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Analysis of SMEs partner proximity preferences for process innovation

By

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Analysis of SMEs partner proximity preferences for process innovation

Abstract

This paper explores small and medium enterprises (SMEs) proximity preferences when selecting partners for collaborative process innovation. Drawing on a survey of 362 Danish SMEs, we address four partner proximity characteristics: geographic, cognitive, organizational, and social. The results show that SMEs prioritize geographic openness over regional clustering. Furthermore, to simultaneously facilitate collaboration and ensure innovation, firms tend to collaborate with partners that are characterized by cognitive similarity at a technological level and knowledge distance at a market level. Technological proximity is also found to be more relevant than social proximity when it comes to bridging the potential geographic and market distance between the collaborative partners. Finally, the results indicate that the tendency of organizational proximity to facilitate informal interactions with partners enhances process innovation only at two of four process innovation levels. Thus, the results highlight the fact that the value of partner proximity characteristics change with the level of process innovation considered.

Keywords: Process innovation; proximity; partner collaboration

JEL classification: O31, O18, O38

Analysis of SMEs partner proximity preferences for process innovation

1. Introduction

Interfirm collaboration creates a knowledge pool that can be searched for innovation opportunities to give companies an innovative advantage (Prahalad and Ramaswamy, 2004). Collaboration with matching partners is important because it helps companies combine their resources, knowledge, and competencies to enhance their joint innovation efforts (Emden et al., 2006). This approach is especially beneficial for small and medium enterprises (SMEs) aiming to achieve economies of scale and scope by innovation (Gnyawali and Park, 2011; Gnyawali and Park, 2009). For SMEs, in fact, partnering with market peers and competitors is often a necessary condition for survival when facing competition from the larger players in the market (Nieto and Santamaría, 2010). However, the potential advantages of collaboration might be mitigated by the related drawbacks. Innovative collaboration between partners enhances the risk of losing proprietary knowledge, secrets, and control in the innovation process (Alvarez and Barney, 2001). This risk of opportunism by partners can be attenuated strategically by holding a portfolio of partners (Lavie, 2007). The multiplicity of benefits, risks, and partners stress the importance of understanding a firm's decision to collaborate with a particular partner.

The existing literature on the selection of partners for innovation purposes agrees on the role played by proximity for collaborative firms. Overall, an optimal degree of proximity is recognized to contribute to knowledge production for innovation by optimizing the trade-off between the need for coordination and understanding (Boschma, 2005; Huggings and Johnston, 2010; Jankowska and Pietrzykowski, 2013) and the inspirational advantage residing in novel distant knowledge (Ahuja and Katila, 2001). Recent literature reviews have identified four main partner proximity characteristics that are valued for interfirm innovation: (i) geographical proximity, which is measured as the spatial distance between partners; (ii) cognitive proximity, which points toward the similarity between the partners' knowledge bases; (iii) organizational proximity, which refers to the interrelation between the firms' structures and inner environments; and (iv) social proximity, which is defined as the strength of the relationship between partners (Aguilera et al., 2012; Balland, 2012; Boschma, 2005; Knobens and Oerlemans, 2006). Although these four dimensions have been discussed in several research works, to

our knowledge they have never been addressed simultaneously in a study related to process innovation. In fact, although several authors have addressed process innovation (Asheim and Isaksen, 1997; Hatch and Mowery, 1998; Kalantaridis, 1999; Lécuyer, 2006; Nieto and Santamaría, 2010; Panizzolo, 1998; Pisano, 1997; Santamaría et al., 2009), the relationship between proximity and collaborative innovation established in the literature typically follows a product-centered perspective (Hervas-Oliver et al., 2014; Reichstein and Salter, 2006). By addressing this gap in the literature, we aim to provide new insights on the value of the proximity dimensions between partners for collaborative process innovation.

Process innovation implies the implementation of new ways of operating (Mol and Birkinshaw, 2009). As such, it has direct impact on productivity and quality, which may also lead to further product innovation. Not surprisingly, it is the dominant form of innovation in the European Union (Eurostat, 2008-2012; Reichstein and Salter, 2006). For instance, in countries such as Hungary, Spain, Denmark, and Belgium, company innovation strategies are dominated by process innovation initiatives rather than by product innovation (Hervas-Oliver et al., 2016). This evidence has created a call for more research both by scholars (Damanpour, 2014) and by governments and international institutions as the OECD (OECD, 2008, 2015), to which the present study is a response. This paper explores the role of geographic, cognitive, organizational, and social proximity in a partner when the focal firm wants to initiate process innovation. Our study is performed on a sample of 362 Danish firms active in the manufacturing, construction, trade, service, and culture industries. Denmark represents an empirically important context for this study because Danish SMEs typically focus their strategy on process innovation rather than product innovation (Hervas-Oliver et al., 2016).

Overall, our investigation highlights the relevance of proximity in partner selection and leads to the conclusion that the impact of partner proximity on process innovation is not unidirectional but depends on the proximity dimension considered. The results show that, first, in their decision to collaborate with a particular partner on process innovation, firms are more likely to pursue geographical openness rather than regional clustering. Second, firms prefer to collaborate with partners that are characterized by cognitive similarity at technological level and distance at market level, in order to facilitate collaboration and simultaneously ensure innovation in business development. Third, our results regarding organizational proximity confirm only partially the expected preference for similar partners.

Fourth, social proximity is not found to be important for collaborative process innovation. Furthermore, our investigation digs into the concept of process innovation, discerning it into four sub-dimensions (strategy, structural, system, and procedural level of process innovation). The analysis of the impact of the four dimensions of partner proximity across these four sub-dimensions of process innovation allows us to give robustness to the results of our study while also highlighting interesting peculiarities.

This paper is organized as follows: First, the conceptual background is presented and the theory underpinning our hypotheses is discussed. The next section presents and discusses a detailed description of the data, descriptive statistics, and estimated regression results. Finally, the implications and limitations are described in the final section.

2. Conceptual background

In all business domains, collaboration between companies is part of the art of doing business. SMEs in particular, due to the resource and capability constraints imposed by their size, can enhance their ability to innovate by establishing a collaboration network with other companies and competitors (Asheim and Isaksen, 1997; Gnyawali and Park, 2011; Gnyawali and Park, 2009). Collaboration allows SMEs to reduce the risk of innovation-related investments and to more rapidly achieve the innovative outcome (Nieto and Santamaría, 2010). Moreover, although the advantages of collaboration are more visible and easier to measure when addressing product innovation, external knowledge from business partners can also benefit the more tacit and less visible dimension of process innovation (Santamaría et al., 2009; Un and Asakawa, 2015). Improving a firm's processes requires more than just imitating the superior practices of other companies. To obtain a successful change, external knowledge and practices first need to be decontextualized and then adapted to the focal firm (Brannen, 2004). Thus, collaboration between partners becomes crucial because the underlying knowledge that supports the adaptation of processes to a new context typically resides in the organization itself (Nieto and Santamaría, 2010; Panizzolo, 1998). Moreover, in the battle against competing technologies, which is waged in particular by SMEs, the value creation benefits from collaboration outweigh the threat of opportunistic behavior on the part of a partner and the risk of losing control (Morris et al., 2007). Within this framework, the purpose of the present

study is to understand the role played by proximity in partner selection for the purpose of process innovation. Toward this end, we first define process innovation and partner proximity before presenting our hypotheses.

2.1 Process innovation

Process innovation is defined as the introduction of new or improved methods into an organization's production processes, service operations, or distribution models (Reichstein and Salter, 2006; Un and Asakawa, 2015). Such process improvements help firms achieve greater operational efficiency by providing increased capacity and flexibility, by rationalizing the production process, and by decreasing labor, capital, and other costs (Hervas-Oliver et al., 2014; Stadler, 2011). As such, unlike product innovation, process innovation typically results in some degree of incremental innovation in which a process is made more efficient rather than radically changed (Stadler, 2011; Un and Asakawa, 2015). Moreover, although process innovation is more visible when it improves the technological aspect of a process, a successful result requires the implementation of managerial improvements (organizational process innovation) (Hervas-Oliver et al., 2016). For this reason, existing process innovation theory identifies the following four organizational levels of process innovation (Damanpour, 2014; Damanpour and Aravind, 2011; Hervas-Oliver and Sempere-Ripoll, 2015). First, the *strategy level* of process innovation refers to changes in the definition of a firm's goals or domains of activity (Gnyawali and Park, 2009; Hagedoorn, 1993) and to the establishment of new relationships through alliances and networks (De Luca and Atuahene-Gima, 2007). Second, the *structural level* of process innovation involves the organizational setting of the firm in terms of the division and allocation of business functions and the level of decentralization of management control. As such, it refers to the form of the organization (Miles et al., 2005; Mol and Birkinshaw, 2014) and to the decision of outsourcing (Hagedoorn, 1993) and of internalization (Heringa et al., 2014) of business divisions. Third, the *system level* of process innovation addresses the implementation and adoption of new or improved systems for knowledge management, administration, quality management, and resource allocation or other IT systems of office automation (Damanpour and Aravind, 2011; Ruiz-Moreno et al., 2016; Wang, 2010).

Finally, at the *procedural level* of process innovation, the firm implements changes at the administrative, control, and optimization levels to increase efficiency (Damanpour et al., 2009; Walker et al., 2011).

2.2 Collaboration and partner proximity

Partner proximity, which is typically defined as similarity, closeness, or relatedness between firms as determined by a variety of parameters, is an important precondition for knowledge sharing, knowledge transfer, and innovation in interfirm collaboration (Balland, 2012; Gertler, 1995; Lagendijk and Lorentzen, 2007). The original proximity dimension found to be relevant for innovation is the firm's spatial distance to collaborative partners (geographic proximity). Specifically, findings in economic planning and regional studies have fostered clustering theory, whose goal is to increase performance and innovation (Lagendijk and Lorentzen, 2007). The well-known case of Silicon Valley (Lécuyer, 2006; Saxenian, 1991) became the benchmark for planning regional development and innovativeness by local governments and states (Knoben and Oerlemans, 2006). However, more recently, the effect of geographic proximity on collaborative innovation has been found less significant (Autant-Bernard et al., 2007). For instance, some clusters of firms fail to innovate despite their geographical proximity (Kalantaridis, 1999; Lagendijk and Lorentzen, 2007; Letaifa and Rabeau, 2013). Thus, an interesting result of research on innovative collaboration is that proximity cannot be defined only in spatial terms; rather, the nonspatial characteristics of partners should also be considered when selecting partners for innovation (Boschma, 2005; Carrincazeaux et al., 2008; Mattes, 2012; Shaw and Gilly, 2000).

The main nonspatial characteristics of partners that are significant for interfirm collaboration on innovation are cognitive, organizational, and social proximity (Aguiléra et al., 2012; Balland, 2012; Boschma, 2005; Knoben and Oerlemans, 2006). First, cognitive proximity concerns the similarity or relatedness between the knowledge bases of partner firms. Second, organizational proximity is defined as the similarity of the managerial systems, which “refers to competencies and knowhow necessary to efficiently and effectively coordinate and supervise organizational resources and processes” (Sammarrà and Biggiero, 2008: 805). Third, social proximity stresses the degree of trust in the union of collaborating partners (Heanue and Jacobson, 2001; Letaifa and Rabeau, 2013), which determines the extent to which organizations are willing to exchange knowledge (Bakhshi and McVittie, 2009).

The importance of these nonspatial proximity dimensions to innovation performance has been demonstrated through empirical studies of patents (Crescenzi et al., 2016), science-industry alliances (Heringa et al., 2014), innovation performance (Oerlemans and Meeus, 2005), and the revenue share of new products (Gesing et al., 2015). In line with existing literature, the present study investigates how the geographic, cognitive, organizational, and social proximity characteristics of partners affect their selection for process innovation collaborations.¹

3. Hypotheses

We base our investigation on how the four types of partner proximity are valued when firms want to initiate process innovation activities on the existing literature. Because the link between partner proximity dimensions and innovation is investigated primarily by product-centered innovation studies (Autant-Bernard et al., 2007; Balland, 2012; Breschi and Lissoni, 2009; Hervás-Oliver et al., 2014; Rallet and Torre, 1999; Reichstein and Salter, 2006), we develop our hypotheses by including SMEs and process innovation arguments in the discussion of the existing literature to fit the specificities of the present investigation.

3.1 Geographic proximity

The physical distance between collaborative partners is the proximity dimension historically receiving the most attention by both researchers and practitioners. The study of innovation successes like Silicon Valley and Northern Italy has focused attention on geographical proximity between collaborating companies as a positive driver of regional innovation (Baptista and Swann, 1998; Huggings and Johnston, 2010; Jankowska and Pietrzykowski, 2013). The main claim of regional clustering theory is that the exchange of knowledge is facilitated by frequent face-to-face meetings, which render the development of informal interactions between potential partners more efficient (Boschma, 2005; Mitze et al., 2015; Rallet and Torre, 1999; Rehm and Goel, 2017). Other than providing a stimulating context

¹ The present study focuses solely on partner-selection criteria at the micro level. Although we acknowledge the debate of macro-level proximity for interfirm collaboration, this aspect is beyond the scope of this paper.

for learning and innovation (Asheim and Isaksen, 1997; Baptista, 2000), regional clusters are also helpful for small entrepreneurs as a means of sharing resources for administrative assistance, office space, and milieu so that the focus can remain on capturing the value of the innovation.

Another literature thread highlights the drawbacks of regional clustering theory. Local clusters may create lock-in effects from the overlap of spatial knowledge bases, and companies may be forced to access global networks to regain innovation momentum (Berchicci et al., 2016; Boschma, 2005). Several studies have also shown that geographic openness and establishing ties outside the region allow firms to increase their innovation performance (Davenport, 2005; Huggings and Johnston, 2010; Oerlemans and Meeus, 2005; Rallet and Torre, 1999; Tallman and Phene, 2007).

However, although extending a firm's spectrum of partners from a local to a global level can accelerate success (Letaifa and Rabeau, 2013; Mol and Birkinshaw, 2009), companies and especially SMEs exhibit bounded rationality and tend to collaborate locally (Boschma, 2005; Broekel and Boschma, 2012). This myopia of firms in focusing on local networks is also supported by the advantage provided to innovation by the exchange of tacit knowledge and local knowledge spillovers (Mitze et al., 2015; Rehm and Goel, 2017). In particular, when the collaboration concerns the optimization of internal processes such as production and quality processes, companies are likely to look for partners within their local networks. This tendency is supported by the fact that process-improvement targets, such as cost reductions, are typically defined internally by management and, as such, are expected to benefit from a close relationship with the potential partners (Un and Asakawa, 2015). Thus, we make the following hypothesis:

H1: Geographic proximity is a valued characteristic of a partner when the focal firm wants to initiate process innovation.

3.2 Cognitive proximity

The existing literature agrees that communication and absorption of knowledge is facilitated by cognitive proximity (Baum et al., 2010; Boschma, 2005; Breschi et al., 2003). In fact, similarities between partner knowledge bases increase mutual understanding and communication while reducing transaction costs (Baum et al., 2010; Boschma, 2005), thereby optimizing the extent to which partners

learn from each other (Knoben and Oerlemans, 2006). However, possessing related knowledge is not a sufficient condition for innovation. Empirical research supports this notion as a negative correlation has been established between innovation and cognitive proximity within strategic alliances (Aguiléra et al., 2012; Colombo, 2003; Heringa et al., 2014; Huber, 2012; Knoben and Oerlemans, 2006; Mowery et al., 1996; Nielsen, 2003; Nooteboom et al., 2007). The Schumpeterian argument is that a diverse knowledge base increases the possibility that the knowledge of partners is recombined into innovations, whereas knowledge similarity is found to maintain the status quo (Foss and Christensen, 2001; Vrande, 2013). However, the knowledge gap may be too large to transform knowledge combinations into innovation (Huber, 2012; Nooteboom et al., 2007; Vrande, 2013). This trade-off between distance and similarity highlights the cognitive proximity paradox. The corporate coherence theory (Teece et al., 1994) and the proximity paradox theory (Broekel and Boschma, 2012; Nooteboom, 2000b; Nooteboom et al., 2007) show that being cognitively too close or too distant inhibits learning and innovation. At the interfirm level, this can translate into the need of the collaborating firm to have a comparable knowledge base (proximity) to recognize a collaboration opportunity and simultaneously a diversified knowledge base (distance) to permit innovation and new learning (Aguiléra et al., 2012; Colombo, 2003; Heringa et al., 2014; Huber, 2012). Within the definition of cognitive proximity, the primary knowledge types for innovation are technological knowledge and market knowledge (Chamberlin et al., 2010; Emden et al., 2006; Sammarra and Biggiero, 2008). On the one hand, technological knowledge refers to the scientific, applied, and experimental knowledge that resides in the production and research and development functions of the partnering company (Sammarra and Biggiero, 2008; Schulze and Brojerdi, 2012). As such, technology-based collaborations are important growth trajectories for SMEs (Nieto and Santamaría, 2010). On the other hand, market knowledge originates in the marketing and sales functions of the partnering organization. It includes competencies and knowhow centered on customer and market characteristics, preferences, and needs (Garcia and Calantone, 2002; Sammarra and Biggiero, 2008). Grounded in the assumption that the absorption of knowledge from a partner is easier when the related knowledge aspects are similar (Colombo, 2003; Dyer and Singh, 1998; Gesing et al., 2015), our hypothesis in relation to cognitive proximity is built on the preferences of the focal firm in terms of the two dimensions of knowledge (technology and market) when handling the proximity paradox. We argue

that distance in one knowledge dimension has to be bridged by proximity in the other dimension (Boschma, 2005; Capaldo and Petruzzelli, 2014; Cohen and Levinthal, 1990; Knobens and Oerlemans, 2006; Schulze and Brojerdi, 2012). Thus, we expect that proximity plays two different roles when a company addresses the technological and market dimensions of cognitive proximity in collaborative innovation efforts.

Cognitive-technological proximity. The literature on strategic partners has established technological knowledge similarity as a partner-selection criterion (Nielsen, 2003). The proximity literature (Aguilera et al., 2012; Huber, 2012) and the co-opetition literature (Morris et al., 2007; Nieto and Santamaría, 2010) present coherent results. SMEs in particular typically tend to be specialized rather than diversified in their technological competencies (Gnyawali and Park, 2009). Thus, to access economies of scale, overcome the lack of internal resources, and increase their innovation speed, SMEs prefer to establish technological collaboration with business peers and competitors rather than with technologically distant partners (Gnyawali and Park, 2011; Nieto and Santamaría, 2010). Thus, we propose the following hypothesis:

H2a: Technological proximity is a valued characteristic of a partner when the focal firm wants to initiate process innovation.

Cognitive-market proximity. The identification of business opportunities that lead to innovation typically originates in a firm's network of customers and suppliers, who possess a diversified market knowledge base with respect to that of the focal firms (Bindroo et al., 2012; Capello and Faggian, 2005). Innovation collaboration with partners holding different market expertise enables a firm to align its business processes to new (foreign) market requirements (Hagedoorn, 1993). The cognitive diversity of the partners' market knowledge also offers the opportunity to gain economies of scope and synergies across different markets due to resource complementarity of the partners' processes (Bindroo et al., 2012; Capello and Faggian, 2005; Emden et al., 2006; Gnyawali and Park, 2011). The high uncertainties in markets tend to make companies increase diversity (Gnyawali and Park, 2009). Therefore, we expect firms to prefer partners with a market knowledge base that differs from their own. Thus, we propose the following hypothesis:

H2b: Low market proximity (diversity) is a valued characteristic of a partner when the focal firm wants to initiate process innovation.

In other words, a firm considers it relevant to collaborate for process innovation scopes with a partner that is characterized by knowledge proximity at the technological level (to facilitate collaboration), and knowledge distance at the market level (to ensure innovation and business development).

3.3 Organizational proximity

The ability of two firms to function together is contingent on whether their internal systems can be connected (Davenport, 2005; Lemarié et al., 2001). To this extent, similarity in organizational mechanisms ensures coordination and control of knowledge transactions, thereby reducing uncertainty and opportunism (Boschma, 2005; Heringa et al., 2014). Moreover, a resemblance of the managerial systems allows for interaction and collaboration between partners without prior definition of code of conduct. As such, organizational proximity has a positive effect on innovation by facilitating knowledge exchange (Broekel and Boschma, 2012), mutual understanding (Knoben and Oerlemans, 2006), and (involuntary) knowledge spillover (Gesing et al., 2015; Letaifa and Rabeau, 2013). In fact, the understanding of the tacit knowledge developed in a particular context and its translation into another user's setting is facilitated by the similarity between the two organizations (Spender, 1996; Szulanski, 1996; Un and Asakawa, 2015). Conversely, the existence of a large contextual distance between sender and recipient constitutes an important barrier to knowledge transfer (Argote and Ingram, 2000; Spender and Grant, 1996). These arguments hold in particular for large companies with very complex hierarchies and organizational systems. As such, organizational proximity may be less crucial for SMEs, which typically are less sophisticated in terms of organizational structure due to their smaller size. Furthermore, the network structure of SMEs makes their managerial systems more flexible to organizational changes and more prone to interaction. However, although organizational proximity is typically less significant for smaller companies, we acknowledge the positive role it plays in relation to knowledge transfer, which leads to the following hypothesis:

H3: Organizational proximity is a valued characteristic of a partner when the focal firm wants to initiate process innovation.

3.4 Social proximity

Social proximity can be considered as a measure of relationship strength. Rooted in the social embeddedness of economic exchange, it embraces aspects of structural embeddedness, i.e., the configuration of the relations, as well as aspects of relational embeddedness, i.e., the quality of the relations (Granovetter, 1985; Moran, 2005). The literature on social capital has established that the strengths of relationships between collaborating partners serve as a social control mechanism that governs partnership behavior (Rowley et al., 2000). The benefits of social proximity stem from the ability of strong relationships to encourage open communication, reduce the risk of opportunistic behavior, and lower the transaction cost of collaboration because of the emotional bond of relationships (Autant-Bernard et al., 2007; Bönte, 2008; Heringa et al., 2014; Knobens and Oerlemans, 2006).

However, although the existing literature agrees on the positive effect of social proximity on collaboration, trust, and knowledge transfer (Nielsen, 2003), its effect on innovation remains unclear (Nielsen, 2003). On the one hand, some studies find that social proximity acts as an accurate determinant of innovative performance (Vasco Eiriz and Barbosa, 2013) and patent filing (Heringa et al., 2014). On the other hand, social embeddedness theory, with its structural holes theory, holds a complementary view on the benefits of strong ties between collaborating partners (Burt, 1997). The insight forwarded here is that weak ties can give access to novel and unique information to a higher degree than strong ties, making weak ties more likely to lead to innovation (Burt, 1997; Granovetter, 1985; Moran, 2005; Rowley et al., 2000). Furthermore, SMEs engage in co-opetition, which means that the ties to partners (competitors) most often are weak and managed by contracts to reduce the risk of exploitation by either part (Gnyawali and Park, 2011). Interfirm network theory has shown that contact networks, where actors partake in nonformalized relations, and which are focused on accessing knowledge, are typical of the network approach used by process innovators (Sammorra and Biggiero, 2008).

Despite these contradictory findings and theories, collaboration for process innovation obliges the partnering companies to expose themselves. Thus, especially in the case of SMEs, which are typically more vulnerable when exposing their processes to business peers and competitors, we expect trust to be a fundamental for the relationship. Thus, we propose the following hypothesis:

H4: Social proximity is a valued characteristic of a partner when the focal firm wants to initiate process innovation.

4. Method

4.1 Data and Sample

Our data collection targeted companies with more than five employees that are active in the Central Jutland region of Denmark (Midtjylland) in December 2014. We addressed firms active in all the economic sectors except industries subject to either government regulation or public administration, or active in “agriculture, forestry, and fishing”, because they were not relevant for our investigation.² Thus, we focused on firms active in the following four macro-industries: manufacturing, construction, trade, and service or culture. In December 2014, there were 5941 firms with more than five employees active in Central Jutland in these four macro-industries. Within this population, we contacted all the firms of the region with over 50 employees and an approximately equal number of firms with size ranging from 10 to 49 employees and from 5 to 9 employees. No discernible differences existed between those who received the questionnaire and those who did not. To correct for the stratification, we constructed post-stratification weights such that the sample matched the population with respect to industry and size. To be more specific, all firms in the population were categorized according to the NACE classification into the four macro-industries and the three size categories mentioned above. The share (population-wise) within each combination of NACE classification and firm size was calculated. The same was done for all the firms in the sample. The ratios of the shares in the population to the shares in the sample were used as analytical weights.

Each firm that agreed to participate was directed to an online version of the questionnaire. We developed the questionnaire in English by using previous studies (Laursen and Salter, 2006; Leiponen

² Specifically, we excluded from the survey firms active in the following industries: agriculture, forestry, and fishing; electricity, gas, steam, and air-conditioning supply; water supply, sewerage, and waste management; financial and insurance; real estate; and public administration, education and health.

and Helfat, 2010) and existent surveys (such as the Community Innovation Survey—CIS) as reference. Next, the questionnaire was professionally translated into Danish to avoid the risk of misunderstandings when targeting Danish firms. Moreover, given the nature of the questions, we explicitly required that the survey be filled in by the person responsible for business development or innovation, because they would be the most knowledgeable source of information. Of the 952 firms that were contacted for the survey, 379 firms returned a completed questionnaire, whereas the remaining 573 firms either returned a partially completed questionnaire (184) or left it blank (389).

Next, to generate further data needed for the analysis, the data collected through the survey were merged with data from the European Business Register (EBR) for Danish companies. Due to missing data among the variables of interest in the EBR, the merger of the two datasets led to a final sample of 362 firms active in manufacturing (84 firms), construction (61 firms), trade (131 firms), and service or culture (86 firms). These firms had an average of 73 employees and an average age of 32 years from founding.

4.2 Variables

Dependent variables

Process innovation intention is the dependent variable in our analysis. It is considered both as an overall measure and at its four levels of specification: strategy, structural, system, and procedural. To address these four levels, we asked the companies surveyed to evaluate in terms of importance several organizational-change activities that a firm can plan for in order to initiate process innovation. We based this list of activities to be evaluated on the works of Jankowska and Pietrzykowski (2013), Nielsen (2003), and Oerlemans and Meeus (2005). The introductory request of the process innovation questions was “Please state if the following organizational changes are important goals for your company for the next three years.” A sample of the survey showing the full list of activities to be evaluated by the respondents is presented in Appendix A. For each of the organizational changes in the list, the respondent had the following four possible answers: no, partially, yes, top priority. This four-answer scale, which is based on that used in the work on external innovation sourcing by Laursen and Salter

(2006), was developed as a response to the disadvantages of binominal scales, which theretofore were typically used in process innovation studies (Damanpour, 2014).

The categorization of the full set of process innovation activities into strategy, structural, system, and procedural levels was done in one exploratory factor analysis, which used principal components and varimax rotation. The factor structure obtained (presented in Appendix B) is congruent with our conceptualization. Each of the four process innovation levels was then measured as the average of the related variables. Similarly, the overall measure of process innovation, which accounts for all the process innovation activities together, was created.

Independent variables

To build our proximity constructs, we used a set of questions inspired by Hansen (2014) and Boschma (2005). These questions refer to the specific characteristics of collaborating partners that guide their selection for process innovation (Hansen, 2014). The respondents were asked to state whether they regarded a stated partner proximity characteristic important (valuable) for collaboration. They chose their answer on a three-point scale (No/Partially/Yes) similar to the one used in the work of Leiponen and Helfat (2010).

Based on the existing literature, we grouped the questions into the five proximity dimensions. Polychoric correlations and the Cronbach's alpha (see Appendix C) were used to determine the structure and the robustness of proximity conceptualization for the sample of companies. Table 4 shows the list of questions for each proximity dimension.

Similarly to the construction of the process innovation measures, each proximity dimension was measured as the average of the answers to the related questions. We acknowledge that the four questions used for the cognitive-market proximity were formulated in a way opposite to all other questions. Specifically, a positive answer to those questions should be interpreted as importance given to low (as

opposed to high) market proximity.³ Therefore, to maintain coherence between the proximity constructs, we inverted the response scale when constructing the cognitive-market proximity variable.

Table 1 shows how process innovation and partner proximity correlate within and across constructs. Cronbach's alphas are displayed on the diagonal.

[insert table 1 about here]

Control variables

We controlled for several characteristics known to affect the process innovation initiatives of companies (Hervas-Oliver et al., 2014; Hervas-Oliver et al., 2016; Mol and Birkinshaw, 2009; Reichstein and Salter, 2006). The descriptive statistics of the sample with regard to the control variables are presented in Table 2.

[insert table 2 about here]

We gather data from the Danish EBR database to account for each company's industry, age, size, and financial performance. In terms of *industry*, which is tracked in the second digit of the NACE industrial classification, we group the firms into four macro-industries: manufacturing, construction, trade, and service and culture. In terms of *age*, we distinguish between three classes: young (1 to 5 years), medium (6 to 20 years), and mature firms (≥ 20 years). Company *size* is estimated by the number of employees. Finally, the company's *financial performance* is measured by the firm's gross profit at time $t - 1$, i.e. the year before the data collection is completed.

Furthermore, although we focus on process innovation, we acknowledge that product and process innovation are related within a firm's strategy and so may influence each other. Thus, we control for the resources that the company invests in product innovation. We gather data throughout our survey by asking a question whose design is congruent with that of a related question from the CIS.⁴ The

³ A respondent's "yes" answer has to be linked to the importance of choosing a partner with knowledge about markets that are new to the focal firm or in which the focal firm is not represented.

⁴ The CIS is a survey used at the European level since 1992 to gather information on the innovativeness of various sectors and regions.

introductory request of the product-innovation question is “Give the percentage of your company’s total current resources investment in the following three types of product innovation: Incremental, new to the firm, and new to the market product innovation.” Resources investment (RI) for incremental product innovation is defined as the “RI of your company to introduce goods and services only marginally modified compared to before.” The RI for new-to-the-firm product innovation is defined as the “RI of your company to introduce new or significantly improved goods or services that were already available from your competitors in your market.” Finally, the RI for new-to-the-market product innovation is defined as the “RI of your company to introduce new or significantly improved goods or services onto your market before your competitors.”

The model used in our analyses is expressed in Equation (1):

$$\begin{aligned}
 \text{Planned Process Innovation} = & \\
 &= \alpha + \beta_{1-3,t} \text{Industry dummies} + \beta_{4,t-1} \text{Financial Performance} \\
 &+ \beta_{5,t} \text{Size} + \beta_{6-7,t} \text{Age dummies} \\
 &+ \beta_{8-9,t} \text{Resources Investment dummies} \\
 &+ \beta_{10,t} \text{Geographic Proximity} \\
 &+ \beta_{11,t} \text{Cognitive Technology Proximity} \\
 &+ \beta_{12,t} \text{Cognitive Market Proximity} \\
 &+ \beta_{13,t} \text{Organizational Proximity} + \beta_{14,t} \text{Social Proximity}
 \end{aligned} \tag{1}$$

where the planned process innovation is an overall measure in addition to its four levels of specification: strategy, structural, system, and procedural.

5. Results and discussion

5.1 Descriptive results

The descriptive results provide a general overview of the process innovation intentions and the valued partner proximity characteristics for the companies sampled. The main figures (mean, count, and percentages) describing the importance of the intended process innovation activities are listed in Table 3. Overall, the sample gives priority, defined by the answers “yes” and “top priority”, to “market position enhancement” (57.5%), “strategic alliance building” (37.58%), and “focus the company’s strategy on

innovation” (37.31%). Observing in more detail the single levels, the results indicate that, first, strategy-level changes are ranked as very important for the entire sample (mean = 2.362). Second, the structural level of process innovation is relatively less important to the companies. Specifically, process changes involving outsourcing and internationalization are given lowest priority among the sample companies (mean = 1.768), but internalization is the highest-priority organizational change planned for (28.41%) at this level of process innovation. Third, for process innovation involving system changes, the results are mixed. Specific investments in embodied technologies, such as total quality management (TQM), enterprise resource planning (ERP), and logistics systems, are not given priority (<46.13%), whereas implementation of more IT to manage business activities (i.e., administrative IT, 37.64%) and resources (32.6%) are seen as important management innovations (mean = 2.081). An explanation of the mixed results for the technology priorities embodied in the sample could be the faded hype of TQM and ERP since the 1990s. Companies no longer see the need to implement these to remain at the forefront of IT (Wang, 2010). Finally, procedural changes targeting efficiency management are also a priority (mean = 2.018). Thus, the planned process innovations seem to be ranked as follows: strategy, procedural, system (administrative IT), and structural levels of process innovation.

[insert table 3 about here]

Table 4 provides the mean and distribution of respondents for the importance of each partner proximity characteristic in interfirm collaborations. Overall, the five partner characteristics are assigned equal value by the companies sampled. The top three proximity characteristics are (i) the partners’ ability to “support access to new markets” (44.5%), (ii) to be “located in Denmark” (39.0%), and (iii) to “know and understand the local culture in a new market” (34.8%). With regard to geographic proximity, a partner should be located in Denmark (39.0%) but not necessarily close by (37.57%). These findings illustrate the difference between “close” and “national” in the understanding of the value of a partner’s geographic proximity. Coupled with “frequent physical interaction,” which is partially important (51.4%) to the companies sampled, “being located in Denmark” could be interpreted as an attractive but unnecessary condition for selecting the given partner. Cognitively, technological relatedness is preferred but only partially important (52.5%). In contrast, a partner that can “support access to” (44.5%) and that

“holds knowledge and understanding of” (34.5%) new markets is important, but the partner does not have to be located in the new market (17.1%). Overall, a cognitive distance to a partner is given a positive value by the focal firm, and the companies sampled in particular value partners that bring knowledge about new markets into the interfirm collaboration. Organizational proximity is valued as partially important (48.1%) by the companies sampled. Finally, the most valuable option is maintaining a long-term relationship with the selected partner, which is at least partially important for 81.44% of the companies sampled.

Thus, the descriptive valuation of partner proximity characteristics finds that social proximity is positively valued. Geographic, cognitive-technological, and organizational proximities are partially valued in partners, whereas distance is more valuable for cognitive-market proximity. The next section presents and discusses how these partner proximity characteristics influence process innovation intentions.

[insert table 4 about here]

5.2 Regression results

Regression analysis was applied to empirically test the hypotheses. The regressions were estimated using STATA 14.0 and applying the Huber–White correction (robust regressions). The coefficients give the value of the partner proximity characteristics for the focal firms’ process innovation planning. Positive (negative) coefficients mean that proximity is (not) a valued characteristic of partners. Table 5 shows the six models estimated in our analysis. Model 1 holds fixed the estimated control-variable effects (see Table 2), models 2–5 test the value of each partner proximity characteristic for the overall process innovation planning, and model 6 is the full model. We followed the same procedure when investigating the four process innovation levels of organizational changes (Table 6). Table 6 shows the full model (model 6) for the four process innovation levels of organizational change, skipping the intermediary steps of models 1 to 5 for the sake of brevity.⁵

[insert table 5 about here]

⁵ The model estimates not reported in the text for the sake of brevity are available upon request.

[insert table 6 about here]

Model 1 in Table 5 shows the effect of the sample's control variables. The results show that, for the various industries represented in the sample, construction and service companies are less likely than manufacturing firms to commit to process innovation. Table 5 also shows that a company's financial performance has a positive effect on the engagement in process innovation ($\beta = 0.138$). However, this effect only holds at the system level ($\beta = 0.162$), which often requires capital investments in embodied technology (Wang, 2010). Finally, company age and size does not influence the planning of organizational-process changes for process innovation. We also control for the resources invested in product innovation to secure unbiased results for the impact of proximity characteristics on process innovation. The insignificance of the coefficients related to investment in product-innovation resources in the full models (model 6 in both Tables 5 and 6) provides evidence that these results are truly representative of process innovation.

Hypothesis 1 states that a firm is expected to assign a positive value to geographic proximity in a partner when initiating a collaboration to promote process innovation. However, model 2 (Table 5) shows that the individual test of the value of geographic proximity is insignificant for the overall process innovation and for the four levels of process innovation. Furthermore, in the full model 6, both in Tables 5 and 6, the geographic proximity of partners gives a significant negative value for overall process innovation ($\beta = -0.089$), for the strategy ($\beta = -0.095$), and for the structural ($\beta = -0.132$) levels of process innovation. This means that we cannot find support for Hypothesis 1 as proposed. Instead, the results show that SMEs prefer global networks rather than local networks. Although surprising, this result suggests that the coordination mechanisms and interaction benefits that were expected to be linked to geographic relatedness between partners can instead be related to nonspatial proximity dimensions (Boschma, 2005; Rallet and Torre, 1999). The results presented in Table 6 support this conclusion.

According to the construction of Hypothesis 2, the cognitive proximity of partners addresses the various roles played by technological and market knowledge in process innovation. As such, handling the enigma of the cognitive proximity paradox means using proximity in one knowledge dimension (technological proximity) to bridge the distance in the other dimension (market knowledge), thereby

simultaneously facilitating collaboration and innovation (Baum et al., 2010; Nooteboom, 2000a). The results show that these two knowledge dimensions have a significant impact on process innovation both individually (model 3 of Table 5) and when included in the full model (model 6 of Tables 5 and 6). In detail, based on the results of the full model 6, cognitive-technology proximity has a positive influence on overall process innovation ($\beta = 0.240$) and on all of its sublevels: strategy ($\beta = 0.186$), structural ($\beta = 0.125$), system ($\beta = 0.222$), and procedural ($\beta = 0.121$). Regarding cognitive-market proximity, the regression results in Table 5 show that a partner's market knowledge distance is valued for the focal firm's initiation of overall process innovation ($\beta = -0.212$). This finding is consistent across all levels of planned process innovation (see Table 6). Thus, the results support our hypotheses H2a and H2b or, in other words, that the technological proximity of partners facilitates understanding and collaboration, whereas market knowledge diversity gives access to novelty needed for innovativeness. The top priority given to strategy process innovations shown in Table 3 supports that this partnering approach is taken by the firms sampled. For the SMEs sampled, "building strategic alliances," "enhancement of market position", and "focus on innovation strategy" are given the highest priority. Interestingly, the cognitive proximity effect on process innovation is not a zero-sum game of technological and market knowledge for all four process innovation types. For the overall process innovation and at the strategy level, the sum of the positive coefficient for technological proximity and the negative coefficient for market proximity in Tables 5 and 6 is close to zero. Structural and procedural process innovations are concerned with reorganization of the focal company through activities such as withdrawal from unprofitable fields, internalization, and outsourcing (see Table 3). To a larger degree, these activities are market related, which may explain why market knowledge diversity (low proximity) of partners exerts more influence at these levels of process innovation than technological proximity to the focal firm. At the system level, technological proximity outweighs market knowledge diversity. One explanation for this result may be that firms seeking new and efficient IT to implement process innovation are simply "jumping on the bandwagon". Adopting IT institutionalized by technologically proximate partners adds legitimacy to the process innovation proposed by the focal firm (Wang, 2010). These nuances within cognitive proximity of partners stress that, although technological and market knowledge play different roles in resolving the cognitive-proximity paradox, the type of process innovation being initiated must also be considered.

Hypothesis 3 concerns organizational proximity, which is defined as similarity in managerial systems and mechanisms between collaborating firms. The results in Table 5 show that organizational proximity of partners exerts a significant effect on overall process innovation planning, both individually in model 4 ($\beta = 0.233$) and in the full model 6 ($\beta = 0.083$). Moreover, when addressing separately the four levels of organizational change, the results reveal interesting nuances about the role played by organizational proximity. Although having a positive effect on process innovation when tested for individually, the results in Table 6 show that only for the strategy ($\beta = 0.186$) and structural ($\beta = 0.098$) levels does organizational proximity maintain its value as a partner characteristic in the full model. Thus, Hypothesis 3 is partially supported. The reduced effects of organizational proximity from the individual models (Table 5) to the full models (last columns of Tables 5 and 6) indicate a potential association of partners' organizational proximity with other proximity characteristics. In particular, research indicates that cognitive and organizational proximity are systematically the most closely associated characteristics of partners (Aguilera et al., 2012; Knobens and Oerlemans, 2006) and that cognitive proximity of partners might replace organizational proximity (Davenport, 2005). In this respect, it is interesting that similitude of organizational systems between collaborating partners is significant for externally oriented process innovation activities (strategy and structural levels) whereas, for internally oriented organizational changes (system and procedural levels), organizational proximity becomes insignificant. Thus, externally oriented process innovation creates a need of organizational proximity of partners in addition to cognitive proximity. This distinction between the types of process innovation provides explanation for the mixed results in the literature for organizational proximity and innovation (Boschma, 2005).

Social proximity enables focal companies to predict fairly accurately the benefits of engagement with the selected partner. Thus, Hypothesis 4 reflects our expectation that social proximity has a positive value for process innovation intentions. However, the results in Tables 5 and 6 show that social proximity is mainly insignificant for process innovation planning, leading to the rejection of Hypothesis 4. Although surprising, because social proximity is a top-rank partner characteristic in the strategic alliance literature (Lin and Darnall, 2015), this result is consistent with the work of Nielsen (2003), who finds that social proximity does not have a direct effect on innovation. Moreover, we believe that, for our finding, two categories of explanations exist: one simple, the second more nuanced and complex.

The first response reflects what we would describe as a “co-opetition” explanation. The key point is that SMEs engage in process innovation with their competitors to overcome resource and competence limitations (Gnyawali and Park, 2009). These collaborations are contracted as SMEs collaborate to create value but compete to capture value (Cairo, 2006). We would describe the second category of answers as the “proximity substitution” explanation. Here the key question is what partner characteristics can replace relationship strength (social proximity). The results show that partners are technologically similar but operate in new markets. In addition, partners are not necessarily close geographically. New partners emerge as the organization moves in its knowledge space (Baum et al., 2010). In other words, technological similarity makes collaboration safer. It is therefore reasonable to deduce that SMEs replace social proximity for technological proximity in their partner selection preferences.

To check the robustness of our analysis, we re-ran the models, controlling for the interaction between the five proximity dimensions and the four industry classes. Our results remain unchanged by the inclusion of proximity-industry interactions in the models. The table presenting the results with the overall planned process innovation as dependent variable are displayed in Appendix D.⁶

6. Conclusion

The purpose of this research is to explore valued partner proximity characteristics of SMEs when initiating process innovation at various organizational levels. Our study is, therefore, based on the assumption that the evaluation of potential collaborative partners reflects a company’s past experiences and simultaneously its current needs in terms of resources, knowledge, and competencies to fulfill business development and innovation. Drawing on a survey of 362 Danish SMEs and their process innovation initiatives, we address the value of four partner proximity characteristics: geographic, cognitive, organizational, and social. The results show that SMEs prioritize geographic openness over

⁶ The results of the analysis performed for each of the four levels of process innovation (i.e., strategy, structural, system, and procedural level) are not reported for the sake of brevity but are available upon request.

regional clustering. Furthermore, to simultaneously facilitate collaboration and ensure innovation and business development, firms tend to collaborate with partners that are characterized by cognitive similarity at a technological level and knowledge distance at a market level. The facilitating role of technological proximity, well accepted in interfirm collaboration theory, is very interesting with regard to process innovation, as most of the existing innovation-management literature suggests instead that a degree of technological diversity is a necessary condition for innovativeness (Garcia and Calantone, 2002) and innovation performance of the focal firm (Ahuja and Katila, 2001; Vrande, 2013). The role of technological proximity is indeed complex. Our results suggest in fact that technological proximity functions also to bridge the eventual geographic and market distance between the collaborative partners. In these terms, technological proximity is found to provide the relational security traditionally associated with social proximity. Thus, technological proximity between firms is a necessary condition for interfirm collaboration to be identified as an opportunity for process innovators because it provides a bridge to absorb new knowledge, overcomes physical distances, and provides operational security. Finally, the results indicate that the tendency of organizational proximity to facilitate informal interactions with partners enhances process innovation only at two (strategy and structural) over four process innovation levels. Thus, our analyses lead to the conclusion that SMEs partner proximity preferences are unique sets for each process innovation type. Thereby, this investigation of proximity and partner selection for process innovation contributes to a growing line of research on the innovation performance of interfirm knowledge networks (Capaldo and Petruzzelli, 2014; Huggings and Johnston, 2010; Reichstein and Salter, 2006).

6.1 Implications

For managers and business owners, our findings suggest that the result of process innovation is contingent on the degree of new market knowledge as opposed to the degree of new technological knowledge held by partnering firms. Although we cannot discriminate between the communicative role and the technological exploitative function of technological proximity, the patterns that appear in the data suggest that the more challenging it is to understand new markets, the more likely the focal firm is to select a partner within a technologically familiar reference group. However, this may lead to the risk

of reducing the eventual innovation result due to the reduced cognitive gap between the partners (Mol and Birkinshaw, 2009). Moreover, our results show that organizational proximity is particularly relevant for the externally oriented levels of process innovation. Thus, managers should take into account the potential competence trap induced by neighborhood firms (Leonard-Barton, 1992).

For policy makers, the present results shed light on what hampers policy instruments for countries or regions that are dominated by process innovating companies. The results show that firms with a process innovation focus are more likely to select nonlocal partners. This implication is important for policy makers because they often aim at creating a “new Silicon Valley” (Engel, 2015). However, policy decisions that follow primarily pure clustering theory defining clusters by industry and by industrial scale infrastructure (internet, technological, and logistic) do not optimally support the collaboration between firms for process innovation changes in the organization (Letaifa and Rabeau, 2013). Thus, such clustering policy programs may be counterproductive for countries whose dominant form of innovation is process innovation because such programs are not likely to provide a return on investment. Instead, what emerges is the need that the local development plan encourages SMEs to integrate themselves into global value chains, to form cross-industry horizontal networks with peers, and to establish clusters defined by process (Engel, 2015). SMEs may also find beneficial the establishment of local intermediary bodies between their local environment and national or international institutions. In fact, as innovation is multifaceted and involves a complex learning and implementing process, the presence of intermediaries may help the creation of a more diverse network (Asheim and Isaksen, 1997; Howells, 2006). Policy makers are advised to build upon existing capabilities and sources of competitive advantage instead of engineering entirely new clusters (Engel, 2015).

6.2 Limitations and suggestions

Although this study provides interesting insights, we acknowledge that it has two main limitations. First, our results stem from analysis on data gathered in a Western cultural approach to interfirm collaboration. Though research has found similarities in innovation practices between Scandinavian and US companies (Kleinschmidt, 1994; Souder and Jenssen, 1999), studies of partner

proximity preferences in Asian-Pacific and Middle-Eastern contexts would be valuable for a full understanding of firms' decision to collaborate with a particular partner.

Second, our study focuses on investigating the preferred partner profile for process innovation, whereas addressing the collaboration's dynamics and outputs goes beyond the scope of this work. Case studies or network studies of interfirm collaboration on process innovation and organizational-process innovation would provide an opportunity for follow-up research. By having contributed with knowledge about various levels of process innovation in firms, we call for more research on interfirm collaboration networks for process innovation.

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Tables

Table 1. Correlation table

Variable	1	2	3	4	5	6	7	8	9	10	Mean	Std. Dev.
1 Process innovation	0.805										2.008	0.502
2 Strategy level	0.78*	0.712									2.362	0.635
3 Structural level	0.61*	0.40*	0.531								1.768	0.703
4 System level	0.84*	0.49*	0.297*	0.767							1.888	0.649
5 Procedural level	0.59*	0.29*	0.302*	0.352*	0.547						2.018	0.682
6 Geographic	−0.04	−0.05	−0.082	0.001	0.007	0.607					1.918	0.523
7 Cognitive-Technology	0.35*	0.31*	0.22*	0.278*	0.19*	0.14*	0.678				1.930	0.591
8 Cognitive-Market	−0.34*	−0.29*	−0.28*	−0.22*	−0.24*	−0.19*	−0.33*	0.643			1.942	0.459
9 Organizational	0.25*	0.314*	0.191*	0.092	0.089	0.175*	−0.374*	0.391*	0.448		1.918	0.454
10 Social	0.07	−0.047	0.018	0.112*	0.090	0.258*	−0.148*	0.128*	0.008		2.414	0.644

Notes: The table presents the correlation coefficients within and between the constructs of dependent and independent variables used in the empirical analysis. For each of the variables, Cronbach's alphas are displayed on the diagonal and descriptive statistics (mean and standard deviation) are displayed in the two columns on the left side of the table. Sample size: 362 observations.

*indicates statistical significance at 5% level.

Table 2. Descriptive statistics of control variables

Variable	Observations	Mean
Industry		
<i>Manufacturing (%)</i>	84	23.3
<i>Construction (%)</i>	61	16.7
<i>Trade (%)</i>	131	36.3
<i>Service/culture (%)</i>	86	23.7
Age		
<i>0–5 years (%)</i>	23	6.4
<i>6–20 years (%)</i>	122	33.7
<i>20+ years (%)</i>	217	59.9
Size		
<i>Number of employees</i>	362	73.11
Financial performance		
<i>Gross profit (DKK)</i>	362	39 220
RI for type of product innovation (PI)		
<i>Incremental PI (%)</i>	362	42.79
<i>New-to-the-firm PI (%)</i>	362	39.31
<i>New-to-the-market PI (%)</i>	362	17.9

Notes: The table presents the descriptive statistics (mean value or percentage) with regard to the control variables ($n = 362$).

Table 3. Descriptive statistics for planned process innovation measures

Planned process innovation	Mean	Importance							
		No		Partially		Yes		Top priority	
		%	(N)	%	(N)	%	(N)	%	(N)
Strategy level	2.362								
<i>Building strategic alliances</i>	2.207	22.93	(83)	39.5	(143)	31.49	(114)	6.08	(22)
<i>Enhancement of the company's market position</i>	2.630	12.15	(44)	30.39	(110)	39.78	(144)	17.7	(64)
<i>Focus the company's strategy on innovation</i>	2.249	20.44	(74)	42.27	(153)	29.28	(106)	8.01	(29)
Structural level	1.768								
<i>Moving some functions to other firms</i>	1.677	55.24	(200)	24.31	(88)	17.96	(65)	2.49	(9)
<i>Internationalization of the company's activities</i>	1.859	50.56	(183)	20.99	(76)	20.44	(74)	8.01	(29)
System level	1.888								
<i>Implementation of quality systems (ISO, TQM, HACCP, etc.)^a</i>	1.773	53.59	(194)	20.72	(75)	20.44	(74)	5.25	(19)
<i>Implementation of resource planning system (ERP)^b</i>	1.691	55.8	(202)	23.76	(86)	16.02	(58)	4.42	(16)
<i>Implementation of logistics systems</i>	1.815	46.13	(167)	29.56	(107)	20.99	(76)	3.32	(12)
<i>Implementation of systems for recording the company's activities and resources</i>	2.028	34.53	(125)	32.87	(119)	27.9	(101)	4.7	(17)
<i>Implementation of IT systems</i>	2.133	29	(105)	33.43	(121)	32.87	(119)	4.7	(17)
Procedural level	2.018								
<i>Implementation of modern models to report costs</i>	1.912	35.37	(128)	40.88	(148)	20.99	(76)	2.76	(10)
<i>Withdrawal from unprofitable fields of activity</i>	2.124	25.41	(92)	41.44	(150)	28.45	(103)	4.7	(17)

Notes: Descriptive statistics of the *planned process innovation* measures: The headline of the process innovation questions is “Please state if the following organizational changes are important goals for your company for the next three years.” For each of the organizational changes of the list, the respondent could choose from among the answers: no; partially; yes; top priority. Sample size: 362 observations.

^aDefinition of acronyms (quality systems). ISO: International Organization for Standardization; TQM: Total Quality Management; HACCP: Hazard analysis and critical control points.

^bDefinition of acronyms. ERP: Enterprise Resources Planning.

Table 4. Descriptive statistics for partner proximity measures

Proximity	Mean	Importance					
		No		Partially		Yes	
		%	(N)	%	(N)	%	(N)
Geographic	1.918						
<i>Are geographically close (same neighborhood/town)</i>	1.784	37.57	(136)	46.41	(168)	16.02	(58)
<i>Are located in Denmark</i>	2.202	18.78	(68)	42.27	(153)	38.95	(141)
<i>Make frequent interaction physically possible</i>	1.77	35.91	(130)	51.38	(186)	12.71	(46)
Cognitive-Technology	1.93						
<i>Work with similar or related technology</i>	1.956	25.97	(94)	52.49	(190)	21.54	(78)
<i>Are active in related technological disciplines</i>	1.903	27.62	(100)	54.42	(197)	17.96	(65)
Cognitive-Market	1.942						
<i>Can support access to a new market</i>	2.372	7.18	(26)	48.34	(175)	44.48	(161)
<i>Operate in markets where we are not represented</i>	1.784	35.91	(130)	50	(181)	14.09	(51)
<i>Are located in new markets</i>	1.878	29.28	(106)	53.59	(194)	17.13	(62)
<i>Know and understand the local culture in a new market</i>	2.199	14.92	(54)	50.28	(182)	34.8	(126)
Organizational	1.918						
<i>Have similar organizational mechanisms</i>	1.707	40.61	(147)	48.07	(174)	11.32	(41)
<i>Have complementary managerial knowledge</i>	2.11	17.4	(63)	53.87	(195)	28.73	(104)
Social	2.414						
<i>With whom we have established long-term relations.</i>	2.414	8.56	(31)	41.44	(150)	50	(181)

Notes: Descriptive statistics of the respondents' *evaluation of partner proximity characteristics*. The headline of the process innovation questions is "With regard to the planned process innovation of your company, please state if it is important to collaborate with partners (that):" For each of the proximity characteristics of the list, the respondent could choose from among the answers: no; partially; yes. Sample size: 362 observations.

Table 5. Estimates for overall planned process innovation

	Overall planned process innovation					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Industry ^a						
<i>Construction</i>	−0.136** (−1.97)	−0.141** (−2.02)	−0.111* (−1.67)	−0.138** (−2.03)	−0.141** (−2.06)	−0.098* (−1.46)
<i>Trade</i>	−0.048 (−0.57)	−0.045 (−0.53)	0.007 (0.08)	−0.042 (−0.50)	−0.046 (−0.55)	−0.003 (−0.04)
<i>Service/culture</i>	−0.103* (−1.42)	−0.104* (−1.44)	−0.108* (−1.60)	−0.151** (−2.14)	−0.101* (−1.41)	−0.120* (−1.78)
Financial performance	0.226**	0.228**	0.171*	0.196*	0.210*	0.146
<i>Gross profit (log)</i>	(2.11)	(2.11)	(1.83)	(1.91)	(1.96)	(1.55)
Size	−0.023	−0.025	0.006	−0.007	−0.010	0.026
<i># of employees (log)</i>	(−0.22)	(−0.24)	(0.06)	(−0.07)	(−0.10)	(0.28)
Age ^b	−0.039	−0.041	−0.025	−0.042	−0.035	−0.017
<i>Young (1–5 years)</i>	(−0.64)	(−0.67)	(−0.48)	(−0.74)	(−0.57)	(−0.33)
<i>Medium (6–20 years)</i>	−0.038 (−0.60)	−0.040 (−0.63)	−0.054 (−0.94)	−0.035 (−0.57)	−0.046 (−0.75)	−0.048 (−0.85)
RI for type of product innovation (PI) ^c						
Incremental PI	−0.120* (−1.49)	−0.122* (−1.51)	−0.077 (−1.02)	−0.117* (−1.47)	−0.124* (−1.57)	−0.074 (−0.98)
New-to-the-market PI	0.102* (1.41)	0.101* (1.38)	0.073 (1.09)	0.058 (0.80)	0.104* (1.41)	0.066 (0.98)
Proximity						
<i>Geographic</i>		0.022 (0.31)				−0.089* (−1.47)
<i>Cognitive-Technology</i>			0.256*** (4.15)			0.240*** (3.75)
<i>Cognitive-Market</i>			−0.227*** (−4.19)			−0.212*** (−3.61)
<i>Organizational</i>				0.233*** (3.91)		0.083* (1.46)
<i>Social</i>					0.083* (1.29)	0.047 (0.81)
Observations	362	362	362	362	362	362

Notes: The table presents the estimation results of the OLS regression models. The Huber-White correction is applied. The dependent variable is the overall measure of planned process innovation. T-statistics are in parentheses.

^a Manufacturing as reference class.

^b 20+ years as reference.

^c New-to-the-firm PI as reference.

***, **, and * indicate that the coefficient is significant at the 1%, 5%, and 10% level, respectively.

Table 6. Estimates for the four levels of planned process innovation

	Strategy level	Structural level	System level	Procedural level
	Model 6	Model 6	Model 6	Model 6
Industry ^a				
<i>Construction</i>	−0.094* (−1.41)	−0.059 (−0.96)	−0.118* (−1.82)	0.050 (0.71)
<i>Trade</i>	0.005 (0.06)	0.006 (0.08)	−0.048 (−0.59)	0.078 (0.98)
<i>Service/culture</i>	−0.018 (−0.26)	−0.069 (−0.93)	−0.172** (−2.46)	−0.039 (−0.51)
Financial performance ^b	0.032 (0.30)	0.099 (0.91)	0.165* (1.89)	0.113 (1.05)
Size	0.071 (0.68)	−0.043 (−0.42)	0.043 (0.47)	−0.050 (−0.46)
<i># of employees (log)</i>				
Age ^c	0.016 (0.25)	0.025 (0.42)	−0.021 (−0.43)	−0.077 (−1.11)
<i>Young (1–5 years)</i>	0.007 (0.12)	−0.026 (−0.44)	−0.064 (−1.06)	−0.049 (−0.78)
<i>Medium (6–20 years)</i>				
RI for type of product innovation (PI)				
Incremental PI	−0.050 (−0.67)	−0.076 (−1.14)	−0.067 (−0.93)	−0.010 (−0.13)
New-to-the-market PI	0.075 (1.11)	0.053 (0.70)	−0.019 (−0.26)	0.154** (2.14)
Proximity				
<i>Geographic</i>	−0.095* (−1.59)	−0.132* (−1.79)	−0.027 (−0.39)	−0.037 (−0.57)
<i>Cognitive-Technology</i>	0.186*** (2.90)	0.125* (1.63)	0.222*** (3.86)	0.121* (1.82)
<i>Cognitive-Market</i>	−0.151*** (−2.63)	−0.199*** (−2.66)	−0.121** (−2.04)	−0.203*** (−3.29)
<i>Organizational</i>	0.186*** (2.98)	0.098* (1.36)	−0.003 (−0.05)	−0.032 (−0.52)
<i>Social</i>	−0.048 (−0.85)	0.025 (0.36)	0.089* (1.53)	0.057 (0.97)
Observations	362	362	362	362

Notes: The table presents the estimation results of the OLS regression models. The Huber-White correction is applied. In each model, the dependent variable is one of the four levels of planned process innovation, respectively. *T*-statistics are in parentheses.

^a Manufacturing as reference class.

^b 20+ years as reference.

^c New-to-the-firm PI as reference.

***, **, and * indicate that the coefficient is significant at the 1%, 5%, and 10% level, respectively.

Appendix A

Table A1. Sample of survey with regard to question about planned process innovation

Please state if the following organizational changes are important goals for your company for the next three years:

	No	Partially	Yes	Top priority
Implementation of modern models to report costs	☐	☐	☐	☐
Withdrawal from unprofitable fields of activity	☐	☐	☐	☐
Moving some functions to other firms	☐	☐	☐	☐
Internationalization of the company's activities	☐	☐	☐	☐
Implementation of logistics systems	☐	☐	☐	☐
Building strategic alliances	☐	☐	☐	☐
Implementation of quality systems (ISO,TQM, HACCP, etc.) ^a	☐	☐	☐	☐
Implementation of resource planning system (ERP) ^b	☐	☐	☐	☐
Implementation of systems for recording the company's activities and resources	☐	☐	☐	☐
Implementation of IT systems	☐	☐	☐	☐
Enhancement of the company's market position	☐	☐	☐	☐
Focus the company's strategy on innovation	☐	☐	☐	☐

^aDefinition of acronyms (quality systems). ISO: International Organization for Standardization; TQM: Total Quality Management; HACCP: Hazard analysis and critical control points.

^bDefinition of acronyms. ERP: Enterprise Resources Planning.

Table A2. Sample of survey with regard to question about partner proximity

With regard to the planned process innovation of your company, please state if it is important to collaborate with partners that:

	No	Partially	Yes
Are geographically close (same neighborhood/town)	☐	☐	☐
Are located in Denmark	☐	☐	☐
Make frequent interaction physically possible	☐	☐	☐
Work with similar or related technology	☐	☐	☐
Are active in related technological disciplines	☐	☐	☐
Can support access to a new market	☐	☐	☐
Operate in markets where we are not represented	☐	☐	☐
Are located in new markets	☐	☐	☐
Know and understand the local culture in a new market	☐	☐	☐
Have similar organizational mechanisms	☐	☐	☐
Have complementary managerial knowledge	☐	☐	☐
With whom we have established long-term relations	☐	☐	☐

Appendix B

Table B1. Variables, Cronbach's alphas, and polychoric correlations for each proximity dimension

Proximity		Cronbach's alphas	Polychoric correlations											
			1	2	3	4	5	6	7	8	9	10	11	12
	Geographic	0.607												
1	<i>Are geographically close (same neighborhood/town)</i>		1											
2	<i>Are located in Denmark</i>		0.47	1										
3	<i>Make frequent interaction physically possible</i>		0.31	0.49	1									
	Cognitive-Technology	0.678												
4	<i>Work with similar or related technology</i>		0	0.06	0.32	1								
5	<i>Are active in related technological disciplines</i>		0.09	0.08	0.34	0.64	1							
	Cognitive-Market	0.643												
6	<i>Can support access to a new market</i>		0.07	0.11	−0.1	−0.16	−0.31	1						
7	<i>Operate in markets where we are not represented</i>		−0.02	−0.06	−0.36	−0.37	−0.32	0.34	1					
8	<i>Are located in new markets</i>		−0.16	−0.18	−0.33	−0.21	−0.3	0.3	0.45	1				
9	<i>Know and understand the local culture in a new market</i>		−0.16	−0.1	−0.3	−0.22	−0.26	0.41	0.39	0.32	1			
	Organizational	0.448												
10	<i>Have similar organizational mechanisms</i>		0.26	0.12	0.36	0.32	0.37	−0.22	−0.54	−0.31	−0.4	1		
11	<i>Have complementary managerial knowledge</i>		−0.04	0.01	−0.24	0.43	0.36	0.12	0.35	0.14	0.23	0.4	1	
	Social													
12	<i>With whom we have established long-term relations</i>		0.33	−0.25	0.19	0.21	0.16	0	−0.11	−0.17	−0.42	0.13	−0.02	1

Appendix C

Table C1. Variables, Cronbach's alphas, and factor loadings for each process innovation level (rotation: varimax)

Planned process innovation	Cronbach's alphas	Loadings
Strategy level	0.712	
<i>Building strategic alliances</i>		0.737
<i>Enhancement of the company's market position</i>		0.864
<i>Focus the company's strategy on innovation</i>		0.853
Structural level	0.531	
<i>Moving some functions to other firms</i>		0.652
<i>Internationalization of the company's activities</i>		0.715
System level	0.767	
<i>Implementation of quality systems (ISO, TQM, HACCP, etc.)^a</i>		0.675
<i>Implementation of resource planning system (ERP)^b</i>		0.772
<i>Implementation of logistics systems</i>		0.644
<i>Implementation of systems for recording the company's activities and resources</i>		0.684
<i>Implementation of IT systems</i>		0.728
Procedural level	0.547	
<i>Implementation of modern models to report costs</i>		0.679
<i>Withdrawal from unprofitable fields of activity</i>		0.864

^a Definition of acronyms (quality systems). ISO: International Organization for Standardization; TQM: Total Quality Management; HACCP: Hazard analysis and critical control points.

^b Definition of acronyms. ERP: Enterprise Resources Planning.

Appendix D

Table D1. Robustness checks

We re-run the models controlling for the interaction between the five proximity dimensions and the four industry classes. The results in relation to the variables of interest of our investigation remain unchanged. Table D1 reports the outcome of this robustness check with the measure of “Overall Planned Process innovation” as dependent variable. In detail, column (1) reports the outcome of the regression as presented in the “Model 6” column of Table 5 in the paper. In Column (2) we introduced the interaction between the five proximity dimensions and the “Construction” industry; in Column (3) we introduced the interaction between the five proximity dimensions and the “Trade” industry; in Column (4) we introduced the interaction between the five proximity dimensions and the “Service and Culture” industry; in and Column (5) we introduced the interaction between the five proximity dimensions and the “Manufacturing” industry.

	Overall Planned Process innovation				
	Model 6 (1)	Model 6 (2)	Model 6 (3)	Model 6 (4)	Model 6 (5)
Industry^a					
<i>Construction</i>	-0.098* (-1.46)	-0.258 (-0.48)	-0.123* (-1.77)	-0.088* (-1.28)	0.021 (0.35)
<i>Trade</i>	-0.003 (-0.04)	0.001 (0.01)	0.923* (1.84)	-0.008 (-0.10)	0.143** (2.20)
<i>Service and culture</i>	-0.120* (-1.78)	-0.116* (-1.70)	-0.130* (-1.91)	-0.832* (-1.76)	rc
<i>Manufacturing</i>	rc	rc	rc	rc	-0.226 (-0.37)
Financial performance					
<i>Gross profit (log)</i>	0.146* (1.55)	0.136 (0.32)	0.152 (0.35)	0.175* (0.03)	0.145 (0.29)
Size					
<i># of employees (log)</i>	0.026 (0.28)	0.029 (0.32)	0.032 (0.35)	0.003 (0.03)	0.028 (0.29)
Age^b					
<i>Young (1-5 years)</i>	-0.017 (-0.33)	-0.024 (-0.47)	-0.012 (-0.24)	-0.016 (-0.30)	-0.01 (-0.20)
<i>Medium (6-20 years)</i>	-0.048 (-0.85)	-0.057 (-1.00)	-0.052 (-0.88)	-0.056 (-1.00)	-0.041 (-0.70)
RI for type of product innovation (PI)^c					
<i>Incremental PI</i>	-0.074 (-0.98)	-0.085 (-1.10)	-0.092 (-1.15)	-0.083 (-1.05)	-0.08 (-1.05)
<i>New to the market PI</i>	0.066 (0.98)	0.051 (0.72)	0.047 (0.67)	0.043 (0.63)	0.037 (0.54)
Proximity					
<i>Geographic</i>	-0.089* (-1.47)	-0.083* (-1.27)	-0.013 (-0.16)	-0.124* (-1.82)	-0.105* (-1.54)
<i>Cognitive-Technology</i>	0.240*** (3.75)	0.248*** (3.56)	0.221*** (2.73)	0.233*** (2.89)	0.241*** (3.56)
<i>Cognitive-Market</i>	-0.212*** (-3.61)	-0.240*** (-3.61)	-0.148** (-1.98)	-0.233*** (-3.24)	-0.209*** (-3.35)
<i>Organizational</i>	0.083* (1.46)	0.064 (1.03)	0.104* (1.49)	0.063 (0.85)	0.118** (2.06)
<i>Social</i>	0.047 (0.81)	0.068 (1.04)	0.103* (1.55)	0.029 (0.41)	-0.007 (-0.12)

To be continued in the next page.

Table D1 continued.

	Overall Planned Process innovation				
	Model 6 (1)	Model 6 (2)	Model 6 (3)	Model 6 (4)	Model 6 (5)
Interaction effects					
<i>P.Geo * Ind_construction</i>		-0.033 (-0.14)			
<i>P.Tech * Ind_construction</i>		-0.063 (-0.28)			
<i>P.Market * Ind_construction</i>		0.322* (1.30)			
<i>P.Org * Ind_construction</i>		0.142 (0.76)			
<i>P.Social * Ind_construction</i>		-0.202 (-1.09)			
<i>P.Geo * Ind_trade</i>			-0.285* (-1.36)		
<i>P.Tech * Ind_trade</i>			0.019 (0.09)		
<i>P.Market * Ind_trade</i>			-0.347 (-1.26)		
<i>P.Org * Ind_trade</i>			-0.073 (-0.36)		
<i>P.Social * Ind_trade</i>			-0.291 (-1.25)		
<i>P.Geo * Ind_service&culture</i>				0.339* (1.49)	
<i>P.Tech * Ind_service&culture</i>				0.011 (0.05)	
<i>P.Market * Ind_service&culture</i>				0.145 (0.60)	
<i>P.Org * Ind_service&culture</i>				0.183 (1.06)	
<i>P.Social * Ind_service&culture</i>				0.064 (0.34)	
<i>P.Geo * Ind_manufacturing</i>					0.129 (0.52)
<i>P.Tech * Ind_manufacturing</i>					0.016 (0.06)
<i>P.Market * Ind_manufacturing</i>					0.033 (0.11)
<i>P.Org * Ind_manufacturing</i>					-0.225 (-0.92)
<i>P.Social * Ind_manufacturing</i>					0.414* (1.66)
Observations	362	362	362	362	362

Notes: The table presents the estimation results of the OLS regression models. The Huber-White correction is applied. The dependent variable is the overall measure of planned process innovation. T-statistics are in parentheses. ^a: Manufacturing as reference class in column (1), (2), (3), (4); Service and Culture as reference class in column (5). ^b: 20+ years as reference. ^c: New-to-the-firm PI as reference. ***, **, and * indicate that the coefficient is significant at the 1%, 5%, and 10% level, respectively.