# Juggling with Proximity and Distance: Collaborative Innovation Projects in the Danish Cleantech Industry.

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# Juggling with proximity and distance. Collaborative innovation projects in the Danish cleantech industry

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## Abstract

Studies increasingly apply a multidimensional proximity framework in the analysis of collaborations between actors. This paper explores the influence of collaboration motives on the desired proximity characteristics of partnerships in innovation projects based on 50 interviews with representatives from Danish cleantech firms. The paper emphasizes how search criteria along proximity dimensions differ depending on the purposes of the collaborations. In this way, the analysis distinguishes between the types of collaboration where geographical proximity is considered highly important, and those where geographically distant partners are preferred. The paper highlights that geographical proximity plays an important role in partnerships motivated by interaction around actual product development and knowledge creation, while long-distance relations appear to be important for partnerships motivated by market access and cost considerations. The insight that the desired proximity characteristics of partnerships are indeed contingent on the motive for collaborating highlights how the proximity framework can be applied in the analysis of firm decision-making.



## Keywords

Proximity, distance, collaboration motives, innovation projects, cleantech

## 1. Introduction

This paper is concerned with proximity and distance in collaborative innovation projects. Knowledge linkages are of significant importance for innovation and growth, and scholars increasingly give attention to the relationship between proximity and partnership formation. A number of recent theoretical (Torre and Gilly 2000; Boschma 2005; Mattes 2012) and empirical (Ponds, Van Oort, and Frenken 2007; Boschma, Eriksson, and Lindgren 2009; Eriksson 2011; Balland 2012; Broekel and Boschma 2012; Hansen 2014) contributions highlight the importance of partnership characteristics along multiple dimensions of proximity for knowledge flows and collaborations. These studies have provided important insights into the interrelationship between different proximity dimensions, and the influence of these dimensions on partnership formation.

The current analysis contributes to this body of literature. The aim is to understand search criteria along proximity dimensions in collaborative innovation projects. Surprisingly, few contributions examine the influence of collaboration motives on search criteria and the desired partnership characteristics, in particular for innovation projects. As highlighted in the writings of Grabher (2002a; 2002b; 2004), the importance and specificity of this organizational form requires explicit attention to the formation processes of this type of relations. However, while several of the empirical contributions within the proximity literature focus on collaborative innovation projects (e.g. Ponds, Van Oort, and Frenken 2007; Balland 2012), they do not examine the process of making choices concerning the formation of linkages at the scale of the firm. Rather, they follow a quite similar methodological approach: data on a certain type of collaborations is collected and analyzed quantitatively, providing insights into the effect

of different proximity dimensions on the formation of firm partnerships. This paper goes beyond the analysis of partnership attributes at an aggregated level and examines how the objectives of the innovation projects influence the desired degree of geographical, cognitive, organizational, social and institutional proximity. In this way, the paper examines processes at an early stage, before agreements to collaborate are reached. Thus, applying an analytical perspective that highlights the strategic choices of firms, the paper follows Glückler (2007) who underlines the need for analyzing processes of tie selection in economic geography.

Through this analysis, the paper seeks to increase the understanding of when geographical proximity matters in collaborative innovation projects. Naturally, this topic has been widely debated, with many authors arguing for the importance of geographical proximity for collaboration (e.g. Piore and Sabel 1984; Howells 2002; Teixeira, Santos, and Brochado 2008), while others stress that different forms of proximity can also facilitate partnerships (e.g. Mowery, Oxley, and Silverman 1998; Kirat and Lung 1999; Ahuja 2000). The paper analyzes the importance of geographical proximity according to different collaboration motives to identify the types of innovation projects where geographical proximity is considered highly important.

Hence, the main research question addressed in this paper is: *How do collaboration motives influence the desired proximity characteristics of partnerships in innovation projects?* While it is not the proximity characteristics *per se,* that are 'desired', there are different qualities associated with being proximate or distant that may facilitate or impede success in the collaboration, and the importance of these qualities may vary depending on the motive for collaborating.

It is argued in the paper that the desired proximity characteristics of partnerships are indeed contingent on the motive for collaborating. The search criteria differ between firms as well as within the same firm depending on the purposes of the collaborations. The flexibility and temporal character of innovation projects allow firms to explicitly seek partners inside the local area in some instances, and explicitly search for partners outside the local area in other. The analysis highlights that geographical proximity plays an important role in partnerships motivated by interaction around actual product development and knowledge creation, which aim at accessing complementary technologies, obtaining knowledge or reducing innovation time-span, while long-distance relations appear to be important for partnerships motivated by market access and cost considerations. In this sense, firms are juggling with proximity and distance depending on the motives for collaborating.

The findings, drawing on 50 in-depth interviews with representatives from Danish cleantech firms on recently completed collaborative product development projects, illustrate the value of a conceptual approach combining insights from economic geography and organization theory. This theoretical point of departure is presented in the second section. The third section outlines the empirical setting and the research design. The fourth section contains the main analysis of the impact of collaboration motives on the desired proximity characteristics of partnerships. The final section concludes.

## 2. Conceptual framework

The conceptual framework of this paper includes two bodies of literature. The paper seeks to contribute to the economic geography literature on proximity dimensions. In

order to do so, analytical concepts from organization theory on the rationale behind collaborations between actors are applied. This combination highlights how collaboration processes differ according to spatial and non-spatial dimensions of proximity, and it emphasizes how the search for partners varies according to the motives for collaborating. In this way, the proximity framework is applied in the analysis of firm decision-making.[1]

### 2.1. Proximity dimensions

During the last decades, a substantial body of literature within economic geography and related disciplines has underlined the beneficial impact of geographical proximity on knowledge production and innovation. In addition to agglomeration effects, which do not necessitate interactions between localized actors, geographical proximity may also influence collaborations between actors (Knoben 2009). It is argued that the exchange and interpretation of information is more difficult in dispersed relations (Cramton 2001), thus, collaborations with geographically close partners are associated with successful outcomes (Teixeira, Santos, and Brochado 2008). Still, certain factors may facilitate collaborations over distance, such as intra-organizational networks (Sole and Edmondson 2002; Zeller 2004), established social relationships (Hansen and Løvås 2004; Corredoira and Rosenkopf 2010), common institutional frameworks (Kirat and

[1] While this paper focuses on the influence of collaboration motives on desired partnership characteristics, the characteristics of the partnerships which are actually established will naturally be influenced by contextual factors, as not all firms have equal possibilities to choose between partners. Factors such as technical capital (Stuart 1998), social capital (Gulati 1995), firm size (Rosenkopf, Metiu, and George 2001), geographical location (Drejer and Vinding 2007) and government policy (Arranz and de Arroyabe 2008) act as filters in the selection process, making some options unlikely or unfeasible. For instance, a well-connected firm with excellent technical capabilities located in a vibrant cluster is in a different position than a start-up with an unproven track record located in the periphery. This interaction between collaboration motives and contextual factors is an interesting area for future research.

Lung 1999; Saxenian and Hsu 2001), and shared cognitive frameworks by, e.g. members of epistemic communities (Knorr Cetina 1999; Amin and Cohendet 2004).

To account for these factors, several multi-dimensional proximity frameworks have been proposed (e.g. Torre and Gilly 2000; Zeller 2004; Knoben and Oerlemans 2006). The framework by Boschma (2005) gives a detailed and thorough reasoning for the inclusion of five proximity dimensions. He argues that the interplay between geographical, cognitive, organizational, social and institutional proximity has a profound influence on interactive innovation processes. Thus, collaborations are characterized by differences in the physical distance between actors (geographical dimension), the extent of similarity in knowledge bases (cognitive dimension), the degree of common ownership (organizational dimension), the strength of social ties (social dimension), and the extent of shared informal, e.g. norms and habits, and formal, e.g. rules and laws, institutions (institutional dimension). Proximity along each of these dimensions facilitates interaction and reduces coordination costs, but too much proximity can be detrimental and may lead to situations of lock-in (Bathelt, Malmberg, and Maskell 2004; Boschma 2005). This proposition is closely related to the concept of optimal cognitive distance, which suggests that an intermediate level of differences in knowledge bases is beneficial in collaborations between actors, as it balances understandability and degree of novelty (Nooteboom 1999). Thus, while it is generally easier to form partnerships with proximate actors, this type of collaborations may not increase innovativeness. Termed the proximity paradox by Boschma and Frenken (2010), this position highlights how some degree of distance is considered a desirable feature in collaborations between actors.

The proximity framework is applied in studies focusing on different levels of analysis, from regions to project collaborations. However, the studies with a regional perspective (e.g. Aguiléra, Lethiais, and Rallet 2012) have an explicit focus on partnerships between actors, reflecting the close relationship between the two analytical levels. As pointed out by Lazonick (2005), external localized learning networks are important to "the innovative firm". Boschma (2005, p. 62) places "interactive learning and innovation" at the center of analysis, and a number of empirical studies have subsequently dealt with the relationship between the different proximity dimensions and the formation of collaborative innovation projects. Ponds, Van Oort, and Frenken (2007) find that geographical proximity is highly important in collaborations characterized by large institutional distance, while less so in partnerships between institutionally proximate collaborators, indicating that one dimension of proximity can substitute another. The results of Balland (2012) suggest that geographical, institutional and organizational proximity facilitate partnership formation while social and cognitive proximity have no significant effects. In a similar study, Broekel and Boschma (2012) find that all four types of proximity analyzed (leaving out institutional proximity) promote partnership formation. They also measure the outcome of the relations and observe that cognitive and organizational proximity have negative impacts, while geographical and social proximity have positive effects. Thus, they conclude that the proximity paradox only exists for the two first types of proximity.

These empirical studies underline the relevance of a multi-dimensional proximity framework for the analysis of collaborative innovation projects. However, they also point to an insufficiency in the current proximity literature, as differences in the search criteria along proximity dimensions in collaborative innovation projects are not taken

into account. Reflecting this, Huber (2012, p. 1171) recently noted that "it remains an empirical question which type and which degree of proximity is vital for knowledge networks", but no mention is made of possible differences in the desired proximity characteristics from one case to another. Thus, studies are for instance needed to examine the possible varying importance of cognitive proximity depending on collaboration motives. As explained above, Nooteboom (1999) suggests an inverted U-shaped effect of cognitive proximity on innovation performance, however, in an empirical analysis Nooteboom, Van Haverbeke, Duysters, Gilsing, and van den Oord (2007) indicate that this effect is stronger in the case of partnerships dealing with exploration than those focusing on exploitation.[2] The possibility of detecting differences according to the coarse distinction between exploration and exploitation encourages a detailed examination of the varying importance of cognitive (as well as the other forms of) proximity according to collaboration motives.

This paper uses insights from organizational theory on collaboration motives, as the required forms of proximity may vary according to collaboration motives. Further, this approach makes it possible to identify the types of collaborative innovation projects where geographical proximity is highly important and those where other forms of proximity may substitute for it.

### 2.2. Collaboration motives

The general increase in partnerships over time (Hagedoorn 2002) has been accompanied by an increase in the literature on the relationship between networks and innovation (Ozman 2009). An important topic is the motives of firms to engage in collaborations. Considering collaborations, broadly defined, Oliver (1990) identifies six critical

[2] Following the classical distinction by March (1991).

contingencies that explain the motivations of actors to collaborate: necessity, asymmetry, reciprocity, efficiency, stability, and legitimacy. However, as noted by Oerlemans and Knoben (2010), these factors are not all equally important for relations concerned with knowledge production and innovation. Thus, a number of frameworks for understanding partnership formation within this specific area have been developed based on different theoretical approaches such as transaction cost economics, the resource-based view of the firm, and dynamic capabilities (Hemphill and Vonortas 2003). With different starting points, the theories provide valuable insights that nevertheless have led to a fragmented research field. On the one hand, transaction cost economics emphasize the high costs of in-house technological development within multiple fields and the inability to create complete contracts due to the activities' uncertainty. On the other hand, theories on strategic incentives stress the opportunity for accessing or acquiring competences and knowledge held by collaborators.

As a result, several calls for an integrated theoretical perspective on partnership motivation have been made (Osborn and Hagedoorn 1997; Hemphill and Vonortas 2003). In line with this, it has been shown that there is not a single theory which covers the different types of information evaluated by managers concerning potential collaborations (Tyler and Steensma 1995). Therefore, a perspective that combines the different theories is necessary to understand the partner search process. The work of Hagedoorn has in particular been influential in synthesizing the contributions of the various theories in a common framework (Hagedoorn 1993; Hagedoorn, Link, and Vonortas 2000). He distinguishes between seven motives underlying technology cooperation, which both take access to concrete resources such as skills and capital, and abstract resources in the form of legitimacy and market power (Eisenhardt and

Schoonhoven 1996) into consideration. Obviously, a firm has often several motives for engaging in a partnership, and the incentives of different firms taking part in the same partnership may also vary (Klijn, Reuer, Buckley, and Glaister 2010). The motives are:

1. High costs and risks of R&D
2. Lack of sufficient financial resources
3. Technological complementarity
4. Reduction of innovation time-span
5. Performing basic research
6. Influencing market structure
7. Monitoring technological opportunities

This framework is applied in the current paper's analysis to examine the influence of collaboration motives (following Hagedoorn 1993) on the desired degree of proximity (following Boschma 2005) in innovation project partnerships.

### 2.3. Collaboration motives and partner search criteria

The literature on the relation between collaboration motives and partner search criteria has in particular been developed within studies of formal collaboration types such as joint ventures. Geringer (1991) showed that collaboration motives significantly influence the choice of partners in international joint ventures. Other early contributions (Glaister and Buckley 1996; 1997) focused on the importance of factors such as partner size, and industry on the changing importance of strategic motives and selection criteria, but recent studies analyze the characteristics of relations between partners in joint ventures. Dong and Glaister (2006) show that trust and prior ties (i.e. high social proximity) are particularly important when the aim of the joint venture is cost and risk

reduction. Nielsen (2003) finds that partnerships motivated by a need for accessing technological expertise are likely to be non-equity joint ventures rather than equity joint ventures (i.e. low organizational proximity). Further, a number of studies suggest that market knowledge and access are the prime motivations for Western firms to engage in long-distance joint ventures with partners in emerging economies (Hitt, Dacin, Levitas, Arregle, and Borza 2000; Tatoglu and Glaister 2000; Dong and Glaister 2006).

Thus, while there is considerable research on the relation between collaboration motives and partner search criteria in formal and stable collaborations, this is not the case for innovation projects, despite their increasing economic importance (Ekstedt, Lundin, Söderholm, and Wirdenius 1999). Innovation projects are characterized by a greater flexibility and temporal limitation, and the differences separating these formal and informal types of relations imply that conclusions cannot be directly transferred between them. The temporal character of projects generates fundamentally different opportunities for introducing change compared to permanent[3] organizational forms (Ekstedt, Lundin, Söderholm, and Wirdenius 1999; Grabher 2002a), thus, the potential for exploring different partner constellations depending on the collaboration motive is high. However, there is an absence of frameworks for understanding the various types of projects (Jones and Lichtenstein 2008), as well as a lack of a fine-grained understanding of the nature of innovation projects, including the characteristics of projects according to different phases of the innovation process (Brady and Hobday 2012). Further, Emden, Calantone, and Droge (2006) note that partner selection processes in collaborative innovation projects is a neglected topic, and although a recent review of the literature on collaborative product development deals specifically with

[3] While no organization is eternal, permanent denotes organizations which are ”planned to exist, if not forever, then for the foreseeable future” (Ekstedt, Lundin, Söderholm, and Wirdenius 1999, p. 41).

partner selection, it does not mention the role of collaboration motives at all (Büyüközkan and Arsenyan 2012). Thus, the influence of motives on search criteria and the desired partnership characteristics appears to be unexamined for collaborative innovation projects.[4]

On this background, the research question that this paper seeks to answer is the following: *How do collaboration motives influence the desired proximity characteristics of partnerships in innovation projects?* Considering the limited amount of existing literature dealing with this topic, the nature of this study is exploratory, applying Hagedoorn's (1993) taxonomy of motives to analyze the desired degree of proximity in innovation project partnerships.

## 3. Empirical setting and research design

The study analyzes collaborative product development projects in the Danish cleantech industry. Denmark has traditionally been an early adopter of environmental technologies and today it maintains this position as a leading cleantech nation on a global scale. According to consultants Roland Berger, the value added of the Danish clean energy technology industry contributes to 3.1 % of Denmark's gross domestic product (GDP) – more than twice the contribution of Chinese cleantech firms to the GDP of China, which is ranked second in the world (van der Slot, van den Berg, and Berkhout 2011). The wind turbine industry is a main driver of the Danish cleantech industry through the presence of the global leader within the industry, Vestas, as well as the wind power division of Siemens. In addition to R&D centers of other global wind

[4] A notable exception being Miotti and Sachwald (2003) who analyze R&D projects of research intensive French firms. However, they only separate between technology and cost driven collaborations, and US and EU partners. Their results indicate that cost-driven R&D collaborations are primarily with EU partners, while partnerships motivated by access to technology are primarily with US partners.

turbine producers, the network of suppliers and consultants is highly specialized. Other cleantech areas with significant concentrations of firms include energy efficiency (e.g. Danfoss and Rockwool) and water technology (e.g. Grundfos).

In this paper, cleantech firms are defined as firms that develop and sell products, solutions or technologies that improve the environment – either directly or through a more efficient utilization of resources (FORA 2009). Consequently, even though most firms come from industries such as renewable energy, water filtration and green construction, the definition does not exclude firms from industries which are generally not considered part of the cleantech sector (e.g. ICT and automotive) if the firms compete on the basis of green solutions. This point towards the increasingly pervasive environmental focus across industries, which is also reflected in the collaboration patterns of cleantech firms. Partnerships often bring together cleantech firms specialized in sustainable technologies with producers of traditional, non-environmentally conscious products. This contributes to make it interesting to analyze collaborative product development processes in cleantech firms.

### 3.1. Method

The analysis is based on 50 interviews with firm representatives from Danish cleantech firms in the period September 2010 to January 2011, all carried out by the author of the paper. Interviews were chosen as a method for several reasons. Firstly, the interview persons often consider the collected information highly sensitive. It was emphasized on several occasions by the interviewees that they were transmitting information on collaborators, which they would not have provided without the trust created by a conversation. Secondly, other studies measure institutional proximity by assessing whether actors are of the same organizational form (industry, academia or government)

(Ponds, Van Oort, and Frenken 2007), or are located in the same country (Balland, de Vaan, and Boschma 2013). The interview approach allows the respondents to take the various aspects of the institutional dimension, ranging from formal to informal institutions, into consideration, by letting the interviewees describe similarities and differences in firm culture in terms of norms and habits. This operationalization allows the interviewees to take different aspects such as dissimilar types of incentive structures and distinctive cultures following from differences in e.g. size or nationality into account. Thirdly, interviews allow a great depth in the data collection process, which makes it possible to get a detailed understanding of the relation between collaboration motives and desired partnership characteristics.

The population of Danish cleantech firms was constructed by FORA, the Danish Enterprise and Construction Authority's division for research and analysis, with the snowball method. The population was supplemented with firms from the list of exporting firms within energy and environmental technology by the Trade Council under the Danish Ministry of Foreign Affairs, and firms from the Confederation of Danish Industry's list on the Danish green economy. Besides from being part of the cleantech industry, firms were furthermore required to undertake product development. Thus, service and technology providers, utility firms and retail businesses were not considered for the interviews, resulting in 279 potential interview firms. Further, it was ensured that the sample reflects the composition of the Danish cleantech industry in terms of firm size (table 1) and geographical distribution.

**Table 1. Employment size distribution of interviewed firms compared to the population**

| | Interviewed firms | Population |
|---|---|---|
| **0-9 employees** | 40 % | 36 % |
| **10-49 employees** | 30 % | 27 % |
| **50-199 employees** | 16 % | 19 % |
| **+ 199 employees** | 14 % | 18 % |
| **Total** | 100 % | 100 % |

In the smaller firms, interviews were typically conducted with Chief Executive Officers (CEOs), while Chief Technology Officers (CTOs) and Development Managers were interviewed in the larger firms. All interviews were audiotaped and the duration varied between 45 and 105 minutes. The main theme of the interviews was the firms' most recently completed product development projects with external partners. This ensures that the described projects are the most fresh in mind and it furthermore also prevents the interviewees from selecting projects according to other criteria, e.g. the most successful or the most international. In total, relations to 180 external partners were described.[5] Importantly, projects, which took the form of knowledge transfer from one partner to another, were not included in the analysis, thus, all collaborations are characterized by a collective learning effort. Further, all projects evolved around the development of a specific product innovation, however, as it will be highlighted below, partners were in many cases selected mainly due to criteria without direct relation to the actual product development, but rather because of e.g. the ability to assist in the diffusion of innovations by entering new markets.

For each partnership, questions were asked to clarify the rationale and content of the collaboration, the roles of the involved partners, the nature of interaction, as well as the distance between the partners according to the five proximity dimensions. The questions

[5] 68 % of the projects involved one external partner, 16 % involved two partners, 12 % involved three partners and 4 % involved four partners.

ranged from those that sought closed ended responses, to open semi-structured questions that allowed respondents to expand on selected themes. Questions concerning the degree of proximity in the partnerships had closed answers. Control can be an issue in interviews with business leaders as they are used to exercise authority over others, and closed questions were therefore chosen to ensure clear answers on these issues (Schoenberger 1991; see also Crang 2002). Concerning the *geographical dimension*, answers separate between partner location in the same Danish region,[6] other parts of Denmark, neighboring countries (Germany, Norway and Sweden), other European countries, and outside of Europe. Regarding the *social dimension*, interviewees were asked to describe how contact between the partners was initiated (did the partners have 'personal relations' or 'acquaintances' across the project team, a 'mutual acquaintance' outside of the project team or had there been 'no previous contact' prior to the project start). On the *institutional dimension*, the interviewees were requested to indicate the similarity of the partner's firm culture in terms of norms and habits compared to their own (on a five-point Likert scale ranging from 'very large differences' to 'no differences'). In regards to the *organizational dimension*, a distinction was made depending on whether the partners were part of the same legal entity or not. Finally, concerning the *cognitive dimension*, respondents were asked to describe the educational background of the partner's key employees in the project compared to their own participating employees, separating between 'same educational backgrounds' (e.g. engineers with common specialization), 'related educational backgrounds' (different specialization within the same scientific field e.g. engineers with different specialization) and 'different educational backgrounds' (education in different scientific

[6] Denmark is divided into five administrative regions, which vary in size from 2,533 $km^2$ (Capital Region of Denmark) to 13,005 $km^2$ (Central Denmark Region).

fields e.g. engineering and social science). While cognitive frameworks are contingent on more than educational background, this is still a central aspect of the cognitive capabilities of actors, especially concerning professional activities. Furthermore, in this way, cognitive proximity is not assessed at the aggregate level, as it is the case with alternative measures such as firm specialization in product segments (used by e.g. Balland 2012), but at the level of the people collaborating in the project. This follows Grabher's (2002a) emphasis on inter-personal relations rather than inter-firm relations in the analysis of project collaborations. Finally, as explained below, follow-up questions allowed the interviewees to expand on answers to the closed questions, which in the case of the cognitive dimension would often lead them to consider other aspects of cognitive capabilities such as learning throughout the career.

The answers by the interviewees to the closed questions were taken as a starting point for enquiring about desired proximity characteristics, through open semi-structured questions. For instance, in the case of low cognitive proximity, respondents would be asked if there were any consequences of this, if it was a desirable feature, if it was coincidental, etc. This combination of questions made it possible to establish a clear picture of the degree of proximity in each partnership, and to access rich data on the importance of motives on the desired degree of proximity.

The interview material was processed right after each interview, which is in reality the first phase of the analysis, as notable relations and quotes were marked. When possible, information provided during the interviews was crosschecked through press releases and articles from industrial journals. Upon completion of data collection, observations were sorted according to the conceptual framework adopted from organization theory, differentiating between seven objectives underlying innovation project partnerships

(Hagedoorn 1993). A detailed transversal analysis was performed by listening to the recordings of the interviews within each of these categories and noting the underlying motivations explained by the interviewees. This led to a modification of the framework, reducing the number of categories from seven to five. Firstly, the decision to develop basic research collaborations was found to result from other motives, e.g. the need to share costs and risks, and was therefore not included as an individual motive. Secondly, no distinction was observed between high costs and risks of R&D, and lack of sufficient financial resources, as it was found that if a firm needs to share the high costs and risks of R&D then it results from a lack of financial resources.[7]

Having identified the relevant objectives, the analysis was structured according to the five categories: accessing complementary technologies, influencing market structure, obtaining knowledge, reducing innovation time-span, and sharing costs and risks.[8] In the final stage of the research process, the different proximity dimensions were analyzed individually for each of the five categories. By carefully going through the partnerships within each category[9], paying attention to answers to both open and closed questions, the relations between the motives and the desired degree of proximity along the different dimensions became clear. A considerable number of quotes from the interviews, that represent these relations and explain the rationale behind them, are

[7] It should be stressed that it may well make sense to distinguish between these categories in other studies. However, it is part of the research process to critically examine theoretical frameworks, rather than uncritically adopt them. In this paper, the five categories appeared as relevant, based on the analysis of the empirical material.

[8] The distinction between accessing complementary technologies and obtaining knowledge is the following: accessing complementary technologies is concerned with gaining access to technologies which are necessary to successfully complete a project. The firm does not necessarily seek to acquire these competences from the partner. Conversely, in the case of obtaining knowledge, learning from the partner is central.

[9] 80 partnerships were motivated by accessing complementary technologies, 66 by influencing market structure, 50 by obtaining knowledge, 40 by reducing innovation time-span, and 20 by sharing costs and risks. 48 of the 180 partnerships were motivated by more than one motive, and were therefore included in the analysis of more than one motive.

included in the analysis. In this study, the approach leads to an empirical validation of the role of objectives as a significant factor influencing the desired characteristics of the partnerships, according to the proximity dimensions. The five motives are analyzed individually in the following analysis.

## 4. Juggling – choosing between close and far

### 4.1. Accessing complementary technologies

Increasing technological complexity as well as the demand for considering environmental issues in a growing number of industries imply that many collaborative innovation projects result from a need to bring actors with different technological competences and skills together. These collaborations primarily gather firms from very different technological background. Firms that possess practical knowledge will often explicitly seek out partners with relevant theoretical knowledge, and vice versa. Thus, in these projects, firms seek partners with low cognitive proximity. While such characteristics may not be the most beneficial for firm partnerships in general, large cognitive differences are a desirable feature in these types of projects as differences in cognitive frameworks broaden the perspective and bring new ideas on the table. The decision by a high-tech green construction firm to initiate a partnership with an architectural agency illustrates this well. Explaining why the firm selected this partner for the project, the Technical Manager refers directly to cognitive differences: “In science, all terms have to be well-defined and accurate, but it’s a quality for them if terms can be mixed [...] It can be difficult and we need to use many words to explain things that are simple to us, but they get associations that we would never have got...

often they get inspired by a single word in a subordinate clause [...] The piano plays differently when you press their keys."

Naturally, there are also costs associated with this type of collaborations, as it is also evident from the quote above. In this case, the two firms are located in the same region and they knew each other before the project was initiated. Both factors had a positive influence on the decision to select the architectural agency as a partner, reflecting the generally high importance of geographical and social proximity for these collaborations to make up for the low cognitive proximity. In many cases, these projects evolve in iterations of face-to-face interactions where partners frequently meet to work together on the project. Thus, it is problematic if geographical proximity is absent (see also Hansen and Winther 2011), and firms prefer partners located within their own region. Partners located in other Danish regions are considered to be too far away. This is exemplified by the case of a water treatment firm who initiated a project with a technology developer from a different part of Denmark. While the lack of co-location was a serious concern prior to the project start, as it prevented spontaneous project meetings, the partners knew each other very well and decided to attempt to create an "everyday atmosphere" through frequent communication and monthly seminars. Still, this failed to provide the type of interaction needed by the water treatment firm, who therefore considers searching for a local partner in the next project.

The organizational proximity in the partnerships seeking to bring complementary technologies together is usually low as the requested type of knowledge is most often very different, making it unlikely to find it in another part of the firm. Regarding the institutional dimension, institutional proximity appears to be a way of overcoming differences in cognitive proximity, similar to the geographical and social dimensions,

and firms therefore prefer collaborations characterized by intermediate or high levels of proximity. Thus, in situations where the needed competences are likely to be found in universities, firms seek out the research groups with a reputation for having an interest in relating their research to the real world. Interestingly, in cases with significant institutional differences between the partners, firms often work strategically with mitigating cultural differences through social activities. These practices often prove to be of significant value. As described by the R&D Manager of an energy efficiency firm concerning collaboration with a machinery producer: “In a project like this, we need the team members to be in contact all the time [...] So we have worked very consciously with leveling the cultural differences and that proved to be vital for reaching the goal.” Table 2 provides additional data from the interviews on this type of partnerships.

**Table 2. Accessing complementary technologies**

| Proximity dimension | Desired degree of proximity | Illustrations from interviews |
|---|---|---|
| Social proximity | High | "We have blind trust in them and their competencies – which is necessary as we cannot check [their work] ourselves."<br>"Product development within water purification is often interdisciplinary, [...] and interdisciplinary work requires certain skills. Therefore, it is important to know that your partners can work in such interdisciplinary teams, to know that they have these skills [...] So it was important for us to know them well." |
| Institutional proximity | Medium to high | "The project needed someone with design competencies, but our previous experiences with pure industrial design firms were bad – they don't know that time is money and that small firms have limited resources. So this time we chose a firm that also produces small batches of goods, and that went very well [...] Their way of working is much closer to us."<br>"There are many researchers [within district heating and ventilation] which are only interested in math and theoretical physics. We collaborate with the ones that are good at relating their research to the real world, and that understand business. They need to have this mindset." |
| Organizational proximity | Low | "We try to develop most things in-house, but we didn't know anything about this topic." |
| Cognitive proximity | Low | "You can understand their methods, but you can never understand their way of thinking. But it was exactly what the user interface needed: people that dream of Apple at night."<br>"Their work is theoretical, while we work with our hands [...] But we needed the theory behind it to really improve the conversion efficiency." |
| Geographical proximity | High | "During some periods of the project we met several times each week, because they were responsible for the tests. So it was perfect that they are only located ½ hour away."<br>"We couldn't find a Danish partner that knew how to do it, so we had to go abroad… unfortunately. It is often difficult to work with partners from other fields, but even more so when they are located so far away [Austria]. But we didn't have a choice." |

## 4.2. Influencing market structure

In the product development projects where a main objective was to influence market structure, the partner is chosen (partly) for strategic reasons, e.g. entering new markets or attaching third parties closer to the firm as a way of strengthening the position *vis-à-vis* competitors. Further, it is beneficial to distinguish between the aims of accessing

new geographical markets and entering new business areas. While the organizational proximity is low in both cases, there are some differences along the other dimensions.

In a considerable number of the product development projects, firms specifically search for partners in countries where they wish to enter the market in order to gain access to the local knowledge, networks and reputation of the partners. This is the case for both neighboring countries, other European countries and countries on other continents. Thus, geographically distant partners are preferred in these projects, and the same is the case for the institutional and social dimensions. Firms seek new partners that can support entrance in a new market, and partners that know and understand the local business culture. The preferred large social distance is linked to the empirical focus of the paper (product development projects). As the actual projects are (to some extent) excuses for getting to know the partner, firms search for collaborators with a low social proximity. Had they already known each other well, it would not have been necessary to link the aim of market access to a product development project. The combination of low geographical, institutional and social proximity implies that these partnerships are risky and some of them do indeed go very wrong. However, the firms are aware of this and the risks they take are most often calculated. One way the firms seek to reduce the uncertainty is by searching for partners that are very similar to themselves along the cognitive dimension. A Senior Developer of an energy efficiency firm describes that his team started a project with "the French version of [name of his own firm]" in order to get access to EDF, the French utility provider. Another way of dealing with uncertainty is to adjust expectations. A CTO of a bioenergy firm describes the reason for initiating a partnership with a leading university in an emerging economy as "purely a matter of

branding" where the expected input to the concrete product development was very low, primarily due to significant cultural differences.

In the cases where firms search for partners in order to enter new business areas, they prefer geographically close partners, located within their own or other Danish regions, as they initially target their geographical home market. Concerning cognitive distance, firms seek partners within related, but not similar, fields, thus, an intermediate level is preferred. As in projects motivated by entering new geographical markets, institutionally and socially distant partners are also preferred in these projects. While, again, the empirical focus might affect the social dimension, the large institutional distance appears to be related to, firstly, differences in business sectors and, secondly, variation in size. In these types of partnerships, the initiating firm is often an SME seeking collaboration with a larger firm that will contribute to legitimatizing the use of a technology or product in a new context. An example is a partnership between an energy efficiency firm and a large engineering consultancy from two different Danish regions, which applied a product previously used for industrial buildings to residential housing. While the geographical distance between the partners is limited, the lack of institutional and social proximity implies that these partnerships also have relatively high risks. Again, the firms seek to reduce the risks by promoting trust and minimizing the incentive of the collaborator to break the agreement. This is illustrated by the quote of a Product Manager of an energy efficiency firm describing a partnership with a producer of agricultural equipment: "These kinds of projects are always risky [...] We do a lot of things for them that we don't do in other cases [...] We invest in building trust." Table 3 provides additional data on this type of partnerships.

**Table 3. Influencing market structure**

| Proximity dimension | Desired degree of proximity | Illustrations from interviews |
|---|---|---|
| Social proximity | Low | "We didn't know them and had little confidence in their ability to contribute to the technical development, but we thought they could help us get into the UK market, which is huge. Both things turned out to be correct." |
| | | "We seek to explore the potential of fuel cells in many different types of products, including mini trucks. So we wanted to find someone that could help us enter that market." |
| Institutional proximity | Low | "Our sales outside of Scandinavia were disappointing, so a decision was taken to find a partner South of the border that could help us understand the German market – someone that is thinking in German [...] We expected the collaboration to be very structured and organized and that was also the case – much less informal dialogue than with our normal Danish partners [...] The German way of collaborating is less pleasant, but more efficient." |
| | | "If we want to sell our batteries for these vehicles [forklift trucks], we need to work with the producers. It's difficult because we are a small engineering firm where everybody is involved in decision-making, while they are big and hierarchical. But we cannot avoid it [...] So it is really two very different work forms." |
| Organizational proximity | Low | "We were planning to enter the German market [for treating residual products from steelworks], and we needed a partner there – that's much more practical – so we started working with them." |
| Cognitive proximity | Medium to high | "We come from the same backgrounds, but have specialized in complementary niches. So that was a very nice fit. The whole idea was then to develop a common product, and use that to promote each other on our respective home markets: we refer to them on the Nordic market, they refer to us on the German market." |
| | | "The aim was to get into the market for energy retrofitting products [...] They make insulation, we make profiles. It was a very equal collaboration, where we managed to combine our products [...] And it is a good example of how it can pay off to work with someone in a related field." |
| Geographical proximity | Varying, but primarily low | "The potential of UK wave energy is very large […] so we wanted local partners to establish a network there." |
| | | "We have learned over the years that you should always start at home with these kinds of projects. So when we wanted to go into this field [solar powered lighting columns] we went for a Danish partner even though a big international one also showed interest." |

### 4.3. Obtaining knowledge

As with the motive of influencing market structure, the aim of this type of collaboration is at least partly unrelated to the actual product development project: the firm expects to gain access to knowledge through the collaboration. Therefore, firms most often seek out universities and research institutes in these types of projects, as new knowledge creation is concentrated here. It follows from this that firms do not seek collaborators with a high organizational proximity. Furthermore, firms prefer collaborators with a low institutional proximity, as they specifically seek partners that have different work routines and are guided by different incentive structures that allow immersion in specific fields. The firms are most often aware that such differences make the collaborations resource demanding, but several interview persons stress the value of such dissimilarities in this type of projects. As described by an R&D Director of a firm from the automotive industry regarding a university partner: "We need to have different approaches. We are not interested in them becoming too focused on commercial aspects, because then they don't do their job properly [...] It is up to us to evaluate if the extra thoroughness pays off." Similarly, the Technology Director of a bioenergy firm notes that "[W]e deliberately tap into knowledge from *milieux* that are culturally different from ours."

A further feature of these partnerships is that they are preferably based on long-term relations with, e.g. former professors or co-students. Firms prefer partners with whom they have established a common communication code, thus, with high social proximity and it is not uncommon that partners have collaborated over decades. The interview persons stress that the personal relations are in particular crucial in the cases where geographical proximity is absent. However, partners located in the same region or

another part of Denmark are preferred. Therefore, even though geographical proximity is not as indispensable, as in the projects concerning complementary technologies, it stimulates these types of collaborations as well. A CTO of a water filtration firm describes how collaborations with two Danish universities progressed in very different ways due to the variation in physical distance to them. The informal character of the social relations, which were developed with the researchers at the nearby university, was a main reason explaining the larger amount of knowledge that was obtained from this partner and the subsequent selection of this university as a collaborator in a follow-up project. In this way, while knowledge can be obtained from distant partners, the social underpinning of such knowledge flows has a distinct geographical dimension.

Concerning the cognitive dimension, the firms seek partners with an intermediate level of proximity. Contrary to collaborations where the motive is merely to access complementary technologies, in these cases the firms seek to actually obtain the knowledge. Thus, a main objective is generally to stay up-to-date with recent developments within a field of knowledge that is related to the firms' key competences. Illustrating this, a CEO of a bioenergy firm explains that in this sector, it is important to possess knowledge within multiple scientific areas, and that the firm is strategically forming links to various universities to learn about current developments within different fields.

Finally, it should be stressed that firms consider the presence of a strong national research center an indispensable asset. In fact, the absence of such a partner may stimulate collective action among competitors promoting the development of one. This was the case within a renewable energy subsector, where all the Danish firms agreed to focus on a single research group at a university, in order to promote it as a center for

this specific type of technology. The firms decided to always include this group in funding applications and this strategy has indeed been successful, as the research group is now a valuable knowledge hub for this technology. This exemplifies how the business sector's need for knowledge flows may also benefit the universities. Table 4 provides additional data on this type of partnerships.

**Table 4. Obtaining knowledge**

| Proximity dimension | Desired degree of proximity | Illustrations from interviews |
|---|---|---|
| Social proximity | High | "We have known them for 20 years, so we don't need to make long contracts and so forth before we start a project [...] The whole process is very flexible, we have a common language and understand each other easily." |
| | | "I was visiting there [German research institute] while I did my PhD, and we have had informal collaboration with them ever since. So it was a natural thing to approach them when we wanted to start this project, because we knew that we could learn from them." |
| Institutional proximity | Low | "There are very large cultural differences, because we are a firm living from developing and selling products, so our main focus is the commercial side. Their interest is the research side [...] But this is also how we supplement each other." |
| | | "Few – if any – research centers are as prominent within offshore wind. As we have no time and limited resources, we need to learn from their expertise [...] It can be difficult to work with them, because "good enough" is never good enough for them – but then again this is also why they are experts." |
| Organizational proximity | Low | "We needed theoretical knowledge about natural ventilation in buildings, so the obvious thing to do was to contact [name of researcher] from [name of university], he has been pioneering simulation within this field [...] These are competencies that we don't have in-house." |
| Cognitive proximity | Medium | "We wanted to develop a new coating for our filters and we wanted to insource the competence [...] Even though we know a lot about this field, we decided to enter into a collaboration with [name of university spin-off], because they are expects in developing this specific technology." |
| | | "They are all much smarter than us [laughs]. We have bachelors in engineering, they are all PhDs, so they are much, much more specialized. They have time to gallivant about, and we try to extract some of the knowledge that they pick up along the way." |
| Geographical proximity | Varying, but primarily high | "These outcomes [examples of learning] are only possible because we know each other so well. The fact that we are located close to each other [two neighboring Danish regions] is much more important for a partnership like this, than for partnerships around production, where we can just send a CAD-drawing." |
| | | "Most of our customers are located in the UK [...], but re-locating our firm is not an option, mainly due to the close relation we have with them [research lab at neighboring university]. It's a balance. You can't have it all." |

### 4.4 Reducing innovation time-span

The speed of commercialization is often the decisive factor between commercial success and failure. Therefore, firms often establish partnerships with the intention of reducing the innovation time-span. In these collaborations, firms prefer partners with a high organizational proximity, as it allows swift access to additional development staff. Thus, firms preferably turn towards subsidiaries and associated companies in situations where the development of a new product is under considerable time pressure. A producer of wind turbine components, who established a project across several divisions in order to keep up with the continuously increasing size of wind turbines, exemplifies this. While fast up-scaling of components offers commercial possibilities for suppliers, it is also a process that is indispensable for the long run existence of these firms. Therefore, collaborative efforts across divisions are important in such situations.

In cases where intra-firm partnerships are not possible, firms preferably rely on well-known partners. However, as the pace of the projects is crucial, firms are unwilling to, e.g. postpone projects in order to secure the participation of a preferred partner and, thus, they may have to settle with partners where the social proximity is relatively low. In these cases, firms use their networks to identify potential partners. The firms generally prefer partners located within their own region, alternatively another Danish region, as the projects are characterized by intense interaction over a limited time period. Further, they seek collaborators with high cognitive proximity, as there is no time to overcome large cognitive differences. The firms are aware that this has a negative effect on the ability to create path-breaking solutions, but this is not what they seek in these types of projects. This strategic prioritization is illustrated by the founder of a bioenergy firm concerning such a partnership: “It is an advantage that we share the

same frame of reference, but it is a weakness that we don't get inputs from other directions [...] However, the set-up was appropriate in this concrete project." Notably, the firm preferred a partner with a higher cognitive distance for a project where the main motive was influencing the market structure.

In this type of projects, firms prefer partners with a high institutional proximity in order to avoid cooperation difficulties and ensure swift execution. However, in some cases firms seek partners that can be responsible for the more simple parts of the product development in order to provide sufficient time for themselves to focus on the more complicated issues. Typically, working routines, norms and habits diverge considerably in these partnerships, thus, firms seek partners with a lower institutional proximity. However, the firms will most often make sure that the partner has at least a small R&D department to ease communication in the project. Reflecting this, a Technical Manager of a green construction firm explains that they selected a partner from the metal plating industry who had some engineers employed in development positions, so that the work routines would not be too different between the two firms. Table 5 provides additional data on this type of partnerships.

**Table 5. Reducing innovation time-span**

| Proximity dimension | Desired degree of proximity | Illustrations from interviews |
|---|---|---|
| Social proximity | High | "[…] and as the market showed large interest, we decided to prioritize this project [...] We included them because we have collaborated before and I trust them, so there was no need to involve lawyers or anything; we just started straight away."<br>"We were already involved with them in another project, so we said "Hey, do you think this would be interesting for you too?" And they agreed to that." |
| Institutional proximity | Medium to high | "Because of the time pressure, they have to be similar to us – it doesn't work out if we are very structured and they are not. These things have to go both ways."<br>"The blue [collar] workers at the glass producer loose the interest very quickly. They don't like to work in this way [...] The solution is that we always go through the technical manager. We have all the important discussions with him." |
| Organizational proximity | High | "Basically, we had a deadline by which it [the product] should be able to handle a higher voltage. In order to achieve that, we included our parent in the process, because there we have quick access to extra resources."<br>"It is a luxury to have an owner like this when there is no time to waste. They have all the right equipment and expertise so it would be stupid to not use it." |
| Cognitive proximity | High | "We think very similarly in many ways and therefore we manage to get things done quickly. On the other hand, it also means that we don't get a lot of offbeat ideas."<br>"It saves a lot of time and resources when you know and use the same terms." |
| Geographical proximity | High | "A project like this would be impossible if [name of partner] was located outside Denmark [...] Because the prototyping had to go quickly, we were meeting several times a month."<br>"At this point, we realized that we needed a partner, so we contacted [name of partner]. They are from [city 20 minutes' drive away] so that made it a lot easier." |

### 4.5. Sharing costs and risks

Even though the cleantech industry has been less affected than many other sectors by the increasingly difficult access to capital as a result of the financial crisis, firms sometimes still need to share the costs and risks associated with product development processes. In these cases, firms often seek partners located in areas with significantly lower labor costs, i.e. outside Europe or European countries beyond Denmark's

neighboring states. While low geographical proximity is preferred in these partnerships, the contrary is the case for organizational and social proximity. In many cases, firms seek out partners from the same company located overseas in order to minimize the risks associated with acting in a very different institutional environment. For these partnerships, differences in norms, e.g. greater respect for authority, are often considered valuable by the firms, even though such cultural differences may also make some partnerships challenging. Even the combination of high organizational and low institutional proximity can present challenges to the firms. As the CTO of a bioenergy company explains on an intra-firm partnership with an Asian division, where work routines are much less formalized than in the Danish office: "The agreements are verbal [...] Basic issues such as IPR ownership or payment of salaries are most often not written down [...] as they are in the contracts we have with suppliers out there. But these [intra-firm] agreements are in the grey zone, unfortunately."

The quote highlights the difficulties of overcoming cultural differences, even in intra-firm partnerships. However, this seems to surprise few of the firms, and most of them take precautions before entering into such partnerships by, e.g. providing key employees with cultural training as well as reserving sufficient resources at the headquarter to follow the process closely and have frequent meetings with representatives from the partner. A supplier of components to bioenergy plants applied a more radical solution when cultural differences hampered collaboration with a newly acquired division in Eastern Europe: the entire management level was fired and replaced with people expected to have a more Western European management style.

Regardless of the means applied, the examples highlight that considerable resources have to be invested to make these collaborations work, hence, the potential savings on

labor costs must be large to make the partnerships meaningful. However, a second type of costs and risks sharing collaborations are not driven by differences in labor costs, but rather by initiation of unusually complicated and capital demanding development projects. While in the labor costs driven collaborations, firms seek partners in similar industries, but at different developmental stages (i.e. an intermediate level of cognitive proximity), firms prefer partners with a high cognitive proximity in this second type of partnerships. Furthermore, firms prefer partners that they know and trust, as the collaborations usually involve a significant amount of knowledge sharing. However, as these projects are often of large importance for the future development of the firms, this socially based trust is complemented by other measures. This is exemplified by an energy efficiency firm that shares all the know-how and all the drawings concerning a specific product with the project partner, but it keeps the codes to the embedded software, which considerably reduces the risk of opportunistic behavior. Table 6 provides additional data on this type of partnerships.

**Table 6. Sharing costs and risks**

| Proximity dimension | Desired degree of proximity | Illustrations from interviews |
|---|---|---|
| Social proximity | High | "Before this, they just produced some of our products. They had showed interest in getting involved in product development as well, and eventually we included them […] At that point, we had a better idea of what they were capable of."<br>"We have relied a lot on our social network […] Being a small firm in a capital intensive business, it is essential to have partners you can rely on. You break your neck if you try to do it all by yourself." |
| Institutional proximity | Low | "It would be weird if there weren't cultural differences. They used to be a state-owned enterprise in a communist country. But it is not all bad. They have respect for authority and are reliable, and the value of that should not be underestimated."<br>"Of course, sometimes it is difficult to work with them. To us, time is going. For Asians, time is coming. So deadlines are handled in a very different way […] I make sure that some of my staff are always available to them. And for each five to ten men working out there, we have one Indian sitting in our office. But once these measures are in place, we can benefit from their way of working." |
| Organizational proximity | High | "[…] because, in the first place, this was the reason that we bought them: to have a contribution to the development team at a very affordable price."<br>"Involving them [another business unit] is also a way of making the rest of our firm aware of this project. We don't want to take all the responsibility upon us." |
| Cognitive proximity | Medium to high | "Yes, they are engineers as well, and most of them mechanical engineers like us. But a Danish and a Czech engineer do not necessarily speak the same [technical] language."<br>"[…] and in the end we decided that it would simply be too big for us on our own […] They were in the same situation, they are very similar to us. So we decided to do it together." |
| Geographical proximity | Low | "We face increasing competition, so we are forced to cut down on our development costs. That's a main reason that a Polish partner was attractive. But now their wages are increasing quickly as well, so we might have to go further away when we start developing the next generation of filters."<br>"It is simply a matter of wage differences between the countries. By including [name of Indian partner] we can do much more because they cost a fraction of our Danish engineers." |

### 4.6. Interaction effects – multiple partners and multiple motives

The preceding analysis abstracts from two relevant interaction effects: firstly, as explained in the methodology section, some projects involve more than one external partner and, secondly, some projects were established with more than one motive in mind. Thus, the relation between collaboration motive and partner selection is relatively straightforward in cell #4 of table 7, but including multiple partners and multiple motives complicates the picture. While abstracting from these factors allows a structured and clear analysis, it is nevertheless important to note these interaction effects. While it is beyond the scope of this paper to provide an exhaustive analysis that includes all possible combinations of motives and number of partners, this section discusses and empirically illustrates the influence of these factors on the search criteria along the proximity dimensions.

**Table 7. Relation between number of motives and number of partners**

| | | **Number of motives** | |
|---|---|---|---|
| | | +1 | 1 |
| **Number of partners** | +1 | #1. Often, each partner is selected due to a specific motive. The degree of proximity that is considered beneficial is influenced by the motive for establishing the bilateral relation | #2. Partners have generally similar proximity characteristics |
| | 1 | #3. Partner selection is difficult due to tensions between the beneficial degrees of proximity associated with different collaboration motives | #4. Collaboration motive influences the desired proximity characteristics of the partner |

In partnerships with several partners and several motives (cell #1), the firms most often involve the various partners due to very different rationales. Thus, the desired proximity characteristics of the individual partners depend on the motivation for including them. For instance, a water technology firm involved two partners in the same project, where the first partner – a local university with whom close personal relations already existed – was involved in order to access complementary technologies, and the second partner –

a utility company located in another Danish region where the collaborators had an acquaintance in common – was included in order to influence the market structure. In this case, the university's advanced radar data processing competencies were necessary in the project, and the utility was included in order to ensure that the developed technology fitted the requirements of Danish utility companies. This example highlights how firms in some cases establish projects where each partner is selected due to a specific motive, and how this influences the degrees of proximity that are considered beneficial in the bilateral relations.

Alternatively, collaboration with multiple external partners may be motivated by the same motive (cell #2), e.g. two partners may both provide a firm access to complementary technologies. In these cases, the proximity characteristics of the partners are typically rather similar, which underlines the importance of collaboration motives for partner selection. For example, a producer of hydrogen supply systems needed access to different forms of complementary technologies and initiated a project with three different Danish universities and research institutes with whom close social relations already existed in advance. Similarly, a supplier to the wind turbine industry sought to speed up the innovation process and established a project with two firms located in geographical proximity. The firm had collaborated with both partners on several other projects and knew that the firm cultures were very similar to their own.

The two cases illustrate that firms generally look for partners with similar characteristics when the motive for including them is the same. While there are a small number of cases, where the degree of proximity to the partners varies considerably, these cases are few and far between. To exemplify, for the geographical dimension there are only two

projects with one motive that involve partners at different scales, thus, it is rare that firms involve local and non-local partners at the same time.

Finally, there are some examples of firms that initiate a project with a single partner due to more than one motive (cell #3). The interviews show that this results in a difficult search process where advantages and disadvantages of potential partners' proximity characteristics are difficult to balance. The collaboration between a Danish developer of environmental technologies and a German producer of lubricants illustrates this well. The Danish firm initiated the collaboration to both enter the German market and obtain knowledge from the partner, and the partnership was characterized by low social proximity, as the two firms had not collaborated before. While on the one hand, engaging with this new partner could potentially facilitate access to the German market for the Danish firm, the interviewed CEO noted that they were initially concerned with the possibilities for learning from their collaborator: "We didn't really know them […] it was difficult to foresee if we would be allowed to enter their 'machine room', which was where we wanted to go. […] But then, on the other side, it was a good chance to enter Germany for us." Eventually, the collaboration ended up in disagreement, partly due to diverging opinions on knowledge and technology sharing, and the Danish firm consequently abandoned the attempt to enter the German market. Thus, while different motives may be successfully combined in the same collaboration, the case highlights that this is not easy due to tensions between the beneficial degrees of proximity associated with different collaboration motives. Consequently, firms risk leaving such collaborations empty-handed.

### 4.7. Summary

The findings of the analysis are synthesized in table 8. To recapitulate, firms prefer project partners located in their own or other Danish regions in three out of the five types of product development projects. In projects with the aim of *accessing complementary technologies*, geographical proximity is important in facilitating social proximity and thereby trust. Further, the functional effect of geographical proximity in allowing easy face-to-face interaction is also central. In projects with the objective of *obtaining knowledge*, it is in particular the close relation between geographical and social proximity, which plays a key role. As the intensity of interaction is generally lower than in the previous type of collaborations, the ability to meet without difficulty due to physical proximity is less important. In contrast, this effect of geographical proximity is vital for partnerships with a focus on *reducing innovation time-span* because of the need for intense interaction, thus, the pure accessibility effect of geographical proximity is important. Further, with the speed of development being a priority, geographical proximity also has a role in facilitating institutional proximity, which allows swift and easy collaboration.

**Table 8. Overview – desired characteristics of proximity dimensions in different types of innovation projects**

| | Accessing complementary technologies | Influencing market structure | Obtaining knowledge | Reducing innovation time-span | Sharing costs and risks |
|---|---|---|---|---|---|
| **Social proximity** | High<br>Partners whom the firm knows and trusts | Low<br>New partners that can support entrance in a new market | High<br>Preferably based on long-term relations with, e.g. former professors or co-students | High<br>Firms preferably rely on well-known partners | High<br>Partners whom the firm knows and trusts |
| **Institutional proximity** | Medium to high<br>Initiatives have often been taken to mitigate differences if they exist | Low<br>Partners that know and understand the local business culture | Low<br>Partners focused on knowledge creation and guided by different incentives | Medium to high<br>Preferably firms with similar cultures | Low<br>Firms operating in a very different cultural context |
| **Organizational proximity** | Low<br>Accessing competences unavailable inside firm | Low<br>Partners in markets where the firm is not represented | Low<br>Obtaining knowledge unavailable inside firm | High<br>Intra-firm collaborations are preferred, if possible | High<br>Partners from the same company located overseas, if possible |
| **Cognitive proximity** | Low<br>Different technological discipline | Medium to high<br>Partners working with similar or related technologies | Medium<br>Related technological discipline with some cognitive overlap needed | High<br>Similar disciplines, no time for overcoming large cognitive differences | Medium to high<br>Partners working with similar technologies, but at a different developmental stage |
| **Geographical proximity** | High<br>Necessary to make up for low cognitive proximity. Frequent interaction | Varying, but primarily low<br>1) Firms located in new markets<br>2) National partners when focus is on entering new business areas | Varying, but primarily high<br>High geographical proximity is often preferred to facilitate social proximity | High<br>Need for frequent interaction | Low<br>Firms located in parts of the world where labor costs are much lower |

In the remaining two types of projects, geographical proximity plays a less prominent role. In projects focused on *influencing market structure*, firms often seek entrance to foreign markets, and partners at a high geographical distance are therefore preferred. For collaborations with the aim of *sharing costs and risks*, firms seek project partners located in parts of the world where labor costs are much lower, and collaboration is enabled by high social and organizational proximity. Thus, summarizing, the analysis highlights the importance of geographical proximity in collaborative product development projects motivated by interaction around the actual product development and knowledge creation – accessing technologies, obtaining knowledge and reducing innovation time-span. Conversely, geographical proximity may in fact be undesirable in projects where the main motive for collaborating is not directly related to the interaction

around the product development, but rather concerned with entering new markets or benefitting from cost advantages.

A final issue worth considering is the distinction between the partners that the firms search for, and those they eventually form partnerships with. Table 9 gives the average degree of proximity of the 180 partnerships that the interviewed firms eventually established. Comparing tables 8 and 9, it is clear that there is a large extent of agreement between the two, exemplified by the geographical dimension where established partnerships motivated by access to complementary technologies, obtaining knowledge or reduction of the innovation time-span have high degrees of geographical proximity. Concerning the social dimension, the main difference between tables 8 and 9 is that established partnerships aimed at speeding up innovation processes have a low degree of social proximity. For the institutional dimension, the degree of proximity in established partnerships reflects the findings in table 8, even if a greater difference between, on the one hand, accessing complementary technologies and, on the other hand, influencing market structure and obtaining knowledge could have been expected. The degrees of organizational and cognitive proximity in established partnerships are generally also in accordance with the priorities of the firms, even if the cognitive proximity in established partnerships with the aim of influencing market structure is lower than expected. Overall, this comparison between the desired proximity characteristics and the degree of proximity in established partnerships strongly suggests that the motivation for collaborating indeed influences the resulting partnerships.

**Table 9. Average degree of proximity of established partnerships**

| | Accessing complementary technologies | Influencing market structure | Obtaining knowledge | Reducing innovation time-span | Sharing costs and risks |
|---|---|---|---|---|---|
| **Social proximity (scale 1-4)** | 2.84 | 2.58 | 2.92 | 2.63 | 2.70 |
| **Institutional proximity (scale 1-5)** | 3.05 | 2.88 | 2.88 | 3.03 | 2.20 |
| **Organizational proximity (scale 1-2)** | 1.04 | 1.06 | 1.04 | 1.10 | 1.40 |
| **Cognitive proximity (scale 1-3)** | 1.80 | 1.77 | 1.98 | 2.08 | 1.90 |
| **Geographical proximity (scale 1-5)** | 4.08 | 3.44 | 3.94 | 4.00 | 2.65 |

*Calculated with the lowest degree of proximity given the value of 1, thus, low values point to low degrees of proximity. The operationalizations of the proximity dimensions are provided in section 3.1.*

## 5. Conclusion

This paper's analysis underlines that collaboration motives have a profound influence on the partner search process and the desired partnership characteristics concerning the degree of proximity along the spatial and non-spatial dimensions in innovation projects. Focusing on how the desired characteristics of collaborators vary according to the objectives of the collaborations highlights how the proximity framework can be applied in the analysis of firm decision-making. Rather than determining whether a certain type of proximity facilitates partnership formation, the paper stresses the importance of recognizing the heterogeneity of desired partnerships characteristics and the reasons for this variation. This leads to the insight that firms specifically seek nearby partners (in both spatial and non-spatial terms) in some innovation projects, while distant partners

are preferred under other circumstances. In this way, they are juggling with distance and proximity.

The empirical analysis of collaborative product development projects in the Danish cleantech industry emphasizes the value of having access to a diverse portfolio of potential partners. This is exemplified by the cognitive dimension, where the analysis illustrates that the optimal cognitive distance (Nooteboom 1999) between partners, for a given firm at a given point in time, is highly influenced by the content of the collaboration. When firms seek partners that can bring complementary technologies into a project, they search for cognitive differences. While such collaborations are difficult and costly, they are nevertheless often necessary to develop a specific product. In partnerships where a main objective is to obtain knowledge, firms prefer partners with an intermediate level of cognitive distance. In these cases, the firms need to obtain the knowledge; hence, the differences must not be too large between the collaborators. Finally, in projects where the objective is to reduce the innovation time-span, firms seek partners with a high cognitive proximity. These partnerships are less inspiring and stimulating than those with a lower cognitive proximity, but speed is the main priority in these collaborations. Thus, firms prefer partners where they do not need to spend time and resources on overcoming cognitive differences.

Turning to the geographical dimension, the analysis stresses that geographical proximity is important in three out of the five types of collaborations. Theoretically, it is possible to substitute non-spatial proximity for geographical proximity in cases where the need for frequent face-to-face interaction is low. However, in reality, the importance of the facilitating effect of geography on social and institutional proximity implies that geographical proximity is often necessary in these types of projects. This has important

consequences for the debate in economic geography on global pipelines (Bathelt, Malmberg, and Maskell 2004). The analysis presented in this paper suggests that global pipelines play a minor role in partnerships with the aim of accessing complementary technologies or obtaining knowledge, where it is the partner's competences that are of main importance. In this way, geographical proximity is highly important in partnerships motivated by interaction around the actual product development and knowledge creation. Still, global pipelines appear to be important when the collaborative knowledge production is less sophisticated or when the partnerships are motivated by market access or cost considerations. This is a very different view on the role of global pipelines compared to the work of Moodysson (2008), where global pipelines are found to play a central role in different forms of interactive knowledge creation. However, Moodysson studies the life science industry, which is generally characterized by a higher reliance on global linkages than most other industries (Moodysson, Coenen, and Asheim 2008; Martin and Moodysson 2013). In contrast, the conclusions of the analysis presented in this paper warn against understating the importance of geographical proximity for partnerships in innovation projects, in particular those motivated by interaction around the actual product development and knowledge creation.

The findings of this study have important implications for the analysis of central themes in economic geography, beyond collaborative innovation projects, such as the location choices of firms. Research shows that single plant and multi-plant location choices differ (Mota and Brandão 2013), but little is known concerning the causes of this variation. Applying an analytical framework that focuses on how motives shape firm decision-making processes will highlight how the location choices of multi-plant firms

depend on the type of proximity (to knowledge sources, new markets, other subsidiaries etc.) they seek to achieve. Further, it will also emphasize how single plant firms, which do not have the opportunity to establish a division in a specific advantageous location, can compensate for the lack of organizational proximity through other forms of proximity.

Finally, acknowledging the limitations of this paper points towards a number of future research questions. First, while this paper has focused on the desired proximity characteristics of partnerships, the characteristics of the partnerships, which are actually established, will naturally be influenced by contextual factors such as geographical location and social capital. This interaction is an interesting and important area for future research. Further, the question of partnership performance remains. It is not certain that the preferred characteristics of partners, according to the collaboration motives, actually deliver the best results. Naturally, such an analysis would need to consider the partnerships' different objectives when selecting the performance variables. Second, partnerships are frequently established with more than one objective in mind. While this paper has provided an initial discussion of this point, more research is needed on the interaction between different motives and the influence on the search for partners. Third, this paper has highlighted the importance of collaboration motive, but other factors may influence the preferred proximity characteristics, such as innovation radicality (Hoetker 2005; Li, Eden, Hitt, and Ireland 2008) and commercial importance. One could for instance speculate that firms prioritize a high social proximity in crucial projects, while new partners are tested in less important projects. Identifying and examining such factors are important to improve the understanding of differences in desired proximity characteristics in collaborative innovation projects.

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