Tilburg University

Proximity and inter-organizational collaboration

Knoben, J.; Oerlemans, L.A.G.

Proximity and inter-organizational collaboration: A literature review

J. Knoben and L.A.G. Oerlemans

The proximity concept is used in many different ways in the literature. These dimensions of proximity are, however, defined and measured in many different (sometimes even contradictory) ways, show large amounts of overlap, and often are under- or over-specified. The goal of this paper is to specify the different dimensions of proximity relevant in inter-organizational collaboration more precisely and to provide definitions of these dimensions. The research presented contributes to reducing the ambiguity of the proximity concept as used in the literature.

Based on the above, the following research question is addressed in this paper: 'Which dimensions of proximity are relevant in inter-organizational collaboration and how are they defined?' A systematic literature review is presented in order to disentangle the dimensions of the proximity concept. Based on this literature review, three dimensions of proximity relevant in inter-organizational collaboration are distinguished: geographical proximity, organizational proximity and technological proximity. Examples (case studies) from the literature are used to illustrate the current conceptual ambiguity as well as to clarify how the proposed dimensions of proximity reduce this conceptual ambiguity.

Introduction

The proximity concept has captured a prominent position in the scientific literature dealing with inter-organizational collaboration (IOC) (e.g. Sternberg 1999), innovation (e.g. Oerlemans *et al*. 2001) and regional economic development (e.g. MacKinnon *et al*. 2002). It is an important emerging concept in several fields of science, for example in innovation studies, organization science and regional science.

When the proximity concept is used, what is often actually meant is geographical proximity. However, other forms of proximity, such as institutional proximity (Kirat and Lung 1999), organizational proximity (Meisters and Werker 2004), cultural proximity (Gill and Butler 2003), social proximity (Bradshaw 2001) and technological proximity (Greunz 2003) are used as well. Even though all of these dimensions of the concept of proximity refer to 'being close to something measured

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on a certain dimension', they are certainly not identical. Many of the dimensions of the proximity concept are, however, defined and measured in many different (sometimes even contradictory) ways, show large amounts of overlap, and often are under- or over-specified. The goal of this paper is to specify the different dimensions of proximity relevant in IOC more precisely and to provide useful definitions of these dimensions. This topic is argued to constitute one of the main gaps in the literature on proximity, as is shown in a recent special issue of *Regional Studies* (February 2005), and especially in the contribution of Boschma (2005). Previous studies have, however, done little more than signal the existing conceptual ambiguity, whereas the main goal of this paper is to reduce the ambiguity of the proximity concept as well.

Based on the above, the following research question has been formulated: 'Which dimensions of proximity are relevant in inter-organizational collaboration and how are they defined?' This specific focus was chosen because proximity in general is often seen as an important pre-condition for knowledge sharing, knowledge transfer and technology acquisition (Gertler 1995), processes which, in turn, are often seen as the primary goals of IOC (Hagedoorn and Schakenraad 1994). Moreover, through inter-organizational knowledge sharing, transfer and technology acquisition, firms are assumed to improve their competences, capabilities and resources, which enable them to strengthen their competitive position. Therefore, in an intricate process, different types of proximity facilitate the performance and survival of organizations.

To answer the research question presented above, a review of the available literature that makes use of the concept of proximity is presented and discussed. The papers yielded by the literature review were categorized based on the dimension of proximity that was used in the study. Subsequently, the different dimensions of proximity used in the literature are discussed to provide detailed insights into the existing conceptual ambiguity. Based on

this discussion, three dimensions of proximity are identified as being of specific importance in IOC, and definitions of these three dimensions are given. Examples (case studies) from the literature are used to illustrate the current conceptual ambiguity as well as to clarify how the proposed dimensions of proximity reduce this conceptual ambiguity. Finally, the findings of the paper are summarized, and its implications for future research are discussed.

Research Approach

To gain insight into the different dimensions of proximity and their definitions, a literature search has been conducted. This literature search specifically focused on the dimensions of proximity being used by scholars. A research approach similar to the one applied by Oliver and Ebers (1998) has been used for this literature review. The ISI database and the ABI/Inform database were used to perform literature searches with the keywords: (1) proximity, innovation and organization; (2) proximity and regional economic development; and (3) proximity, network(s) and inter-firm collaboration. These keywords correspond to the three main fields of science in which proximity is studied (Caniëls and Romijn 2003). The papers were finally selected on the basis of their abstracts.[1] These searches yielded 37, 21 and 21 papers, respectively. Furthermore, the literature search yielded seven papers that turned up in more than one of the literature groups. Papers were categorized according to the type of proximity used by the authors, and the theoretical mechanisms specifying the function of proximity.

This method of searching literature has a few disadvantages. First, only papers are included in these databases, leading to the omission of books and book chapters from the search. Second, the ISI database includes only papers from the period 1984–2005, whereas the ABI/Inform database includes papers from the period 1971–2005. As a result, papers published before 1971 are excluded from the search. Nevertheless, the literature reviewed gives

Table 1. Types of proximity used in the literature

Literature search	Type of proximity						
	Geographical	Organizational	Cultural	Technological	Cognitive	Institutional	Social
Proximity, organization and innovation (37 papers)	35	9	3	3	2	3	3
Proximity and regional development (21 papers)	19	0	1	0	0	0	1
Proximity and collaboration (21 papers)	19	2	1	1	1	0	2
Overlapping papers (7 papers)	7	2	1	0	1	0	1

a reliable overview of the content of the leading journals with regard to inter-organizational proximity. Therefore, it can be assumed to contain the most relevant insights concerning this field of science.

The Dimensions of Proximity in the Literature

Discussing all papers yielded by the literature search in detail is beyond to the scope of this paper. Therefore, only the dimensions of proximity studied in the papers were used as criteria for this analysis. The main results of this analysis can be found in Table 1. The cells in Table 1 represent the frequency with which a certain dimension of proximity has been used in a certain part of the literature. Since a paper can use more than one dimension of proximity, the cells do not add up to the total number of papers in that part of the literature.

The construction of this table was, in fact, not as straightforward an activity as might be expected (see Figure 1). First, different authors sometimes use different labels for identical dimensions of proximity. For example, the dimension 'personal proximity' (Schamp *et al.* 2004) and the dimension 'relational proximity' (e.g. Coenen *et al.* 2004) are identical to the more commonly used dimension 'social proximity' (Boschma 2005). Even though this

is a clear sign of conceptual ambiguity by itself, these different labels for identical dimensions of proximity have been condensed into one dimension in order to make Table 1 more comprehensible.

Second, some of the dimensions of proximity used in the literature are actually blanket dimensions. As a result, they define different dimensions of proximity under a single heading. For example, Goessling (2004) uses the concept of non-spatial proximity, without making its content explicit. Thus, what at first glance seem to be different concepts of proximity are sometimes blanket concepts that had to be decomposed in order to construct Table 1.

In order to clarify what each dimension of proximity presented in Table 1 encompasses, the different dimensions of proximity are discussed in detail in this section. Specific attention will be paid to the differences in the definitions and measurements by different authors within the dimensions of proximity. The main goal is to create detailed insights into the scope and composition of the existing conceptual ambiguity. Finally, the link between each dimension of proximity and IOC will be discussed in this section as well.

Geographical Proximity

Geographical proximity, which is denoted as territorial, spatial, local or physical proximity

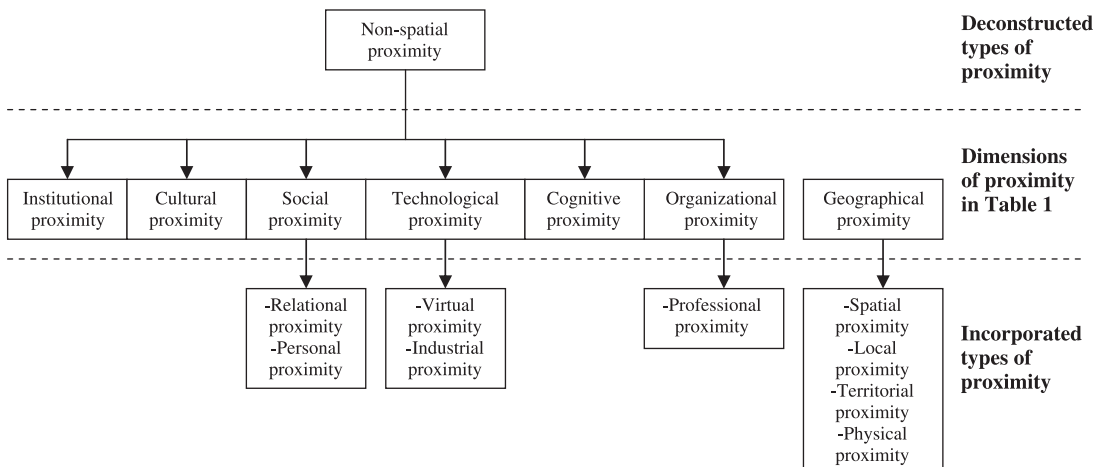# Proximity and inter-organizational collaboration: A literature review

Figure 1. The (de)composition of the dimensions of proximity.

as well, is the most frequently used dimension of proximity in the literature. Many studies do not even explicitly state that geographical proximity is being used, but just use the term 'proximity'. The definition of this dimension of proximity differs slightly between different authors. Some studies define the level of geographical proximity as the absolute geographical distance that separates actors, whereas others use the distance relative to the means of transport (travel times) or the perception of these distances by actors. Differences also exist with regard to the scale at which geographical proximity is defined. Some studies look at the distance between two interaction organizations (dyadic distance), whereas others look at the presence of groups of firms in a geographical unit (agglomerations).

Nevertheless, the definitions of geographical proximity are all fairly similar and use the same underlying mechanism for explaining the importance of geographical proximity. Therefore, the level of ambiguity within this dimension of proximity is fairly low. The importance of geographical proximity in IOC lies in the fact that small geographical distances facilitate face-to-face interactions (both planned and serendipitous) and, therefore, fosters knowledge transfer and innovation. The main reasoning behind these effects is that short geographical distances bring

organizations together, favor interaction with a high level of information richness and facilitate the exchange of, especially tacit, knowledge between actors (Torre and Gilly 2000). The larger the distance between actors, the more difficult it is to transfer these tacit forms of knowledge. This is even argued to be true for the exchange and use of codified knowledge, because its interpretation still requires tacit knowledge and thus spatial proximity (Howells 2002).

Recently, several authors have put forward the notion of temporary geographical proximity (e.g. Gallaud and Torre 2004, 2005; Hyypiä and Kautonen 2005; Torre and Rallet 2005). This notion implies that actors need not be in constant geographical proximity when collaborating, but that meetings, short visits and temporary co-location might be sufficient for actors to build other forms of proximity (such as organizational), which subsequently allow collaboration over large geographical distances. Moreover, it can be argued that geographical proximity is only necessary in certain phases of (innovative) collaborations, such as during the production of fundamental and tacit knowledge or during negotiations, but not during others, such as the codification or commercialization phase (Gallaud and Torre 2004, 142; 2005, 138). Even though the idea of temporary geographical

proximity seems plausible, empirical testing of this idea is lacking so far.

Organizational Proximity

Organizational proximity suffers from a relatively high level of conceptual ambiguity. First, different authors define organizational proximity in slightly different ways. For example, Oerlemans and Meeus (2005) define organizational proximity as 'actors that belong to the same space of relations'. Torre and Rallet (2005), however, define organizational proximity as 'actors whose interactions are facilitated by (explicit or implicit) rules and routines of behavior and that share a same system of representations, or set of beliefs', based on the idea of communities of practice (cf. Brown and Duguid 1991). Even though these definitions are similar to a certain extent, the second definition is broader than the first.

Burmeister and Colletis-Wahl (1997) define organizational proximity as a composite dimension consisting out of a geographical and a circulatory scale. This definition is extremely problematic, since it defines this circulatory scale as a 'rapid, reliable and well-adapted circulation of goods and information as well as the efficient mobilization of external resources'. What is seen as a consequence of organizational proximity by most authors is included as a determinant of organizational proximity in the study by Burmeister and Colletis-Wahl (1997). Finally, Schamp *et al.* (2004) define organizational proximity as 'the proximity between employees of a multi-plant firm who identify with each other as a result of belonging to the same firm and of their knowledge of firm specific routines' (p. 609). Even though this definition is similar to the first part of the definition used by Torre and Rallet (2005), it is clearly different from the definition used by Burmeister and Colletis-Wahl (1997) and, to a lesser extent, by Oerlemans and Meeus (2005).

Second, organizational proximity can be distinguished at two different levels, namely the structural and the dyadic level. Some

authors explicitly include these two different levels in their definition of organizational proximity (e.g. Torre and Rallet 2005). In these cases, no ambiguity is likely to arise. In other cases, however, only one of the two levels is used. Authors that use the structural definition of organizational proximity often focus on features such as the structural equivalence of actors (e.g. Rice and Aydin 1991) or whether or not firms belong to the same network (e.g. Oerlemans and Meeus 2005). As a consequence, these authors focus on the characteristics of networks rather than on the characteristics of a relationship between two firms. Other authors do look at specific relationships and thereby focus on the so-called dyadic level (e.g. Wilkof *et al.* 1995). In this approach, the similarity in organizational context in which members of different organizations operate determines the level of organizational proximity. The fact that these two levels of analysis are used throughout the literature is likely to lead to ambiguity about the concept, since one can assume that mechanisms at work at the dyadic level will differ from those at the network level (cf. Granovetter 1985).

The reasoning behind the importance of organizational proximity for IOC is that IOCs are more efficient and lead to better results when the organizational context of both interacting partners is similar due to the fact that this similarity facilitates mutual understanding. As such, organizational proximity generates a capacity to combine information and knowledge from the collaborating parties, to transfer tacit knowledge and other non-standardized resources between collaborating parties (Burmeister and Colletis-Wahl 1997). Thus, this form of proximity is seen as a prerequisite for dyadic and collective learning and in the joint creation of new resources and innovation (Kirat and Lung 1999).

Cultural Proximity

Cultural proximity is used throughout the literature, albeit at a relatively low frequency.

The definitions of culture are relatively consistent between authors. A definition of culture found in the papers reviewed is:

> Culture is the pattern of thoughts, feelings, behaviors, symbols and so forth that give meaning to actions and behaviors, and provide interpretations of situations for people. Culture is publicly shared and accepted by a given group at a given time, binding members together and defining or separating one group from others groups. (Adapted from: Burns and Stalker 1961; Pettigrew 1979; Wilkof *et al.* 1995)

However, two different levels of analysis of cultural proximity can be distinguished (Gertler 1995). The first level of analysis looks at cultural differences between continents, nations or regions. In these studies, it is assumed, but often not researched empirically, that organizations within these geographical areas share the same culture. The literature shows, however, that this is not always the case (Lenartowicz and Roth 1999). The second level of analysis focuses on differences in organizational culture between collaborating actors and measures these differences at the relational level (e.g. Wilkof *et al.* 1995).

When organizational cultures are similar, organizations are expected to interact more easily and with better results, because common interpretations and routines allow organizations to interpret and give meaning to actions without making all these difficult interpretations explicit. The dimension of cultural proximity defined at the organizational level is very similar to the definition of organizational proximity discussed earlier. Both dimensions facilitate the interpretation of actions and allow for smoother collaboration without the difficult process of making implicit actions and knowledge explicit. Therefore, it can be argued that, especially when focusing on IOC, cultural proximity at the organizational level is overlapping with the conceptualization of organizational proximity.

Institutional Proximity

As with cultural proximity, the definition of institutional proximity is largely undisputed. Most of the definitions are based on the one by North:

> Institutions are the humanly devised constraints that structure political, economic and social interaction. They consist of both informal constraints; (sanctions, taboos, customs, traditions, and codes of conduct), and formal rules (constitutions, laws, property rights). (North 1991, 97)

However, ambiguity arises from the fact that the concept of institutional proximity is studied on two different levels of analysis, which often are conflated by scholars. At the general level, the concept of institutional proximity is often based on similarities between the institutional frameworks of countries and regions, such as legislative conditions, labor relations, business practices, accounting rules and training systems (e.g. Zeller 2004). Formal institutions (such as laws and norms) and informal institutions (cultural norms and habits) influence the way in which actions are co-ordinated (Kirat and Lung 1999). However, at a lower level of analysis one can also determine the effects of these national institutions on the norms and routines present in an organization, which are not by definition identical to their national counterparts. The level of similarity of the norms and routines between organizations determines the level of institutional proximity at the organizational level.

Institutional proximity facilitates collective learning by allowing free knowledge transfer among agents based on a common space of representations, models, norms, procedures and rules being applied to thought and action (Capello 1999, 356; Kirat and Lung 1999, 30). When definitions are compared, it becomes clear that institutional proximity is almost identical to cultural proximity. Institutions and culture are strongly inter-related and are almost impossible to disentangle, as is illustrated by the fact that some authors define institutions

as 'cultural artifacts' (e.g. Morgan 1997, 493). Moreover, Hofstede (2001, 10–11) argues that culture determines institutions, which, in turn, re-enforce the existing culture. As such, it can be argued that, especially in the context of IOCs, cultural proximity and institutional proximity are identical.

Moreover, since the dyadic level of analysis of institutional proximity includes organizational norms and routines, institutional proximity at the dyadic level as well as cultural proximity at the dyadic level could simply be seen as a part of organizational proximity. Nevertheless, the literature treats organizational, cultural and institutional as separate dimensions of proximity, resulting in conceptual ambiguity.

Cognitive Proximity

The concept of cognitive proximity has been developed by Nooteboom (1999; 2000). Cognitive proximity is commonly defined as the similarities in the way actors perceive, interpret, understand and evaluate the world (Wuyts *et al*. 2005). The underlying rationale is that different conditions, such as organizational culture, customs, norms and routines influence the way actors see and know the world. In order to communicate and transfer (new) knowledge effectively and efficiently, actors need to have similar (but not necessarily identical) frames of reference.

Cognitive proximity as defined by Nooteboom is a relational attribute, and it is used as such by several authors (Tremblay *et al*. 2003; Wuyts *et al*. 2005). However, several other authors also use the term cognitive proximity to refer to groups of people that belong to a 'community of practice' and therefore can communicate efficiently despite large geographical distances. It should be noted that this second group of authors commonly see cognitive proximity as a part of organizational proximity (e.g. Rallet and Torre 1999; Torre and Rallet 2005).

Comparing the definition and the underlying rationale of cognitive proximity makes it clear that the concept is strongly linked to the concepts of cultural proximity and institutional proximity. Cognitive proximity can be considered to be a 'translation' of these two concepts from the national or regional level to the organizational level and applied to a context in which knowledge transfer is important. Therefore, it seems logical to consider cognitive proximity as a part of organizational prox-imity, since it is also based on the notion that sharing routines, cultures, values and norms facilitates the interaction of actors over geographical distances.

Technological Proximity

Technological proximity is based on shared technological experiences and knowledge bases. Technology can be defined as those tools, devices and knowledge that mediate between inputs and outputs (process technology) and/or that create new products or services (product technology) (Tushman and Anderson 1986). Technological proximity refers not to these technologies themselves, but to the knowledge actors possess about these technologies. Similarities in technological knowledge, which is sometimes denoted as virtual proximity (Schamp *et al*. 2004), facilitate technological learning as well as the anticipation of technological developments (Tremblay *et al*. 2003; Zeller 2004). Technological proximity between actors facilitates the acquisition and development of technological knowledge and technologies. The ambiguity with regard to this dimension of proximity arises from the fact that two different levels of analysis, the general and the dyadic level, can be found in the literature.

The importance of technological proximity at the general level is based on the concept of absorptive capacity. Absorptive capacity is 'a firm's ability to recognize the value of new, external knowledge, assimilate it and apply it to commercial ends' (Cohen and Levinthal 1990, 128). Cohen and Levinthal state that, in order to collaborate successfully, the prior (technological) knowledge of a firm must be

similar to the new knowledge on the basic level, but fairly diverse on the specialized level (1990, 136). Basic knowledge refers to the general understanding of the techniques upon which a scientific discipline is based, whereas specialized knowledge refers to the specific knowledge used by the actors in its everyday functioning. The concept of absorptive capacity is an actor level concept, which implies that a firm with a certain absorptive capacity can learn from all other organizations equally.

The importance of technological proximity at the dyadic level is explained by the concept of relative absorptive capacity (Lane and Lubatkin 1998). Contrary to the general concept of absorptive capacity, which assumes that a firm's capacity to learn depends only on the firm itself, the concept of relative absorptive capacity states that this capacity also depends on the source of the knowledge exchanged. The dyadic level of technological proximity states that firms must have comparable knowledge bases in order to be able to recognize the opportunities offered by collaboration, but a different specialized knowledge base in order to permit effective and creative utilization of new knowledge (Colombo 2003). In other words, firms need to be similar enough in knowledge bases to be able to recognize the opportunities that the other actor's knowledge gives, but different enough to contribute new knowledge to the IOC. The more different firms are in knowledge bases, the more there is to learn, but the more difficult is becomes to learn as well. The knowledge base of firms is commonly measured by looking at the products they produce or the scientific or technological fields in which they file patents (Fung 2003).

Technological proximity seems similar to the concept of cognitive proximity, but there is an important difference. Cognitive proximity is a much broader concept that refers to the extent to which actors can communicate efficiently, whereas technological proximity refers to the extent to which actors can actually learn from each other. One might argue

that cognitive proximity deals with the issue of 'how' actors interact, whereas technological proximity deals with the issue of 'what' they exchange and the potential value of these exchanges.

Social Proximity

Social proximity, sometimes denoted as personal proximity (Schamp *et al.* 2004) or as relational proximity (Coenen *et al.* 2004) as well, is seen by several authors as part of organizational proximity (e.g. Filippi and Torre 2003), whereas others use it as an independent type of proximity (Coenen *et al.* 2004). This, by itself, is a source of ambiguity. However, both groups of authors do use largely similar definitions of the dimension. Social proximity always refers to actors that belong to the same space of relations (Oerlemans and Meeus 2005). This view is strongly linked to the concepts of structural equivalence (Mizruchi 1993) and embeddedness (Granovetter 1985) in which the economic action and outcomes of firms is affected by their dyadic relations and by the structure of the overall network of relations (Oerlemans and Meeus 2005).

Another source of ambiguity is the fact that relational proximity can be studied at two different levels. On the one hand, one can look at whether firms belong to the same 'community of practice' or occupy structurally equivalent positions in networks. On the other hand, one can determine to what extent the IOCs of two firms with third-party firms are similar (Rice and Aydin 1991). The first approach focuses on characteristics of groups of firms or networks, whereas the second approach focuses on characteristics of the collaborating organizations themselves.

The main reasoning underlying the importance of social proximity (on both levels of analysis) for IOC lies in the fact that social relations not only co-ordinate transactions but are also vehicles that enable the exchange of knowledge because of mutual trust, kinship and experience as well as external resources to be mobilized (Boschma 2005; Oerlemans
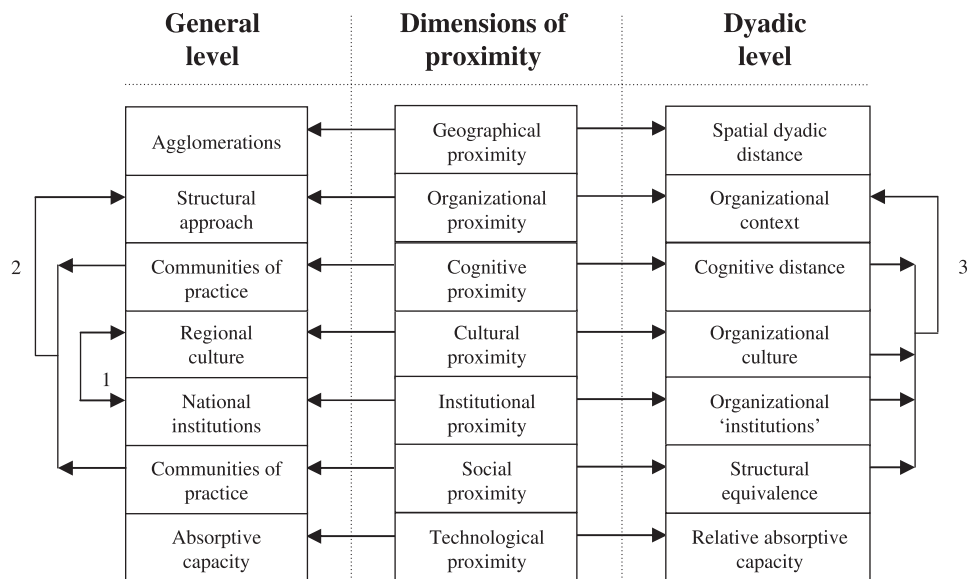
General level	Dimensions of proximity	Dyadic level
Agglomerations	Geographical proximity	Spatial dyadic distance
Structural approach	Organizational proximity	Organizational context
Communities of practice	Cognitive proximity	Cognitive distance
Regional culture	Cultural proximity	Organizational culture
National institutions	Institutional proximity	Organizational 'institutions'
Communities of practice	Social proximity	Structural equivalence
Absorptive capacity	Technological proximity	Relative absorptive capacity

Figure 2. Condensing the dimensions of proximity.

and Meeus 2005). As such, it seems logically to include the notion of social proximity in the concept of organizational proximity when looking at IOCs, as several authors already do (e.g. Filippi and Torre 2003; Oerlemans and Meeus 2005; Torre and Rallet 2005).

The preceding discussion of the different dimensions of proximity indicates that the concept of proximity suffers from a certain degree of conceptual ambiguity. The sources of ambiguity that are identified are:

- Different labels are used for identical dimensions of proximity (e.g. spatial proximity and geographical proximity).
- Blanket dimensions of proximity are being used (e.g. non-spatial proximity).
- Different dimensions of proximity show large amounts of overlap and cannot be disentangled (e.g. cultural and institutional proximity).
- Different definitions exist of the same dimension of proximity (e.g. the relational definition vs the spatial definition of organizational proximity).

- The dimensions of proximity are being used at different levels of analysis (e.g. geographical proximity as groups of firms in a geographical unit or as the geographical distance between two collaborating firms).

Dimensions of Proximity Relevant in Inter-organizational Collaboration: A Proposal

Figure 2 illustrates the different types of proximity, their levels of analysis and the existing overlap between them.

Based on their definitions, the distinction between institutional and cultural proximity seems artificial. Both are integrated into a single dimension of proximity (arrow 1 in Figure 2). Furthermore, the general level of analysis of relational proximity as well as organizational proximity and cognitive proximity is based on the concept of communities of practice (cf. Brown and Duguid 1991) (arrow 2) and are integrated into a single dimension. Arrow 3 in Figure 2 illustrates that institutions and culture are only of importance for IOC if these institutional and cultural characteristics have

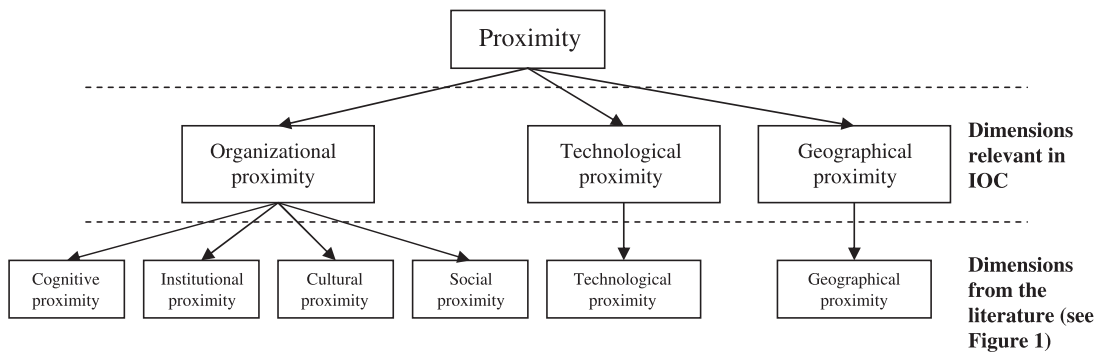# Proximity and inter-organizational collaboration: A literature review

Figure 3. Dimensions of proximity at the dyadic level.

seeped through to the organizational level (Kirat and Lung 1999, 29). This is not necessarily the case, as it is possible, for example, to have an organization with an Asian organizational culture and institutions located in Europe or the US. When this is the case, however, the rationales underlying the importance of these characteristics are identical to the rationales underlying the importance of organizational proximity and social proximity. All of these assume that shared routines, values, norms, cultures and relations facilitate interactions between actors. Therefore, these can be integrated into a single dimension of proximity. This integration is in line with Capello (1999), Torre and Gilly (2000) and Torre and Rallet (2005), who state that organizational (in their definition including social proximity), institutional and cultural proximity combined allow interaction between economically separated actors.

Based on this discussion, it can be argued that the dyadic dimensions of organizational proximity combined with geographical and technological proximity are able to capture all the effects of different types of proximity on IOC.

Figure 3 depicts the three dimensions of proximity proposed in the above and their composition at the dyadic level. Technological proximity is defined as 'the level of overlap of the knowledge bases of two collaborating actors' (Lane and Lubatkin 1998). Geographically, proximity is defined as 'the extent

to which two collaborating actors can have daily face-to-face relations without prohibitive costs' (Capello 1999, 357). Finally, organizational proximity is defined as 'the set of routines – explicit or implicit – which allows coordination without having to define beforehand how to do so. The set of routines incorporates organizational structure, organizational culture, performance measurements systems, language and so on' (Rallet and Torre 1999). This definition clearly reflects all the components of organizational proximity as depicted in Figure 3.

The three dimensions of proximity proposed and defined in the above reduce the existing conceptual ambiguity in several ways. First, the plethora of names used in the proximity literature is reduced to three clear-cut names. Second, existing blanket dimensions are abolished. Third, the existing overlap between different dimensions is reduced considerably. Fourth, the different definitions of one dimension of proximity are abolished, allowing for more comparability between studies and more cumulative knowledge building. Finally, the level of analysis of the dimensions of proximity is made explicit.

Illustrating the Reduction of Conceptual Ambiguity

To illustrate the effects of the three proposed dimensions of proximity on the existing conceptual ambiguity, several case studies found
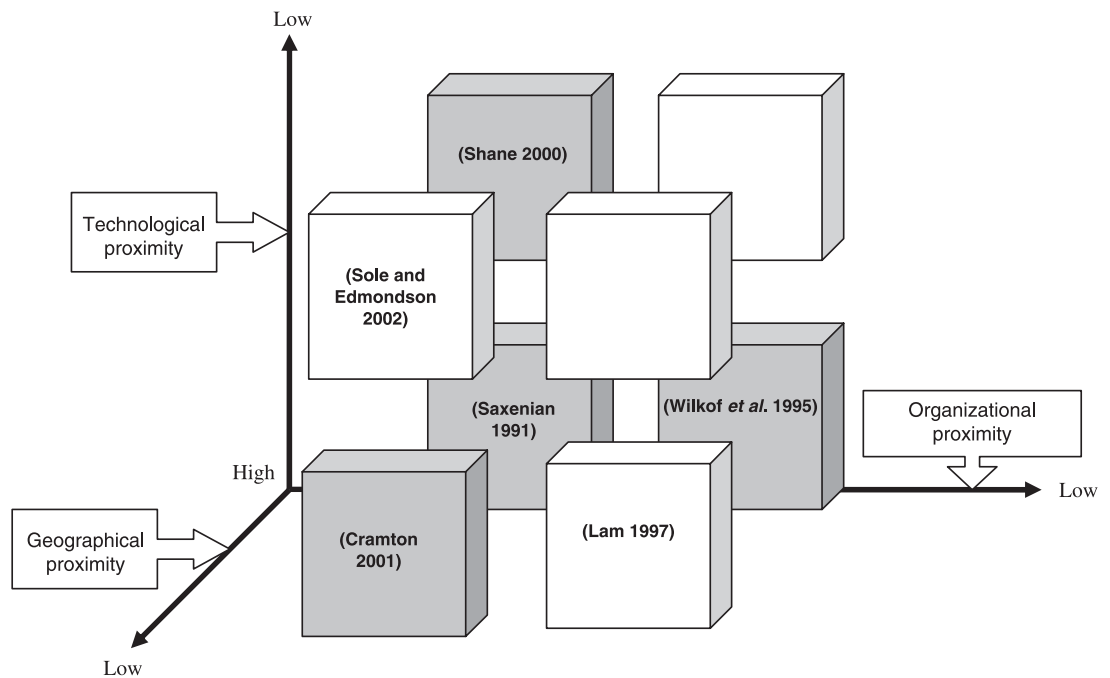
Figure 4. Dimensions of proximity positioned according to authors.

in the literature will be discussed. To find these case studies, another literature search was performed. The ISI database and the ABI/Inform database were searched for several key words that correspond to the three proposed dimensions of proximity, such as 'technological', 'geographical' and 'organizational'. Furthermore, terms like 'distance', 'dispersion' and 'mismatch' as well as 'case' and 'qualitative' were used. The strategy was not to discuss all and any of the papers that would fit in one of the cells of Figure 4, but rather to find illustrative cases for each of these cells. The cases have not been randomly drawn from the available population, but they were primarily selected on the richness of their data description. The discussion of these cases serves only to illustrate the existing conceptual ambiguity and to clarify the effect of the proposed dimensions of proximity, rather than as a formal test of the proposed dimensions.

Figure 4 depicts the three dimensions of proximity proposed in the above. In this figure, the case studies are classified based on

the descriptions of the original authors. Not all cells of Figure 4 are filled, since no applicable case studies could be found for some configurations of proximity. Subsequently, these cases will be discussed on the basis of the newly proposed dimensions of proximity and their working definitions. These discussions are not meant to show that the original authors were 'wrong', but serve to illustrate the effects of the use of the three proposed dimensions of proximity on the findings of existing studies.

Proximate on All Dimensions

Saxenian (1991) describes the well-known case of Silicon Valley. Silicon Valley represents a case in which actors are able to have frequent (in)formal face-to-face contacts, work with many different applications of the same technology and share the same cultural and organizational norms and routines even though entrepreneurs from many different cultures and backgrounds work in the region (Castells

and Hall 1994). Therefore, Silicon Valley represents a case in which actors are proximate on all three dimensions. As a result, a climate that facilitates collaboration, knowledge exchange and innovation has ensued. The case of Silicon Valley will serve as a benchmark for discussing the other cases.

Geographical Proximity

Developments in communication technologies have made it feasible for actors to work together despite physical dispersion of group members. The study by Cramton (2001) focuses on an experiment in which team members had to collaborate without meeting face-to-face and therefore had trouble building mutual knowledge. Cramton (2001) proceeds by linking certain problems in building mutual knowledge to the lack of face-to-face contacts and thereby attributes all problems in the IOC to the lack of geographical proximity. The problems she described are: failure to communicate and retain contextual information, unevenly distributed information, differences in the salience of information, relative differences in the speed of access to information and differences in interpreting the meaning of silence. When looking at these problems in detail, however, other explanations than the lack of face-to-face contacts can be derived from the paper. For example, it is described that actors had trouble creating and updating a mental 'map' of their distant partners' situation, which includes the failure to communicate and retain (firm-specific) goals of the collaboration or even very basic information such as upcoming holidays that might be specific to one of the parties in the IOC. Furthermore, differences in the interpretation of silence also lead to problems in the IOC. Silence can mean anything from 'I agree' to 'I don't know', 'I strongly disagree' or 'I am having technical problems and am unable to respond at the moment'. Both examples illustrate that the collaborating actors were unable to co-ordinate their actions.

When applying the three proposed dimensions of proximity to the study of Cramton (2001), it becomes clear that both geographical proximity (the lack of frequent face-to-face contacts) and organizational proximity (the lack of routines that enabled co-ordination) were present. No characteristics of technological proximity were found, however.

Organizational Proximity

Wilkof *et al*. (1995) study a case with two collaborating partners with completely different organizational cultures in the computer industry. However, the description of the organizational cultures given by Wilkof *et al*. (1995) includes the firms' structure, their (in)formal rules and their type of governance. This definition of organizational culture includes characteristics of institutional and organizational proximity as well and can, therefore, be characterized as organizational proximity, instead of cultural proximity.

Firm A buys hardware from firm B, which programs it with its own software and resells the complete systems. Firm A is a mechanistic organization with a formal, hierarchical and bureaucratic structure, whereas firm B is an organic organization with an informal, decentralized and non-bureaucratic structure. Firm A used only established rules and procedures, whereas firm B used a 'do the right thing from a win–win perspective' mechanism to guide task accomplishment. These large differences in almost every aspect of the organizational culture had a large impact on the success of the collaboration between both firms. Differences in procedures between the two firms often led to mutual frustration or loss of faith in the partner's capabilities, whereas differences in problem-solving tactics between the firms often led to the problem not being solved at all. Furthermore, the management of both firms constantly misinterpreted the other firm's actions and motives. Rather than working together and solving the conflicts, both firms began blaming each other, which ultimately led to the demise of the collaboration.

A closer examination of the arguments presented by Wilkof *et al.* (1995) reveals that, besides the cultural differences, there were difficulties resulting from technological differences as well. For example, both firms disagreed as to whether the systems produced by firm A were high availability or medium availability ones, which resulted from the different technological background of both firms.[2]

According to the definitions of proximity proposed in this paper, this case is actually studied by focusing on both technological proximity and organizational proximity, instead of only organizational culture. Geographical proximity was not an issue in this paper, as both firms were located close to each other. Interestingly, the topic is touched upon when it is mentioned that firm A had no trouble getting mechanics of firm B to its own site (Wilkof *et al.* 1995, 379).

Technological Proximity

Shane (2000) uses the concept of technological proximity to analyze the case of a research institute that developed three-dimensional printing (3DP™) and the ensuing collaboration with other organizations to commercialize this invention. Shane finds that entrepreneurs will discover only those opportunities that are related to their prior knowledge (Shane 2000, 499). This is the case since the search for new knowledge can only be undertaken if the searcher is aware of what is not known and how this unknown might complement its own knowledge. This notion is used to explain many of the problems that arise during the ensuing collaboration that result from a lack of technological proximity, as is illustrated in the following examples:

> I absolutely could not have seen the business concepts that the other licensees were doing. I knew nothing about casting. Also, you could not make metal parts using the 3DP™ process. And I do not think that it would have ever occurred to me in a thousand years that you could print pills . . . . (Shane 2000, 456)

The effects of differences in technological knowledge bases between collaborators nicely fit the working definition of technological proximity used in this paper. No characteristics of other dimensions of proximity could be found in the paper.

Geographical and Technological Proximity

Sole and Edmondson (2002) discuss a case in which dispersed collaboration (without face-to-face contacts) has central stage. The main difference with the study of Cramton (2001) is that Sole and Edmondson explicitly pay attention to the differences in (technological) knowledge bases between the collaborators by focusing on cross-functional product development teams. The effects of these differences are that team members from different functions often struggle to understand each other (Sole and Edmondson 2002), as is illustrated in the following quotations:

> On each of these dispersed projects, our big challenge is that we just don't get together as a team because we are spread so far apart. (Sole and Edmondson 2002, 17)
>
> We in the US were getting frustrated that our Japanese colleagues were not providing the information that we wanted. It was an ah-ha for us when we realized that they truly do not have the right [information]. (Sole and Edmondson 2002, 26)

However, when relating these quotations to definitions of proximity proposed in this paper, they reflect a lack of geographical and organizational proximity.

Based on their case study, Sole and Edmondson conclude that, when knowledge from another location is needed, they must first recognize, and adjust for, location-specific practices within which that knowledge is embodied before they can use it (Sole and Edmondson 2002). This finding, however, bears many characteristics of organizational proximity and is not directly related to the differences in technological knowledge bases.

Proximity and inter-organizational collaboration: A literature review

The presence of the characteristics of organizational proximity is illustrated by the fact that different locations manifested substantially different, typically taken for granted approaches to similar work, as can be seen in the following quote:

> In site C, research folk are more experimentalist; they tend to do a lot of lab work on a small scale. In site W, the research people are more involved with paper studies, concepts and ideas. They wouldn't do lab work to evaluate those. (Sole and Edmondson 2002, 23)

The above reflects characteristics of working routines and organizational culture, but in the same field of knowledge. As such, this paper incorporates both organizational and geographical proximity, but not technological proximity.

Geographical and Organizational Proximity

Lam (1997) describes an IOC in which, besides being geographically dispersed (one in the UK and one in Japan), both firms are characterized by completely different organizational structures, processes and routines. Both firms, however, do work with the same technology and are known as very innovative. The large geographical distance between both firms was largely negated by (temporarily) co-locating engineers from both firms at one of the two firms. Nevertheless, the differences in routines, skill formation, utilization practices and labor division between both organizations were so large that engineers became frustrated, as is illustrated by the following quote:

> The Japanese tend to get everybody involved. For example, obviously this project involved a lot of their different groups . . . Before they commit to anything, all the groups have to be involved. Whereas we tend to make the decision, then go back to sort it out later with all the different groups. It is very frustrating and we don't know how to cope with the long discussion that goes on. (Lam 1997, 985)

When the working definitions of proximity are applied to Lam's study, it can be concluded that, owing to the co-location of engineers, frequent face-to-face contacts were possible. As such, the level of geographical proximity can be considered to be high. Furthermore, the described differences in routines, skill formation, utilization practices and labor division between both organizations reflect a low level of organizational proximity. Interestingly, co-locating engineers at the same location could not negate the large organizational distance between both firms as is suggested by several authors (e.g. Filippi and Torre 2003; Kirat and Lung 1999; Rallet and Torre 1999). The level of technological proximity was high since both firms work with the same technologies.

Discussion and Conclusion

After analyzing the case studies using the definitions of the dimensions of proximity proposed in this research, several changes can be made to Figure 4. In Figure 5, the cases are repositioned on the basis of the definitions of proximity formulated in this research.

Figure 5 reflects the fact that many of the case studies that were analyzed contain characteristics of dimensions of proximity that are not made explicit in these studies or vice versa. As a result, several characteristics of IOCs are wrongfully attributed to certain dimensions of proximity. Cramton (2001), for example, attributes many communication problems to a lack of geographical proximity, even though these problems actually arise from a low level of organizational proximity.

The main contribution of the proposed three dimensions of proximity is that a large part of the conceptual ambiguity is negated. The plethora of different dimensions of proximity is reduced to three dimensions that can be theoretically disentangled. Blanket dimensions of proximity are abolished, and the level of analysis is made explicit. Finally, the definitions of each of the dimensions are made more precise. By reducing the conceptual
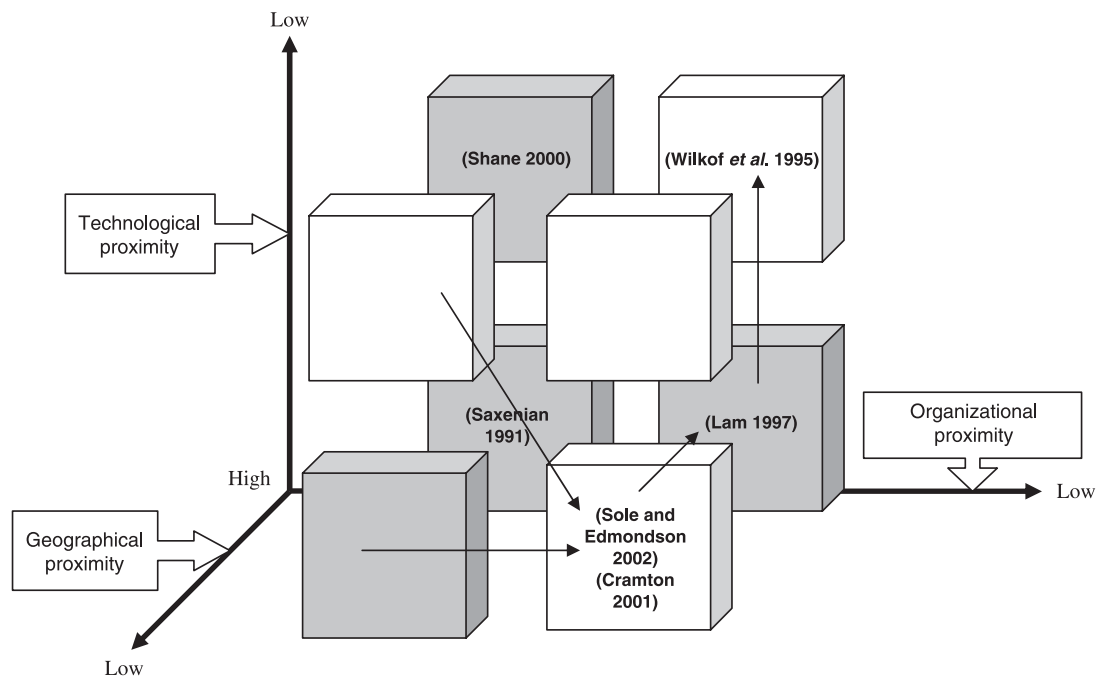
Figure 5. Newly positioned dimensions of proximity.

ambiguity, this research adds to the existing research, which has only signaled the existence of the ambiguity. As a result, findings of different studies become more comparable, which allows for, hopefully, more consistent findings and more cumulative knowledge development.

It should be noted, however, that even though the proposed dimensions of proximity can be separated theoretically as well as empirically, this does not imply that the three dimension of proximity do not influence each other. First, the dimensions of proximity can interact over time. For example, several authors claim that the development of organizational proximity can be facilitated by (temporarily) creating geographical proximity (e.g. Kirat and Lung 1999). The notion of temporary geographical proximity is triggered by the increased mobility of individuals, information and goods (Gallaud and Torre 2004). As a result of this increase in mobility, the constraints of collaborating over large geographical distances can be temporarily

overcome through travelling, but without the prohibitive costs of permanent co-location. Since the need for geographical proximity is generally assumed to be not permanent, creating temporary geographical proximity might be a sufficient precondition for efficient IOC.

Furthermore, different types of proximity can strengthen or weaken each other's effect at a certain point in time. For example, two collaborating partners that are geographically dispersed face difficulties arranging face-to-face contacts. Firms that are proximate on the technological and organizational dimension might be able to substitute these face-to-face contacts with modern communication technologies and, thereby, overcome the problems caused by large geographical distances. For firms with low levels of technological or organizational proximity, however, trying to do so might result in even more problems due to miscommunication and misinterpretations of electronic communication, as is illustrated in the study by Cramton (2001).

Proximity and inter-organizational collaboration: A literature review

These interactions present difficulties when studying the effects of one dimension of proximity in isolation, as these cases might not be very common. Therefore, simulation studies, such as the one by Cowan *et al*. (2004), might prove valuable. Furthermore, longitudinal research is necessary to test whether or not different dimensions of proximity really interact over time. Such claims are impossible to test in cross-sectional research designs, but published longitudinal research on this topic seems lacking. Future research should aim to take these types of interactions into account or to make sure that only one type of proximity is really studied (e.g. in experiments). From a scientific point of view, disentangling effects of the different types of proximity on IOC can provide very valuable information. On the other hand, specifically because the different forms of proximity are heavily correlated, these correlations should be incorporated in future theoretical and empirical research. The three dimensions of proximity distinguished in this paper might provide a starting point for this research and could prevent further ambiguity with regard to the concept of proximity.

Besides the scientific lessons that can be drawn from this paper, several managerial implications can be formulated as well. Even though alliances are considered to create value by most managers (Anand and Khanna 2000), alliances appear to be notoriously difficult to manage, as is evidenced by the large number of failures among alliances (Park and Russo 1996). Therefore, the questions 'what makes IOCs succeed?' and 'what are the roles of different forms of proximity related to this?' remain prominent questions for managers and scientists alike (Lambe *et al*. 2002).

First, the notion of temporary geographical proximity seems promising for organizations that seek knowledge but cannot find it in their own vicinity. Creating permanent geographical proximity, by co-location, is prohibitively expensive for most firms and is highly impractical, since each new IOC would have to lead to a reconsideration of the location of the firm. The use of temporary geographical proximity to build organizational proximity seems a logical strategy to follow in such cases.

Another important consideration for managers is that the ability of a firm to benefit from an alliance is largely a function of the dyad in question, rather than of either of the individual firms (Anand and Khanna 2000; Lambe *et al*. 2002; Lane and Lubatkin 1998). Therefore, organizations that start an IOC should be prepared to invest in building organizational proximity. Doing so costs time and resources, and even several failures, or at least disappointing results, in the beginning of an IOC should be seen as learning and not as failure. That firms can indeed 'learn' to collaborate is proven empirically in several papers (e.g. Anand and Khanna 2000; Lambe *et al*. 2002; de Man 2005).

Given the fact that building organizational proximity asks for investments, organizations should focus on a relatively small number of collaborations. Empirical research has shown that organizations can manage at most six collaborations simultaneously (Draulans *et al*. 2003). Furthermore, research has also shown that it is more sensible for organizations to implement similar types of collaborations. Different types of collaborations have different requirements. Consequently, the building of organizational proximity takes place faster when similar types of collaborations are set up (Draulans *et al*. 2003).

However, even when organizational proximity can successfully be developed and either temporary or permanent geographical proximity has overcome the problems of geographical distance, success is not guaranteed. The match between organizations in terms of strategy, structure and culture is an important aspect, but only facilitates the exchange of (technological) knowledge. A certain amount of technological proximity is also required in order to be able to use the knowledge and capabilities of the other actor. As such, firms have to take the field knowledge in which their partner is active into account.

From the above, it can be concluded that managers should, when considering an alliance with a certain potential partner, take into account all three dimensions of proximity specified in this paper. When over-valuing one form of proximity and failing to recognize the importance of other types of proximity, it might be difficult to harvest the potential gains of such an alliance (Höyssä and Sandberg 2005). A firm could focus, for example, on creating (temporary) geographical proximity, but it seems unlikely that, without enough organizational and technological proximity, such an effort will be very fruitful.

Notes

1 Omitted papers usually came from a completely different field of science (such as chemistry), excluding these parts of the databases would have resulted in fewer omitted papers. However, some papers, in particular those dealing with innovations and technological collaborations, would have been lost as well. Therefore, it was decided to include these parts of the databases in the search.

2 High availability systems are ones that are always 'up and running', either because there is enough redundancy built into the main systems or because there is a redundant backup system (Wilkof *et al.* 1995).

References

Anand, B.N. and Khanna, T. (2000). Do firms learn to create value? The case of alliances. *Strategic Management Journal*, **21**(3), 295–315.

Boschma, R.A. (2005). Proximity and innovation: a critical assessment. *Regional Studies*, **39**(1), 61–74.

Bradshaw, M. (2001). Multiple proximities: culture and geography in the transport logistics of newsprint manufactured in Australia. *Environment and Planning A*, **33**(10), 1717–1739.

Brown, J.S. and Duguid, P. (1991). Organizational learning and communities of practice: toward a unified view of working, learning and innovation. *Organization Science*, **2**(1), 40–57.

Burmeister, A. and Colletis-Wahl, K. (1997). Proximity in production networks: the circulatory dimension. *European Urban and Regional Studies*, **4**(3), 231–241.

Burns, T. and Stalker, G.M. (1961). *The Management of Innovation*. London: Tavistock.

Caniëls, M.J.C. and Romijn, H. (2003). Firm-level knowledge accumulation and regional dynamics. *Industrial and Corporate Change*, **12**(6), 1253–1278.

Capello, R. (1999). Spatial transfers of knowledge in high technology milieux: learning versus collective learning processes. *Regional Studies*, **33**(4), 353–366.

Castells, M. and Hall, P. (1994). *Technopoles of the World: The Making of Twenty-first-century Industrial Complexes*. London: Routledge.

Coenen, L., Moodysson, J. and Asheim, B.T. (2004). Nodes, networks and proximities: on the knowledge dynamics of the Medicon Valley biotech cluster. *European Planning Studies*, **12**(7), 1003–1018.

Cohen, W.M. and Levinthal, D.A. (1990). Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly*, **35**(1), 128–152.

Colombo, M.G. (2003). Alliance form: a test of the contractual and competence perspectives. *Strategic Management Journal*, **24**(12), 1209–1229.

Cowan, R., Jonard, N. and Özman, M. (2004). Knowledge dynamics in a network industry. *Technological Forecasting and Social Change*, **71**, 469–484.

Cramton, C.D. (2001). The mutual knowledge problem and its consequences for dispersed collaboration. *Organization Science*, **12**(3), 346–371.

Draulans, J., de Man, A.-P. and Volberda, H.W. (2003). Building alliance capability: management techniques for superior alliance performance. *Long Range Planning*, **36**(2), 151–166.

Filippi, M. and Torre, A. (2003). Local organisations and institutions. How can geographical proximity be activated by collective projects? *International Journal of Technology Management*, **26**(2–4), 386–400.

Fung, M.K. (2003). Technological proximity and co-movements of stock returns. *Economics Letters*, **79**(1), 131–136.

Gallaud, D. and Torre, A. (2004). Geographical proximity and circulation of knowledge trough inter-firm cooperation. In Wink, R. (ed.), *Academia–Business Links: European Policy Strategies and Lessons Learnt*. Basingstoke: Palgrave Macmillan, pp. 137–158.

Gallaud, D. and Torre, A. (2005). Geographical proximity and the diffusion of knowledge: the case of

SME's in biotechnology. In Koch, A. (ed.), *Rethinking Regional Innovation*. Dordrecht: Kluwer, pp. 127–146.

Gertler, M.S. (1995). Being there – proximity, organization, and culture in the development and adoption of advanced manufacturing technologies. *Economic Geography*, **71**(1), 1–26.

Gill, J. and Butler, R.J. (2003). Managing instability in cross-cultural alliances. *Long Range Planning*, **36**(6), 543–563.

Goessling, T. (2004). Proximity, trust and morality in networks. *European Planning Studies*, **12**(5), 675–689.

Granovetter, M.S. (1985). Economic action and social structure: the problem of embeddedness. *American Journal of Sociology*, **91**(3), 481–510.

Greunz, L. (2003). Geographically and technologically mediated knowledge spillovers between European regions. *Annals of Regional Science*, **37**(4), 657–680.

Hagedoorn, J. and Schakenraad, J. (1994). The effect of strategic technology alliances on company performance. *Strategic Management Journal*, **15**(4), 291–309.

Hofstede, G. (2001). *Culture's Consequences: Comparing Values, Behaviors, Institutions, and Organizations Across Nations*. Thousand Oaks, CA: Sage.

Howells, J.R.L. (2002). Tacit knowledge, innovation and economic geography. *Urban Studies*, **39**(5–6), 871–884.

Höyssä, M. and Sandberg, B. (2005). *Proximity in the Strategic Alliances of Small Knowledge-Intensive Firms*. Copenhagen: The Copenhagen Conference on Strategic Management.

Hyypiä, M. and Kautonen, M. (2005). *Dimensions of Proximity in Relationships between Knowledge Intensive Business Service Firms and Their Clients*. Aalborg: Regional Studies Association International Conference on Regional Growth Agendas.

Kirat, T. and Lung, Y. (1999). Innovation and proximity – Territories as loci of collective learning processes. *European Urban and Regional Studies*, **6**(1), 27–38.

Lam, A. (1997). Embedded firms, embedded knowledge: problems of collaboration and knowledge transfer in global cooperative ventures. *Organization Studies*, **18**(6), 973–996.

Lambe, C.J., Spekman, R.E. and Hunt, S.D. (2002). Alliance competence, resources, and alliance success: conceptualization, measurement, and initial test. *Journal of the Academy of Marketing Science*, **30**(2), 141–158.

Laneh, P.J. and Lubatkin, M.H. (1998). Relative absorptive capacity and interorganizational learning. *Strategic Management Journal*, **19**(5), 461–477.

Lenartowicz, T. and Roth, K. (1999). A framework for culture assessment. *Journal of International Business Studies*, **30**(4), 781–798.

MacKinnon, D., Cumbers, A. and Chapman, K. (2002). Learning, innovation and regional development: a critical appraisal of recent debates. *Progress in Human Geography*, **26**(3), 293–311.

Man, A.-P. de (2005). Alliance capability: a comparison of the alliance strength of European and American companies. *European Management Journal*, **23**(3), 315–323.

Meisters, C. and Werker, C. (2004). Physical and organizational proximity in territorial innovation systems: introduction to the special issue. *Journal of Economic Geography*, **4**(1), 1–2.

Mizruchi, M.S. (1993). Cohesion, equivalence, and similarity of behavior: a theoretical and empirical assessment. *Social Networks*, **15**(3), 275–307.

Morgan, K. (1997). The learning region: institutions, innovation and regional renewal. *Regional Studies*, **31**(5), 491–503.

Nooteboom, B. (1999). Innovation and inter-firm linkages: new implications for policy. *Research Policy*, **28**(8), 793–805.

Nooteboom, B. (2000). *Learning and Innovation in Organizations and Economies*. Oxford: Oxford University Press.

North, D.C. (1991). Institutions. *Journal of Economic Perspectives*, **5**(1), 97–112.

Oerlemans, L.A.G. and Meeus, M.T.H. (2005). Do organisational and spatial proximity impact on firm performance? *Regional Studies*, **39**(1), 89–104.

Oerlemans, L.A.G., Meeus, M.T.H. and Boekema, F.W.M. (2001). On the spatial embeddedness of innovation networks: an exploration of the proximity effect. *Tijdschrift voor Economische en Sociale Geografie*, **92**(1), 60–75.

Oliver, A.L. and Ebers, M. (1998). Networking network studies: an analysis of conceptual configurations in the study of inter-organizational relationships. *Organization Studies*, **19**(4), 549–583.

Park, S.H. and Russo, M.V. (1996). When competition eclipses cooperation: an event history analysis of joint venture failure. *Management Science*, **42**(6), 875–889.

Pettigrew, A.M. (1979). On studying organizational cultures. *Administrative Science Quarterly*, **24**(4), 570–581.

Rallet, A. and Torre, A. (1999). Is geographical proximity necessary in the innovation networks in the era of global economy? *Geo Journal*, **49**(4), 373–380.

Rice, R.E. and Aydin, C. (1991). Attitudes toward new organizational technology: network proximity as a mechanism for social information-processing. *Administrative Science Quarterly*, **36**(2), 219–244.

Saxenian, A. (1991). The origins and dynamics of production networks in Silicon Valley. *Research Policy*, **20**(5), 423–437.

Schamp, E.W., Rentmeister, B. and Lo, V. (2004). Dimensions of proximity in knowledge-based networks: the cases of investment banking and automobile design. *European Planning Studies*, **12**(5), 607–624.

Shane, S. (2000). Prior knowledge and the discovery of entrepreneurial opportunities. *Organization Science*, **11**(4), 448–469.

Sole, D. and Edmondson, A. (2002). Situated knowledge and learning in dispersed teams. *British Journal of Management*, **13**(Special issue), S17–S34.

Sternberg, R. (1999). Innovative linkages and proximity: empirical results from recent surveys of small and medium sized firms in German regions. *Regional Studies*, **33**(6), 529–540.

Torre, A. and Gilly, J.P. (2000). On the analytical dimension of proximity dynamics. *Regional Studies*, **34**(2), 169–180.

Torre, A. and Rallet, A. (2005). Proximity and localization. *Regional Studies*, **39**(1), 47–59.

Tremblay, D., Klein, J., Fontan, J. and Roussaeau, S. (2003). Territorial proximity and innovation: a survey in the Montreal region. *Revue d'Economie Regionale et Urbaine*, (5), 835–852.

Tushman, M.L. and Anderson, P. (1986). Technological discontinuities and organizational environments. *Administrative Science Quarterly*, **31**(3), 439–465.

Wilkof, M.V., Brown, D.W. and Selsky, J.W. (1995). When the stories are different: the influence of corporate culture mismatches on interorganizational relations. *The Journal of Applied Behavioral Science*, **31**, 373–388.

Wuyts, S., Colomb, M.G., Dutta, S. and Nooteboom, B. (2005). Empirical tests of optimal cognitive distance. *Journal of Economic Behavior & Organization*, **58**(2), 277–302.

Zeller, C. (2004). North Atlantic innovative relations of Swiss pharmaceuticals and the proximities with regional biotech arenas. *Economic Geography*, **80**(1), 83–111.

J. Knoben is from the Department of Organisation Studies, Tilburg University, Warandelaan 2, PO Box 90153, 5000 LE Tilburg, The Netherlands. L.A.G. Oerlemans is from the Department of Organisation Studies, Tilburg University, Warandelaan 2, PO Box 90153, 5000 LE Tilburg, The Netherlands, and from the Department of Engineering and Technology Management, University of Pretoria, Republic of South Africa.