2006) argue that the strategy of using different search channels such as suppliers, users, other firms, universities, and other research institutions is important in explaining heterogeneity in innovation performance. By investigating a large dataset of

UK manufacturing firms, their work shows that innovation performance is linked to the openness of a firm to use different sources of knowledge. Other studies find empirical evidence that the inclusion of different partners increases the probability of achieving product innovations (Becker & Dietz, 2004), and increases the novelty of those innovations (Nieto & Santamaria, 2007). These approaches take into account that each channel is regarded as a separate search space embedded in an environment with different routines, habits, norms, and rules (Brown & Duguid, 2002; Cook & Brown, 1999). Despite the possibility that the innovation activities of a firm can generate substantial advantages by establishing new linkages to various partners, there is the inherent risk of increased opportunistic behavior. At the same time, different knowledge domains require different organizational practices to manage the search effectively and efficiently. In addition, managing relationships to external partners also requires managerial attention, which is not an unlimited resource (Ocasio, 1997). In a nutshell, we expect that diversity in cooperation partners might be advisable for a firm, however the integration of too many different types of cooperation partners could be negatively related to innovation performance owing to high complexity.

Following the above-mentioned arguments, we believe that a firm can take advantage in terms of increasing innovation performance by focusing on one specific type of partner. Theoretical and previous empirical work has shown that learning from external partners and integrating external knowledge located outside the firm's boundaries takes a lot of effort, time, know-how and resources (Laursen & Salter, 2006), and this may be challenging if multiple types of partners are involved. This also goes along with the arguments influenced by the attention-based theory (Ocasio, 1997) that managing a divers set of external cooperation partners requires significant managerial attention. Given the fact, that this resource is scarce in a company, we assume that a firm should take advantage by not focusing on too many different types of partners. This is in alignment with Laursen & Salter (2006) who argue that innovation search and managerial attention should not be paid to too many different types of knowledge sources in avoidance of negative returns on innovation performance due to an overdoses of search (see also Koput, 1997). Furthermore, relying on limited types of partners can facilitate innovative activities inside the firm by establishing routines (Levinthal & March, 1981) and forming reliable and trustful ties to the cooperation partner. To conclude, we assume positive effects of a focused cooperation strategy on innovation output performance.

Conversely, a too narrow approach in integrating external sources of knowledge, technology, and capabilities from cooperation partners can also limit the firm's ability to increase internal innovative capacities to create new products (Chiang & Hung, 2010; Nieto & Santamaria, 2007; Ritala & Hurmelinna-Laukkanen, 2009). Evolutionary economists therefore claim that a firm should not stick persistently in a specific knowledge trajectory (Dosi, 1988), because the benefits of which a firm can take advantage decline over time, and hence, a firm should rely on different paths to accumulate new ideas for innovative activities (Nelson & Winter, 1982). Other scholars argue that implementing a diversified cooperating network improves firm's capacity of organizational learning, increases the variety of knowledge, improves the firm's ability to adapt to changes in demand and technology, generally contributing to problem-solving and innovation (Levinthal & March, 1993; March, 1991), Indeed, recent empirical studies have provided some evidence, that a broad strategy in search for new knowledge and new innovative ideas can lead to improve firms' ability to innovate (Katila & Ahuja, 2002; Laursen & Salter, 2006; Sofka & Grimpe, 2010). These above-mentioned reflections and

findings are also in alignment with our expectation, that diversity in types of cooperation partners in a network can increase firm's innovation output performance.

Hence, the main hypotheses can be formulated as follows:

Hypothesis 1 A firm which is engaged in cooperation activities with external partners benefits in term of innovation output performance compared to non-cooperating firms.

Hypothesis 2a A focused cooperation strategy increases innovation output performance of a firm.

Hypothesis 2b A diversified cooperation strategy leads to an increase in innovation output performance of a firm.

Hypothesis 2c The more divers firm's cooperation arrangements with external partners are, the higher is the innovation output performance.

Hypothesis 3 The relationship between diversity in types of cooperation partners and innovation output performance follows an inverted U-shaped curvilinear form.

2.5 Diversity in cooperation partners and the moderating effects of R&D expenditures and firm size

We proceed by analyzing some key moderating effects in the relationship between diversity in cooperation partners and innovation performance. The importance of internal R&D activities as a source of innovation is widely acknowledged, more recent research focuses on the moderation effect of firm's R&D efforts on innovation performance (Grimpe & Kaiser, 2010). We investigate the moderating role of R&D expenditures on the relationship between diversity in types of cooperation partners and innovation output performance. The concept of absorptive capacity (Cohen & Levinthal, 1990) emphasizes the relevance of firms in-house R&D activities to provide firms with the necessary know-how to be able to absorb and apply external knowledge in order to create product innovations. Previous research (Grimpe & Kaiser, 2010; Mowery, Oxley, & Silverman, 1996) has also found positive effects of firm's R&D investments to increase the ability to take advantage of external sources of knowledge. For instance, Grimpe & Kaiser (2010) argue, that firm-specific (internal) R&D expenditures enhance the firm's ability to improve its "integrative capabilities", which should lead to better exploitation of superior resource and technology combinations derived from internal and external sources. Thus, conducting high levels of (internal) R&D activities may prevent a firm to loose valuable process knowledge in manufacturing and engineering, and helps a firm to fully exploit external knowledge (Kotabe, 1990; Weigelt, 2009). To conclude, we assume that higher levels of R&D expenditures positively moderate the relationship between diversity in types of cooperation partners and innovation performance, resulting in a shift of the tipping point to the right.

Hypothesis 4 The relationship between diversity in types of cooperation partners and innovation output performance is positively moderated by higher levels of R&D expenditures, such that the maximum of innovation performance is reached at more types of cooperation partners.

Literature has shown that firm size plays a characteristic role for innovation activities (Cassiman & Veugelers, 2002). As small and medium-sized enterprises (SMEs) are per se limited in size and in their human and financial resources, collaborative innovation provide them with an interesting mode of organizing their innovation activities and getting access to externally located sources of knowledge (Kesting et al., 2011; Powell et al., 1996). However, organizing external relationships costs resources, and managerial attention, and therefore it may be very challenging for SMEs to manage a diversified network effectively. Consequently, SMEs might not get full potential out of their external relationships. Conversely, in contrast to larger enterprises, SMEs may have a better overview on their collaboration network, and might be better in placing appropriate people with an ideal combination of business sense and technological expertise on the right places to reap the full value of the cooperative arrangements. In conclusion, we expect that both firm groups – the small and the medium-sized enterprises – are more likely to positively moderate the relationship between diversity in cooperation network and innovation output performance. We therefore can state the following hypothesis:

Hypothesis 5a/(b) The relationship between diversity in types of cooperation partners and innovation output performance is positively moderated by small-sized (medium-sized) firms, such that the maximum of innovation performance is reached at more types of cooperation partners.

3 Data and model specification

3.1 Data

For the empirical analysis, this study uses micro aggregated firm level data from Swiss firms. The data is derived from postal innovation surveys conducted by the Swiss Economic Institute (KOF) in the years 1999, 2002, 2005, and 2008. In total, the panel contains 9454 observations from 4973 firms. The aim of the survey is to observe and collect data about technological innovation. The questionnaires are methodologically similar to the well-established "Community Innovation Survey" from the European Commission following the broad innovation perspective of the Oslo Innovation Manual (OECD, 1992). The dataset is designed as a panel and contains detailed firm-level data on firm characteristics (firm size, exports, sector affiliation), R&D and innovation activities, cooperation motives, and cooperation activities among other things. The survey provides a representative sample of Swiss firms, including firms from all relevant manufacturing, service, and construction sectors (28 industries in total). The survey is based on a disproportionate stratified random sample (according to firm size), capturing firms with at least five employees but with full coverage of the upper distribution part. The response rates for the years 1999, 2002, 2005, and 2008 are 33.8%, 39.6%, 38.7%, and 36.1%. We restrict our sample to successfully innovating firms, because we are interested in the market success of product innovations. As we focus on R&D active firms, this study only uses data from firms which conduct R&D activities in the relevant period.[3] Finally, our analyzed panel comprises 2404 observations without missing data from 1609 firms.

The average firm participates 1.5 times in the survey, which is satisfactory regarding the relevant time span of the survey.

3.2 Model specification

For the purpose of this study, we define diversity in cooperation as the number of different types of partners, which have a cooperation arrangement with the focal firm. In total we define seven different types of cooperation partners. Cooperation with customers and clients, cooperation with suppliers, cooperation with competitors, cooperation with non-competing firms, cooperation with firms from the same corporate group, cooperation with universities, and cooperation with other research institutions. Further, we define four different diversity strategies with the non-cooperating strategy as reference group: A focused cooperation strategy comprises cooperation arrangements with only one specific type of partners. An intermediate strategy includes two or three different types of partners as defined above. Finally, a diversified strategy is characterized by more than three different types of partners.

In total, we estimate seven different models to explain innovation performance by different cooperation strategies. In the first, we begin by assessing whether participation in cooperation activities leads to better innovation performance (model_1a). This can be seen as a replication of previous results to validate our model. We continue by investigating the effects of the inclusion of different types of cooperation partners on innovation performance (model_1b). Therefore, we include a continuous counting variable (coopPart) in our model. Further we look on the effects of the firm's different diversity strategies on innovation performance (model_1c). According to our model, a firm can run four different diversity strategies: only in-house R&D activities (no cooperation strategy—noCoop), one specific type of cooperation partners (the focused strategy—coFoc), two to three different types of partners (the intermediate strategy—coMed), or four or more different types of cooperation partners (the diversified strategy—coDiv). Next, we examine the shape of the relationship between diversity in cooperation partners and innovation performance (model_1d). To accomplish this, we add the squared term of the continuous counting variable (coopPartSq) to test a curvilinear relationship, which would be indicated through a positive significant coefficient of *coopPart* and a negative significant coefficient of the squared term.[4]

In the next steps, we test our hypotheses regarding the moderating effects of firm size and internal absorptive capacity on this curvilinear relationship. In model_1e we include the interaction term between the linear continuous counting variable (coopPart) and the natural logarithm of the share of expenditures for R&D activities over total sales. In model_1f and _1g we test the hypotheses on the moderating effect of firm size by interacting coopPart together with the dummy variables of small and medium sized firms. A significant positive coefficient would indicate a moderating effect of the variables and would lead to a right-shift of the tipping point of the curvilinear relationship.

A. Dependent variables

The dependent variable is the output innovation performance of firms. Firms' innovation output performance is measured by the turnover of new or considerably improved products divided by total firm turnover. In alignment with the definitions of the Oslo Manual (OECD, 1992), these products have to be new to the firm or modified in a

considerable way, therefore products with only minor modifications such as customer specifications and design adjustments are excluded. Thus, this measure takes values between 0 and 100. This measure has broad acceptance in empirical analysis and has been used in several previous empirical studies (Belderbos, Carree, & Lokshin, 2004b; Grimpe & Kaiser, 2010; Loof & Heshmati, 2002). In our analysis, we employ the natural logarithm of that measure (lnInSales) (e.g. Arvanitis & Bolli, 2012).

B. Independent variables

As independent variables, we consider variables that reflect the theoretical and empirical insights gathered in the previous section. In our model, we refer to the resource-based approach in explaining innovation performance. Our model contains different variables to integrate our reflections on different diversity strategies in the cooperation behavior of firms. For the model, we use a dummy variable (rdCoop) to indicate that a firm participates in cooperation activities with external partners. Taking into consideration that the type of cooperation partners influences innovation performance (Atallah, 2002; Belderbos et al., 2004a), we construct the variable *coopPart* to represent the number of the different types of external partners in the cooperation network. Different types of partners include collaborative agreements with customers, suppliers, competitors, firms from other industries, firms from the same corporate group, universities, and other research entities. Our model contains four dichotomous variables to capture the different diversity strategies of a firm (noCoop, coFoc, coMed, and coDiv). Finally, in alignment with previous studies (Grimpe & Kaiser, 2010; Laursen & Salter, 2006) who used similar measures to control for an inverted U-shaped curvilinear relationship of R&D outsourcing to the effects of knowledge sources, we include the squared term of *coopPart* (coopPartSq) to control for potentially decreasing effects of diversity.

Following the argument that the stock of resources and capabilities of a firm is crucially important for it to benefit from cooperation with external partners, our model captures several firm characteristic variables. The amount of resources invested in innovation activities influences the decision to cooperate, and the propensity to generate successful innovations (de Faria, Lima, & Santos, 2010). Therefore, we include a variable (lnRDInt) measured as the natural logarithm of the share of total expenditures in R&D activities on total turnover as a proxy for the intensity of a firm's devotion of resources to innovation activities.

According to the concept of absorptive capacity (Cohen & Levinthal, 1989, 1990), pre-existing knowledge and internal technological capacities are essential to better exploit the benefits of joint innovative activities. With increasing technological resources and capabilities, a firm is better prepared for innovative projects with external partners. In the presence of internal technological capacities and capabilities, a firm can take advantage and absorb incoming spillovers as long as there is not significant recontextualization (Brannen, 2004). Similarly, a well-prepared firm can better install appropriability mechanisms (e.g. patents, copyrights, trademarks, registered design, complex product design, lead time advantages) to protect outgoing spillovers (Cassiman & Veugelers, 2002). In order to capture these arguments about absorptive capacity, we include an additional variable to consider the level of education in a firm's workforce (lnEmpAca).[5]

In line with Abramovsky et al. (2009), we include a variable to approximate the level of competitiveness a firm is facing. We construct the variable *firmComp* as the share of exports on total turnover, where the export attitude is a proxy for competitiveness (de

Faria et al., 2010). This assumes that a firm with high export ratios is embedded in a more competitive environment (Cassiman & Veugelers, 2002), and at the same time those firms are more likely to cooperate with external partners (Dachs et al., 2008).

Following the argument and empirical findings that the technological environment in which a firm operates influences cooperation propensity and innovation performance (Bayona, Garcia-Marco, & Huerta, 2001; Dachs et al., 2008; Miotti & Sachwald, 2003), our model contains a binary variable to control for high technology levels.

Firm size is also considered having an influence on the decision to cooperate (Cassiman & Veugelers, 2002; Cohen & Levinthal, 1990). Thus we include different dichotomous variables to proxy firm size (smallFirm, midFirm, largeFirm). However, the effect of firm size on the decision to engage in cooperative activities with external partners is ambiguous. Cohen & Levinthal (1990) state that with increasing firm size a firm possesses higher absorptive capacity and is able to devote more resources to innovation activities. Consequently, they argue that firm size is linked with a higher propensity to cooperate. Contrarily, Cassiman & Veugelers (2002) remark that with increasing firm size, the capabilities of a firm increase along with the possibility to conduct innovation activities internally, without the necessity of including external parties. Thus, it is not *a priori* clear, how firm size affects innovation performance. As younger firms are expected to be more innovative in order to gain market access, our model controls for start-up firms younger than 15 years (startUp). Furthermore, our model includes dummy variables for industry affiliation.

4 Results and discussion

Descriptive results

In the four waves of our panel (years 1999, 2002, 2005, and 2008) we use 9454 observations from 4973 firms. As can been seen from Table 1 over the four waves 65.9% of the innovating firms conduct R&D, and 25.2% cooperate with external partners. The average number of different cooperation types is 3.28. According to our diversity definition, 14.2% of the cooperating firms follow a focused cooperation strategy (coFoc), 45.0% cooperate with two up to three different types of cooperation partners (coMed), and another 40.8% cooperate with more than three types of cooperation partners (coDiv). With respect to the types of partners, Table 2 represents the shares of the cooperating firms, which have cooperation arrangements with customers (average 61.7%), suppliers (68.3%), competitors (36.9%), non-competing firms (38.7%), firms from the same corporate group (41.1%), universities (53.6%), and other research institutions (27.6%) in the four waves of the survey.

Table 1 Frequencies and shares of firms successfully innovating, conducting R&D, cooperating with external partners, and diversity strategies (focused, intermediate, diversified) 1999, 2002, 2005, and 2008 respectively

		thereof		*thereof*			
Years	*Inno*	*R&D*	*Coop*	*coopType*	*coFoc*	*coMed*	*coDiv*
1999	1355	891	341	3.31	46	144	144
	62.4%	66.3%	38.5%		13.8%	43.1%	43.1%
2002	1539	1075	300	3.15	48	135	111
	59.5%	70.2%	19.6%		16.3%	45.9%	37.8%
2005	1488	974	372	3.17	57	174	136
	58.2%	65.5%	25.3%		15.5%	47.4%	37.1%
2008	1265	768	287	3.51	31	124	131
	59.7%	60.7%	22.7%		10.8%	43.4%	45.8%
Total	**5647**	**3708**	**1300**	**3.28**	**182**	**577**	**522**
	60%	**65.9%**	**25.2%**		**14.2%**	**45.0%**	**40.8%**

Source: Own calculations. Data derived from the Innovation survey conducted by the Swiss Economic Institute (KOF).

Table 2 Frequencies and shares of cooperating firms with respect to their type of cooperation partners (customers, supplier, competitors, non-competitors, firms from the same corporate group, universities, and other research institutions) 1999, 2002, 2005, and 2008 respectively

Years	Cooperating	Customers	Suppliers	Competitors	Non-Competitors	Firms from same corporate group	Universities	Other Research Institutions
1999	341	199	225	136	130	141	175	101
		59.6%	67.4%	40.7%	38.9%	42.2%	52.4%	30.2%
2002	300	176	197	111	118	114	139	72
		59.9%	67.0%	37.8%	40.1%	38.8%	47.3%	24.5%
2005	372	221	249	129	123	150	203	88
		60.2%	67.9%	35.2%	33.5%	40.9%	55.3%	24.0%
2008	287	194	204	97	125	122	170	93
		67.8%	71.3%	33.9%	43.7%	42.7%	59.4%	32.5%
Total	**1300**	790	875	473	496	527	687	354
		61.7%	**68.3%**	**36.9%**	**38.7%**	**41.1%**	**53.6%**	**27.6%**

Source: Own calculations. Data derived from the Innovation survey conducted by the Swiss Economic Institute (KOF).

Estimation procedure

We apply a random-effect panel tobit model to estimate our model. We choose a tobit estimation procedure, because many firms do not have any sales with market novelties, thus our measure for innovation output performance is "left-censored". A tobit model takes account for this property of our data by treating data from firms with or without sales with product novelties differently. We use a left-hand side censored tobit model with *lnInSales* as the dependent variable to estimate the impact of diversity on innovation output performance. *LnInSales* is downward censored at 0. The summary statistics can be found in Table A.2.

Impact of diversity in cooperation partners on innovation performance

Table 3 presents the results of the tobit regression with innovation output as the dependent variable, measured as the share of sales made up by innovative products (lnInSales). In model_1a the results for *rdCoop* suggest that there is a strong positive and significant effect for firms that are engaged in cooperation activities with external partners. A positive and significant effect is still present for the continuous counting variable *coPart*. This finding shows that with increased diversity in cooperation partners, firms can improve innovation output performance. In model_1c where we focus on the effects of different diversity strategies, we find the most positive effect on firms' innovation performance for firms following the diversified strategy. Compared to non-cooperating firms (the reference group) we cannot find a statistically significant effect for firms cooperating only with one specific partner or firms with two or three different types of partner. The strongest positive effect (at the 1%-level) on innovation performance, as mentioned, is for firms that follow the diversified strategy and cooperate with more than three different types of partners (coDiv). In model_1d, the results show a significant positive coefficient for *coPart* and a significant negative coefficient for *coPartSq*, indicating that there is a curvilinear relationship between diversity in cooperation partners and innovation performance.

In the next sub-models we include several interaction terms to analyze the moderating effects of internal R&D and firm size. Referring to model_1e, we cannot find any statistically significant moderating effect of internal R&D on sales with innovative products. Considering the moderating effects of firm size, the results in model_1f exhibit a positive and significant coefficient for the interaction between small firms and the continuous counting variable (intCoSE), as well as a positive and significant coefficient for *coopPart* and a negatively significant coefficient for the squared term. Consequently, the tipping point of the inverted U-shape relationship shifts to the right. Comparing the coefficients from model_1d and model_1f, we find similar coefficient strengths for *coopPart* in the two models, indicating that the curve is similarly steep for small firms as it is for all firms. As the tipping point shifts to the right, the results show that small firms benefit more from integrating a greater variety of external cooperation partner into their cooperation network. In the last sub-model (model_1g), the results show no statistically significant effect for the interaction between including different types of cooperation partners and medium-sized firms (intCoME).

In accordance with our expectations and in alignment with other previous studies (e.g. de Faria et al., 2010), the results show a significant positive correlation between the resources invested in innovative activities (lnRDInt) and innovation output for all of our

models. We expected that our proxy for absorptive capacity, the workforce level of employees with tertiary education (lnEmpAca), would influence innovation output, but we find no statistically significant influence. Moreover, the results show also no impact of being a startup firm (startUp) on the dependent variable. In line with our expectations and previous empirical research (e.g. Abramovsky et al., 2009), we detect a small positive but significant correlation between the competitiveness of a firm's environment (firmComp) and innovation output. Additionally, the results exhibit statistically significant evidence that high technological potential and technological opportunities (hiTecPot) relate to better innovation performance. With respect to firm size, we find negative and significant relationships if firms belong to medium and large sized firm groups compared to the reference group of small sized firms. The results also show strong sector affiliation effects.

Table 3 Tobit regression estimates for innovation output performance (lnInSales). Reference category for model_1c are non-cooperating firms.)

lnInSales	model_1a	model_1b	model_1c	model_1d	model_1e	model_1f	model_1g
rdCoop	0.095*						
	(0.05)						
coopPart		0.045***		0.131**	0.148***	0.130**	0.129**
		(0.013)		(0.053)	(0.055)	(0.053)	(0.054)
coFoc			-0.084				
			(0.109)				
coMed			0.059				
			(0.065)				
coDiv			0.203***				
			(0.068)				
coopPartSq				-0.184*	-0.196*	-0.211*	-0.184*
				(0.111)	(0.111)	(0.112)	(0.111)
intCoRDInt					-0.307		
					(0.207)		
intCoSE						0.048*	
						(0.029)	
intCoME							0.003
							(0.026)
lnRDInt	2.424***	2.417***	2.421***	2.437***	3.006***	2.408***	2.438***
	(0.449)	(0.448)	(0.448)	(0.448)	(0.589)	(0.448)	(0.448)
lnEmpAca	0.012	0.004	0.007	0.005	0.005	0.003	0.005
	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
midFirm	-0.167***	-0.173***	-0.175***	-0.176***	-0.175***	-0.135**	-0.179***

	(0.058)	(0.058)	(0.058)	(0.058)	(0.058)	(0.063)	(0.063)
largeFirm	-0.129*	-0.146**	-0.143**	-0.151**	-0.150**	-0.101	-0.150**
	(0.073)	(0.073)	(0.073)	(0.073)	(0.073)	(0.079)	(0.074)
startUp	0.149	0.143	0.143	0.136	0.139	0.136	0.136
	(0.143)	(0.142)	(0.142)	(0.142)	(0.142)	(0.142)	(0.142)
firmComp	0.003***	0.003***	0.003***	0.003***	0.003***	0.003***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Consumer	1.023***	1.023***	1.018***	1.024***	1.025***	1.020***	1.024***
	(0.142)	(0.142)	(0.142)	(0.141)	(0.141)	(0.141)	(0.141)
intMedGoods	0.834***	0.837***	0.836***	0.843***	0.843***	0.841***	0.843***
	(0.128)	(0.128)	(0.127)	(0.127)	(0.127)	(0.127)	(0.127)
invGoods	1.203***	1.203***	1.198***	1.204***	1.200***	1.204***	1.204***
	(0.124)	(0.124)	(0.124)	(0.124)	(0.124)	(0.124)	(0.124)
TradServ	0.770***	0.772***	0.769***	0.771***	0.772***	0.766***	0.771***
	(0.142)	(0.142)	(0.142)	(0.142)	(0.142)	(0.142)	(0.142)
KwServ	0.625***	0.648***	0.647***	0.655***	0.655***	0.655***	0.656***
	(0.139)	(0.138)	(0.138)	(0.138)	(0.138)	(0.138)	(0.138)
othServ	1.009***	1.016***	1.004***	1.011***	1.009***	1.011***	1.011***
	(0.226)	(0.225)	(0.225)	(0.225)	(0.225)	(0.225)	(0.225)
hiTecPot	0.155***	0.151***	0.153***	0.150***	0.146***	0.150***	0.150***
	(0.048)	(0.048)	(0.048)	(0.048)	(0.048)	(0.048)	(0.048)
Constant	1.915***	1.918***	1.930***	1.930***	1.918***	1.907***	1.931***
	(0.121)	(0.120)	(0.120)	(0.120)	(0.120)	(0.121)	(0.120)
sigma_u							
Constant	0.643***	0.636***	0.633***	0.632***	0.630***	0.632***	0.632***
	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)
sigma_e							
Constant	0.933***	0.934***	0.936***	0.935***	0.936***	0.934***	0.935***
	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)
N	2404	2396	2396	2396	2396	2396	2396
uncensored	146	145	145	145	145	145	145
right-censored	2258	2251	2251	2251	2251	2251	2251

Source: Own calculations. Data derived from the Innovation survey conducted by the Swiss Economic Institute (KOF). Note: *, **, and *** denote coefficients are significant at the 10%, 5%, and 1% test-level. Standard errors in parentheses.

Discussion

The results strengthen our hypotheses that diversity in types of cooperation partners matters for innovation performance. Evidently, firms that participate in external cooperation agreements can achieve performance enhancement with respect to innovation output. Therefore hypothesis 1 can be confirmed. Based on the results from model_1b/c we can state that a firm benefits from a more diverse cooperation strategy, and hypothesis 2 can be confirmed. We argue that the firm's decision to cooperate with external partners and not rely only on in-house R&D activities is crucial for the firm's innovation success. Surprisingly, the results show the strongest and most significant effect for the diversified cooperation strategy compared to the intermediate and focused strategies. Considering the potential risk of an over-diversified cooperation strategy causing negative returns in innovation output, we assumed a curvilinear relationship (inverted U-shape) between diversity in types of cooperation partners and innovation output. The results show statistical evidence for this assumption, and hypothesis 3 can be supported. These findings give support to our ideas that innovating firms can benefit from the know-how, resources, and capabilities of external partners, and that a wide diversity in types of cooperation partners in a cooperation network can enhance firm innovation output performance. However, this only applies to certain level of diversity, an over-diversified cooperation network can also leads to decreasing returns. Additionally, firms are only able to benefit from externally available resources and capabilities in the presence of sufficient technological potential and financial investment in R&D activities.

To investigate in more detail how investment in R&D activities moderates the relationship between diversity and innovation performance, we analyzed this moderating effect in a separate model. Although our model does show a negative coefficient for the interaction term (intCoRDInt), indicating a substitution effect between R&D investment and engagement in external cooperation arrangements, we found no statistically significant evidence for this moderating effect. Recall, though, that our interaction variable (lnRDInt) does not represent internal investment in R&D, but rather the overall expenditures on R&D, meaning that it includes expenditures on external R&D activities.

To focus on how firm size influences the benefits of external cooperation agreements with different types of partners in a cooperation network, we analyzed the moderating effect of small- and medium-sized firms. For medium-sized firms, our model does not generate statistically significant moderating effects. With respect to the moderating effect of small firms, we can clearly state that small firms derive significant advantages from diversity in cooperation partners compared to the other firm-size groups. Regarding theoretical implications that small firms possess only limited internal capacity and resources to take advantage of a wide range of external sources of knowledge and that it is difficult for small firms to manage a manifold cooperation network, these findings are quite counterintuitive. Thus, these findings give a hint that for small firms it may be less difficult to pay managerial attention to these different types of partners as compared to larger firms. Therefore, this may suggest that small firms have less difficulty managing and controlling relationships to external partners, and that they are more likely to improve their innovation performance by complementing their internal resources and capabilities with external partners. One reason for the higher effectiveness of small firms in improving their innovation performance may be the fact that organizational issues are less complex and less bureaucratic for small firms (Jaruzelski et al., 2012), and as a result small firms are able to convert ideas into innovative products more quickly. Another

reason for the better performance of small firms may be because small firms are more effective in placing the right people with a good combination of experience, technology, and business sense in charge of managing collaborative relationships (Jaruzelski et al., 2012).

Surprisingly, level of competitiveness only plays a marginal role in explaining innovation performance. In addition, we cannot find significant evidence that being a start-up firm explains innovation performance. Furthermore, previous studies have emphasized the influence of absorptive capacity on innovation performance. In our analysis, the variable *lnEmpAca,* representing absorptive capacity by modelling the workforce share of employees with tertiary education, shows a small negative but not significant influence on innovation performance.

5 Conclusion and future research

This study investigates the influence of diversity in types of cooperation partners on innovation performance. Our model is guided by a conceptual framework stating that innovation performance is essentially influenced by the firm's cooperation strategy and further determinants such as R&D expenditures, absorptive capacity, technological potential, level of competitiveness, and other firm characteristics. We created a model to incorporate different diversity cooperation strategies in two econometric specifications: First, we distinguished between a focused strategy (one specific type of cooperation partners), an intermediate strategy (two or three different types), and a diversified strategy (more than three different types); and, second, we also applied a counting variable to capture the different types of cooperation partners. Proceeding this way, our work contributes to a better understanding of the effects of specific firms' cooperation decisions on innovation performance. This study hence provides more concise insights on the impact of different cooperation strategies on innovation performance. This additional knowledge is necessary to develop appropriate innovation and technology policies to foster national competitiveness (from a policy point of view) as well as to define and to create appropriate HRM and knowledge management policies and practices to facilitate and foster innovative activities in firms (from a managerial point of view).

Based on an econometric estimation using panel data from Swiss firms comprising four waves (1999, 2002, 2005, and 2008), the results show that innovating firms choosing a diversified cooperation strategy benefit most with respect to innovation output performance, measured by the sales' share of innovative products on total turnover compared to a focused or intermediate strategy. Further, our results exhibit a tipping point indicating that the benefits from diversity decrease after a certain degree of diversification. Additionally, the findings give support that the relation between diversity in cooperation partners and innovation performance follow a curvilinear relationship. To conclude, despite the gains from diversity in cooperation networks, higher diversity can also be linked to risks such as protection of core technologies and appropriability mechanism as well as to managerial attention problems to overview the manifold relationships to external partners and the complex technology base and business opportunities located outside the firm.

Overall, the findings indeed support our theoretical reflections that firms are able to benefit in terms of increased innovation performance by complementing their internal resources and capabilities and getting access to external partners. Especially, in a

business environment in which firms are exposed to more and more competition, not only from a national but also from a global point of view, firms need to become successful innovators. In this regard, it is essential to identify effective mechanisms, which drive the positive impacts from diversity. Therefore, from a strategic management perspective, managerial decision makers should carefully evaluate the firm's cooperation strategy in order to find the balance between the advantages from special knowledge, and technologies located outside the firm and the problems and risks associated with leaking out knowledge on the other side. In that regard, HRM and knowledge management are challenged to create appropriate practices and policies enabling firms to better exploit their external cooperation network. Our study has further shown that the gains from diversity in cooperation network are moderated by firm size. However, there is still some need for future research. It is still unclear, which mechanisms in small firms drive the better innovation performance. Future research could try to identify those effective mechanisms and try to adapt those to larger enterprises.

In our study we have only taken into account the impact of the diversity of general types of cooperation partners, without the consideration of the national origin of the partners. Future research could deal with the question if the distinction between national and international partners affects innovation performance. From one point of view the cooperation with international partners could enable firms to take advantage of special knowledge, and technologies from abroad, but on the other side these cooperation arrangements come along with additional problems and risks such as cultural and social distances, and different intellectual protection rights and laws. Going one step further, future research could deal with the question how cultural and social factors affect these relationships in a cooperation network and could investigate the impact on innovation performance.

Appendix

Tables

Table A.1 Description of variables

Variable	Description
Dependent variable	
lnInSales	Natural logarithm of the sales shares of innovative products (sum of the sales of new products and considerably modified products) on total turnover.
Independent variables	
rdCoop	Dummy variable; 1 represents firms which have a RD cooperation arrangement with an external partner. 0 otherwise.
coopPart	Continous variable. Represents the firm's amount of external cooperation partners. The number ranges between 0 and 7.
coFoc	Dummy variable; 1 represents firms which follow a focused cooperation strategy. Firms cooperate with one specific type of cooperation partner. 0 otherwise.
coMed	Dummy variable; 1 represents firms which follow an intermediate cooperation strategy. Firms cooperate with two or three different types of cooperation partners. 0 otherwise.
coDiv	Dummy variable; 1 represents firms which follow a diversified cooperation strategy. Firms cooperate with more than 3 different types of cooperation partners. 0 otherwise.
lnRDInt	natural logarithm of R&D expenditures divided by total sales.
lnEmpAca	natural logarithm of the employment share of employees with tertiary education.
smallFirm	Dummy variable; 1 represents firms with a firm size which ranges between 0 and 50. 0 otherwise.
midFirm	Dummy variable; 1 represents firms with a firm size which ranges between 51 and 250. 0 otherwise.
largeFirm	Dummy variable; 1 represents firms with a firm size larger than 251. 0 otherwise.
startUp	Dummy variable; 1 represents firms with a firm age not older than 15 years. 0 otherwise.
firmComp	represents the level of competitiveness. Share of exports on total turnover.
techPot	nominal variable; represents the general technological potential, i.e. scientifical and technological knowledge relevant to the firm's R&D or innovation activity (on a five point Likert-scale; 1 very low, 5 very high technological potential).
Construction	2-digit NACE classification code. Mining, construction, energy (10-14, and 40-41).
Consumer	Consumer goods (NACE code: 15-19)
intMedGoods	Intermediate goods (NACE code: 20-27)
invGoods	Investment goods (NACE code: 28-37)
TradServ	Traditional services excluding hotels and restaurants (NACE code: 50-52; 60-64)
KwServ	Knowledge-based services (NACE code:65-67; 72-74)
othServ	Other services (NACE code: 55; 70-71; 80; 8511; 853; 90; 92)

Table A.2 Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
lnInSales	3241	3.093259	1.17406	0	4.61512
coopPart	3673	1.133406	1.821309	0	7
coopPartSq	3673	0.6051642	0.8760086	0	2.645751
coFoc	3673	0.0481895	0.2141956	0	1
coMed	3673	0.154642	0.3616123	0	1
coDiv	3673	0.1415736	0.3486598	0	1
intCoSE	3673	0.2951266	0.9942759	0	7
intCoME	3673	0.4492241	1.258823	0	7
lnRDInt	2760	0.0319416	0.061157	0	0.6951563
lnEmpAca	3527	1.340143	1.190825	0	4.61512
smallFirm	3727	0.3748323	0.4841445	0	1
midFirm	3727	0.4156158	0.492894	0	1
largeFirm	3727	0.2240408	0.417005	0	1
startUp	3727	0.0284411	0.1662517	0	1
firmComp	3598	37.15567	37.54463	0	100
Construction	3727	0.0477596	0.2132858	0	1
Consumer	3727	0.0874698	0.2825602	0	1
intMedGoods	3727	0.1950631	0.3963024	0	1
invGoods	3727	0.4373491	0.4961259	0	1
TradServ	3727	0.0877381	0.2829516	0	1
KwServ	3727	0.1244969	0.3301919	0	1
othServ	3727	0.0201234	0.1404413	0	1
hiTecPot	3727	0.4199088	0.4936099	0	1

Source: Own calculations. Data derived from the Innovation survey conducted by the Swiss Economic Institute (KOF).

Table A.3 Cross correlation matrix

		1	2	3	4	5	6	7	8	9	10
1	coopPart	1.000									
2	coopPartSq	0.972	1.000								
3	coFoc	-0.019	0.097	1.000							
4	coMed	0.330	0.478	-0.097	1.000						
5	coDiv	0.834	0.738	-0.092	-0.179	1.000					
6	lnRDInt	0.109	0.118	-0.006	0.091	0.068	1.000				
7	lnEmpAca	0.219	0.226	0.028	0.110	0.163	0.319	1.000			
8	smallFirm	-0.142	-0.130	0.005	-0.019	-0.127	0.082	-0.098	1.000		
9	midFirm	-0.010	-0.011	-0.006	-0.010	-0.002	-0.077	-0.021	-0.631	1.000	
10	largeFirm	0.177	0.163	-0.005	0.031	0.153	-0.001	0.142	-0.395	-0.437	1.000
11	startUp	0.011	0.004	-0.016	0.002	0.001	0.023	0.009	0.004	-0.022	0.023
12	firmComp	0.222	0.215	0.012	0.073	0.177	0.209	0.225	-0.222	0.107	0.134
13	Construction	-0.032	-0.037	-0.011	-0.015	-0.032	-0.083	-0.070	-0.034	0.000	0.035
14	Consumer	-0.030	-0.034	-0.011	-0.032	-0.010	-0.103	-0.095	-0.040	0.003	0.036
15	intMedGoods	0.007	0.014	0.010	0.024	-0.003	-0.077	-0.011	0.002	0.001	-0.014
16	invGoods	0.075	0.065	-0.016	0.003	0.072	0.105	-0.020	-0.051	0.072	-0.018
17	TradServ	-0.066	-0.069	-0.004	-0.036	-0.051	-0.089	-0.117	0.032	-0.003	-0.026
18	KwServ	0.004	0.022	0.044	0.048	-0.017	0.166	0.314	0.096	-0.102	0.015
19	othServ	-0.064	-0.069	-0.029	-0.032	-0.046	-0.031	-0.098	0.033	-0.029	-0.007
20	hiTecPot	0.149	0.146	-0.004	0.054	0.120	0.158	0.185	-0.043	-0.006	0.051

continued		11	12	13	14	15	16	17	18	19	20
11	startUp	1.000									
12	firmComp	-0.001	1.000								
13	Construction	0.055	-0.198	1.000							
14	Consumer	-0.012	-0.113	-0.072	1.000						
15	intMedGoods	-0.002	-0.031	-0.114	-0.150	1.000					
16	invGoods	-0.027	0.442	-0.214	-0.283	-0.450	1.000				
17	TradServ	-0.007	-0.228	-0.068	-0.090	-0.143	-0.268	1.000			
18	KwServ	-0.012	-0.189	-0.084	-0.111	-0.177	-0.333	-0.106	1.000		
19	othServ	0.085	-0.084	-0.031	-0.040	-0.064	-0.121	-0.038	-0.048	1.000	
20	hiTecPot	0.013	0.172	-0.029	-0.037	0.004	0.055	-0.066	0.043	-0.060	1.000

Source: Own calculations. Data derived from the Innovation survey conducted by the Swiss Economic Institute (KOF).

References

Abramovsky, L., Kremp, E., Lopez, A., Schmidt, T., & Simpson, H. 2009. Understanding co-operative innovative activity: evidence from four European countries. *Economics of Innovation and New Technology*, 18(3): 243-265.

Aguirre, D., Post, L., & Hewlett, S. A. 2009. Global talent innovation: Strategies for Breakthrough Performance. *Strategy + Business*, 56: 39-49.

Ahuja, G. 2000. Collaboration networks, structural holes, and innovation: A longitudinal study. *Administrative Science Quarterly*, 45(3): 425-455.

Amara, N., & Landry, R. 2005. Sources of information as determinants of novelty of innovation in manufacturing firms: evidence from the 1999 Statistics Canada Innovation Survey. *Technovation*, 25(3): 245-259.

Arvanitis, S., & Bolli, T. 2012. A Comparison of National and International Innovation Cooperation in Five European couuntries. *Review of Industrial Organization*: forthcoming.

Atallah, G. 2002. Vertical R&D Spillovers, Cooperation, Market Structure, and Innovation. *Economics of Innovation and New Technology*, 11(3): 179-209.

Atuahene-Gima, K. 1995. An Exploratory Analysis of the Impact of Market Orientation on New Product Performance - a Contingency Approach. *Journal of Product Innovation Management*, 12(4): 275-293.

Bayona, C., Garcia-Marco, T., & Huerta, E. 2001. Firms' motivations for cooperative R&D: an empirical analysis of Spanish firms. *Research Policy*, 30(8): 1289-1307.

Becker, W., & Dietz, J. 2004. R&D cooperation and innovation activities of firms - evidence for the German manufacturing industry. *Research Policy*, 33(2): 209-223.

Belderbos, R., Carree, M., Diederen, B., Lokshin, B., & Veugelers, R. 2004a. Heterogeneity in R&D cooperation strategies. *International Journal of Industrial Organization*, 22(8,Äì9): 1237-1263.

Belderbos, R., Carree, M., & Lokshin, B. 2004b. Cooperative R&D and firm performance. *Research Policy*, 33(10): 1477-1492.

Bozeman, B. 2000. Technology transfer and public policy: a review of research and theory. *Research Policy*, 29(4-5): 627-655.

Brannen, M. Y. 2004. When Mickey loses face: Recontextualization, semantic fit, and the semiotics of foreignness. *Academy of Management Review*, 29(4): 593-616.

Brown, J. S., & Duguid, P. 2002. *The social life of information*. Boston, M.A.: Harvard Business School Press.

Caloghirou, Y., Ioannides, S., & Vonortas, N. S. 2003. Research joint ventures. *Journal of Economic Surveys*, 17(4): 541-570.

Cassiman, B., & Veugelers, R. 2002. R&D cooperation and spillovers: Some empirical evidence from Belgium. *American Economic Review*, 92(4): 1169-1184.

Chesbrough, H. W. 2003a. The era of open innovation. *Mit Sloan Management Review*, 44(3): 35-41.

Chesbrough, H. W. 2003b. Open innovation: The new imperative for creating and profiting from technology.

Chesbrough, H. W., Vanhaverbeke, W., & West, J. 2006. *Open innovation : researching a new paradigm*. Oxford: Oxford University Press.

Chiang, Y. H., & Hung, K. P. 2010. Exploring open search strategies and perceived innovation performance from the perspective of inter-organizational knowledge flows. *R & D Management*, 40(3): 292-299.

Chung, S., & Kim, G. M. 2003. Performance effects of partnership between manufacturers and suppliers for new product development: the supplier's standpoint. *Research Policy*, 32(4): 587-603.

Coase, R. H. 1937. The Nature of the Firm. *Economica-New Series*, 4(16): 386-405.

Cohen, W. M., & Levinthal, D. A. 1989. Innovation and Learning - the 2 Faces of R-and-D. *Economic Journal*, 99(397): 569-596.

Cohen, W. M., & Levinthal, D. A. 1990. Absorptive-Capacity - a New Perspective on Learning and Innovation. *Administrative Science Quarterly*, 35(1): 128-152.

Cook, S. D. N., & Brown, J. S. 1999. Bridging epistemologies: The generative dance between organizational knowledge and organizational knowing. *Organization Science*, 10(4): 381-400.

Coombs, R. 1996. *Technological collaboration : the dynamics of cooperation in industrial innovation*. Cheltenham, UK ; Brookfield, Vt., US: E. Elgar.

D'Aspremont, C., & Jacquemin, A. 1988. Cooperative and Noncooperative R&D in Duopoly with Spillovers. *American Economic Review*, 78(5): 1133-1137.

Dachs, B., Ebersberger, B., & Pyka, A. 2008. Why do firms cooperate for innovation? A comparison of Austrian and Finnish CIS3 results. *International Journal of Foresight and Innovation Policy*, 4(3): 200-229.

Das, S., Sen, P. K., & Sengupta, S. 1998. Impact of strategic alliances on firm valuation. *Academy of Management Journal*, 41(1): 27-41.

Dasgupta, P., & Stiglitz, J. 1980. Industrial-Structure and the Nature of Innovative Activity. *Economic Journal*, 90(358): 266-293.

de Faria, P., Lima, F., & Santos, R. 2010. Cooperation in innovation activities: The importance of partners. *Research Policy*, 39(8): 1082-1092.

Dodgson, M. 1991. Technology Learning, Technology Strategy and Competitive Pressures. *British Journal of Management*, 2(3): 133-149.

Dosi, G. 1988. Sources, Procedures, and Microeconomic Effects of Innovation. *Journal of Economic Literature*, 26(3): 1120-1171.

Dosi, G. 1997. Opportunities, incentives and the collective patterns of technological change. *Economic Journal*, 107(444): 1530-1547.

Doz, Y. L., Santos, J., & Williamson, P. J. 2001. *From global to metanational : how companies win in the knowledge economy*. Boston, Mass.: Harvard Business School Press.

Drejer, I., & Jorgensen, B. H. 2005. The dynamic creation of knowledge: Analysing public-private collaborations. *Technovation*, 25(2): 83-94.

Drucker, P. F. 1995. The Network Society. *International Forum on Information and Documentation*, 20(1): 5-7.

Engqvist, H., Edlund, S., Gomez-Ortega, G., Loof, J., & Hermansson, L. 2006. In vitro mechanical properties of a calcium silicate based bone void filler. *Bioceramics 18, Pts 1 and 2*, 309-311: 829-832.

Freel, M. S., & Harrison, R. T. 2006. Innovation and cooperation in the small firm sector: Evidence from 'Northern Britain'. *Regional Studies*, 40(4): 289-305.

Fritsch, M., & Lukas, R. 2001. Who cooperates on R&D? *Research Policy*, 30(2): 297-312.

Gemünden, H. G., Heydebreck, P., & Herden, R. 1992. Technological Interweavement - a Means of Achieving Innovation Success. *R&D Management*, 22(4): 359-376.

Granstrand, O., Oskarsson, C., Sjoberg, N., & Sjolander, S. 1990. Business strategies for development: Acquisition of new technologies. Chalmers University of Technology.

Grimpe, C., & Kaiser, U. 2010. Balancing Internal and External Knowledge Acquisition: The Gains and Pains from R&D Outsourcing. *Journal of Management Studies*, 47(8): 1483-1509.

Gulati, R. 1995. Social structure and alliance formation patterns: A longitudinal analysis. *Administrative Science Quarterly*, 40(4): 619-652.

Hagedoorn, J. 1993. Understanding the Rationale of Strategic Technology Partnering - Interorganizational Modes of Cooperation and Sectoral Differences. *Strategic Management Journal*, 14(5): 371-385.

Hagedoorn, J. 2002. Inter-firm R&D partnerships: an overview of major trends and patterns since 1960. *Research Policy*, 31(4): 477-492.

Hagedoorn, J., Link, A. N., & Vonortas, N. S. 2000. Research partnerships. *Research Policy*, 29(4-5): 567-586.

Henttonen, K., Ritala, P., & Jauhiainen, T. 2011. Exploring open search strategie and their perceived impact on innovation performance - Empirical evidence. *International Journal of Innovation Management*, 15(03): 525-541.

Hippel, E. v. 1988. *The sources of innovation*. New York: Oxford University Press.

Jaffe, A. 1996. Economic Analysis of Research Spillovers : implications for the Advanced Technology Program, *Advanced Technology Program*. Gaithersburg, MD.

Jaruzelski, B., Loehr, J., & Holman, R. 2012. The global innovation 1000: Making ideas work. *Strategy + Business*, Winter 2012(69).

Jimenez-Jimenez, D., & Sanz-Valle, R. 2005. Innovation and human resource management fit: an empirical study. *International Journal of Manpower*, 26(4): 364-381.

Kaiser, U. 2002. An empirical test of models explaining research expenditures and research cooperation: evidence for the German service sector. *International Journal of Industrial Organization*, 20(6): 747-774.

Katila, R. 2002. New product search overtime: Past ideas in their prime? *Academy of Management Journal*, 45(5): 995-1010.

Katila, R., & Ahuja, G. 2002. Something old, something new: A longitudinal study of search behavior and new product introduction. *Academy of Management Journal*, 45(6): 1183-1194.

Katila, R., Rosenberger, J. D., & Eisenhardt, K. M. 2008. Swimming with sharks: Technology ventures, defense mechanisms and corporate relationships. *Administrative Science Quarterly*, 53(2): 295-332.

Kesting, P., Mueller, S., Jorgensen, F., & Ulhoi, J. P. 2011. Innovation and network collaboration: an HRM perspective. *International Journal of Technology Management*, 56(2-4): 138-153.

Klevorick, A. K., Levin, R. C., Nelson, R. R., & Winter, S. G. 1995. On the Sources and Significance of Interindustry Differences in Technological Opportunities. *Research Policy*, 24(2): 185-205.

Kogut, B. 1988. Joint Ventures - Theoretical and Empirical-Perspectives. *Strategic Management Journal*, 9(4): 319-332.

Koput, K. W. 1997. A chaotic model of innovative search: Some answers, many questions. *Organization Science*, 8(5): 528-542.

Kotabe, M. 1990. The Relationship between Offshore Sourcing and Innovativeness of United-States Multinational Firms - an Empirical-Investigation. *Journal of International Business Studies*, 21(4): 623-638.

Laursen, K., & Foss, N. J. 2003. New human resource management practices, complementarities and the impact on innovation performance. *Cambridge Journal of Economics*, 27(2): 243-263.

Laursen, K., & Salter, A. 2006. Open for innovation: The role of openness in explaining innovation performance among UK manufacturing firms. *Strategic Management Journal*, 27(2): 131-150.

Leiponen, A., & Helfat, C. E. 2010. Innovation Objectives, Knowledge Sources, and the Benefits of Breadth. *Strategic Management Journal*, 31(2): 224-236.

Levinthal, D., & March, J. G. 1981. A Model of Adaptive Organizational Search. *Journal of Economic Behavior & Organization*, 2(4): 307-333.

Levinthal, D. A., & March, J. G. 1993. The Myopia of Learning. *Strategic Management Journal*, 14: 95-112.

Lichtenthaler, U. 2008. Open innovation in practice: An analysis of strategic approaches to technology transactions. *Ieee Transactions on Engineering Management*, 55(1): 148-157.

Lichtenthaler, U. 2011. Open Innovation: Past research, Current Debates, and Future Directions. *Academy of Management Perspectives*, 25(1): 75-93.

Liker, J. K., Collins, P. D., & Hull, F. M. 1999. Flexibility and standardization: Test of a contingency model of product design-manufacturing integration. *Journal of Product Innovation Management*, 16(3): 248-267.

Loof, H., & Heshmati, A. 2002. Knowledge capital and performance heterogeneity: A firm-level innovation study. *International Journal of Production Economics*, 76(1): 61-85.

Lundvall, B.-Å. 1992. User-producer relationships, national systems of innovation and internationalization, *National systems of innovation: towards a theory of innovation and interactive learning*: xiii, 342 p. London: Pinter Publishers.

March, J. G. 1991. Exploration and Exploitation in Organizational Learning. *Organization Science*, 2(1): 71-87.

Martin, S. 1994. Private and social incentives to form R & D joint ventures. *Review of Industrial Organization*, 9(2): 157-171.

Martin, S. 2002. Spillovers, appropriability, and R&D. *Journal of Economics*, 75(1): 1-32.

Metcalfe, J. S. 1994. Evolutionary Economics and Technology Policy. *Economic Journal*, 104(425): 931-944.

Miotti, L., & Sachwald, F. 2003. Co-operative R&D: why and with whom? An integrated framework of analysis. *Research Policy*, 32(8): 1481-1499.

Mowery, D. C., Oxley, J. E., & Silverman, B. S. 1996. Strategic alliances and interfirm knowledge transfer. *Strategic Management Journal*, 17: 77-91.

Mowery, D. C., Oxley, J. E., & Silverman, B. S. 1998. Technological overlap and interfirm cooperation: implications for the resource-based view of the firm. *Research Policy*, 27(5): 507-523.

Negassi, S. 2004. R&D co-operation and innovation a microeconometric study on French firms. *Research Policy*, 33(3): 365-384.

Nelson, R. R., & Winter, S. G. 1982. *An evolutionary theory of economic change*. Cambridge, Mass.: Belknap Press of Harvard University Press.

Nieto, M. J., & Santamaria, L. 2007. The importance of diverse collaborative networks for the novelty of product innovation. *Technovation*, 27(6-7): 367-377.

Nijssen, E. J., Van Reekum, R., & Hulshoff, H. E. 2001. Gathering and using information for the selection of technology partners. *Technological Forecasting and Social Change*, 67(2-3): 221-237.

Nonaka, I. o., & Takeuchi, H. 1995. *The knowledge-creating company : how Japanese companies create the dynamics of innovation*. New York: Oxford University Press.

Nooteboom, B. 1999. *Inter-firm alliances : analysis and design*. London ; New York: Routledge.

Ocasio, W. 1997. Towards an attention-based view of the firm. *Strategic Management Journal*, 18: 187-206.

OECD. 1992. *Proposed guidelines for collecting and interpreting technology innovation data. Oslo Manual.* Paris: Organisation for Economic Co-operation and Development.

OECD, & Eurostat. 2005. *Oslo manual : guidelines for collecting and interpreting innovation data* (3rd ed.). Paris: Organisation for Economic Co-operation and Development : Statistical Office of the European Communities.

Pavitt, K. 1988. International Patterns of Technological Accumulation. In N. Hood, & J.-E. Vahlne (Eds.), *Strategies in Global Competition*. London: Croom Helm.

Penrose, E. T. 1959. *The theory of the growth of the firm*. New York,: Wiley.

Pisano, G. P. 1990. The R&D Boundaries of the Firm: An Empirical Analysis. *Administrative Science Quarterly*, 35(1): 153-176.

Porter, M. E. 1980. *Competitive strategy : techniques for analyzing industries and competitors*. New York: Free Press.

Porter, M. E. 1990. *The competitive advantage of nations*. New York: Free Press.

Powell, W. W., Koput, K. W., & SmithDoerr, L. 1996. Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology. *Administrative Science Quarterly*, 41(1): 116-145.

Richardson, G. B. 1972. The Organisation of Industry. *The Economic Journal*, 82(327): 883-896.

Ritala, P., & Hurmelinna-Laukkanen, P. 2009. What's in it for me? Creating and appropriating value in innovation-related coopetition. *Technovation*, 29(12): 819-828.

Roberts, E. B. 1988. What Weve Learned - Managing Invention and Innovation. *Research-Technology Management*, 31(1): 11-29.

Rosenfeld, S. A. 1996. Does cooperation enhance competitiveness? Assessing the impacts of inter-firm collaboration. *Research Policy*, 25(2): 247-263.

Schuler, R. S., & Jackson, S. E. 1987. Linking Competitive Strategies with Human Resource Management Practices. *Academy of Management Executive (08963789)*, 1(3): 207-219.

Schuler, R. S., & Jackson, S. E. 2007. *Strategic human resource management* (2nd ed.). Malden, MA: Blackwell.

Schumpeter, J. A. 1939. *Business cycles; a theoretical, historical, and statistical analysis of the capitalist process* (1st ed.). New York, London,: McGraw-Hill Book Company, inc.

Schumpeter, J. A., & Opie, R. 1934. *The theory of economic development; an inquiry into profits, capital, credit, interest, and the business cycle*. Cambridge, Mass.,: Harvard University Press.

Sofka, W., & Grimpe, C. 2010. Specialized search and innovation performance - evidence across Europe. *R & D Management*, 40(3): 310-323.

Spence, M. 1984. Cost Reduction, Competition, and Industry Performance. *Econometrica*, 52(1): 101-121.

Teece, D. J. 1982. Towards an Economic-Theory of the Multiproduct Firm. *Journal of Economic Behavior & Organization*, 3(1): 39-63.

Teece, D. J. 1986. Profiting from Technological Innovation - Implications for Integration, Collaboration, Licensing and Public-Policy. *Research Policy*, 15(6): 285-305.

Teece, D. J. 1992. Competition, Cooperation, and Innovation - Organizational Arrangements for Regimes of Rapid Technological-Progress. *Journal of Economic Behavior & Organization*, 18(1): 1-25.

Tether, B. S. 2002. Who co-operates for innovation, and why - An empirical analysis. *Research Policy*, 31(6): 947-967.

Tsang, E. W. K. 2000. Transaction cost and resource-based explanations of joint ventures: A comparison and synthesis. *Organization Studies*, 21(1): 215-242.

Tseng, M. M., & Piller, F. T. 2003. *The customer centric enterprise : advances in mass customization and personalizaton*. Berlin ; New York: Springer.

Vuola, O., & Hameri, A. P. 2006. Mutually benefiting joint innovation process between industry and big-science. *Technovation*, 26(1): 3-12.

Wallin, M. W., & von Krogh, G. 2010. Organizing for Open Innovation: Focus on the Integration of Knowledge. *Organizational Dynamics*, 39(2): 145-154.

Weigelt, C. 2009. The Impact of Outsourcing New Technologies on Integrative Capabilities and Performance. *Strategic Management Journal*, 30(6): 595-616.

Whitley, R. 2002. Developing innovative competences: the role of institutional frameworks. *Industrial and Corporate Change*, 11(3): 497-528.

Williamson, O. E. 1975. *Markets and hierarchies, analysis and antitrust implications : a study in the economics of internal organization*. New York: Free Press.

Williamson, O. E. 1985. *The economic institutions of capitalism: firms, markets, relational contracting*. New York: Free Press.

Williamson, O. E. 1989. Transaction cost economics. In R. Schmalensee, & R. D. Willig (Eds.), *Handbook of industrial organization*. New York: Elsevier Science Pub. Co.

Wozniak, G. D. 1987. Human-Capital, Information, and the Early Adoption of New Technology. *Journal of Human Resources*, 22(1): 101-112.

Notes

[1] For example in Switzerland, the Commission for Technology and Innovation has increased its effort and devotes higher amounts of money for the support of cooperation arrangements of Swiss firms.

[2] Caloghirou et al. (2003) provide a detailed overview of theoretical perspectives regarding transaction cost economics, industrial organization, and (strategic) management literature.

[3] As not all firms in our panel are involved in R&D activities and we do not control for possible selection bias, our results can only be interpreted for firms, which conduct R&D. The Heckman procedure is one possibility to detect a possible bias in the sample.

[4] A joint significance of both variables would also allow assuming an inverted U-shape relationship (see for example Grimpe & Kaiser, 2010).

[5] Please refer to Table A.1 for detailed information on the variables.