

Dynamic Proximities – Bridging Connective, Cognitive, and Spatial Distances

October 24th, 2007

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ABSTRACT: The proximity literature describes why geography matters for the innovative dynamics that take place in networks. The intention of this paper is to go one step further, namely to elaborate how these dynamics change the network, i.e. how distances are actually bridged. The paper elaborates three different dynamics that bridge distances: a connective dynamic that bases upon network position and governance of the network; a spatial dynamic that describes the implications of face-to-face interaction; and a cognitive dynamic that depicts learning processes. Upon these three dynamics, a proximity concept is elaborated that describes the change of relation as a process of bridging and generating distances. It is argued that distance in one dimension requires proximity in another dimension.

Introduction

Since Marshall's fundamental pages on industrial districts, scholars from different disciplines have asked the question about the advantages of co-localisation. A particular strand in this discussion is the proximity concept. The notion "proximity" describes that and relations are neither spaceless nor bound to a particular place, but can be described by various dimensions of proximity and distance. The proximity concept contributes essentially to the understanding of economic co-ordination on different geographical scales and found way in many contributions that deal with the spatiality of networks (Morgan 1997, Boschma 2005, Zeller 2004).

Relations are dynamic and can change. New actors get in contact, while other parts of the network diminish. Coping with dynamics requires a proximity concept that not only explains the spatiality of networks but also their evolution (Glückler 2007). The existing proximity approaches describe the "proximity dynamics" (Torre and Rallet 2005) within the network. The intention of this paper is to go one step further, namely to elaborate how these dynamics change the network.

A dynamic conceptualization of proximities requires two aspects. The first is a view on relations as continuum between proximity and distance. Relations are often described in a dichotomous way, either by proximity or distance, which is defined as the non-existence of proximity. A step towards a conceptualization of proximities as continual variables is already illustrated in Boschma (2005), where he argues that both "too much and too little proximity may be harmful for effective interactive learning and innovation" (Boschma 2005: 62). The second aspect points to the very foundation of a dynamic proximity concept, namely how distances are actually bridged. The argument of the paper is that the bridging of distances is the crucial process in changing relations and that the bridging of distances takes place upon three distinct dynamics: a connective dynamic (Barabasi 2003, Burt 1992, Watts 2004) that bases upon the network position of actors and the governance of the network; a spatial dynamic (Torre and Rallet 2005, Storper and Venables 2004) that describes the implications of face-to-face interaction; and a cognitive dynamic (Johnson-Laird 1983, Nooteboom 1999a, Denzau and North 1994) that depicts learning processes. Upon these three dynamics, a proximity concept is elaborated that describes the change of relation as a process of bridging and generating distances, whereby bridging of distance in one dimension requires proximity in other dimensions.

The paper proceeds as follows. The next section gives an overview on the proximity literature and indicates the interfaces for a dynamic conceptualisation. The third section elaborates on the different proximity dimensions. The interdependence of the different dimensions and how proximity in one dimension contributes to bridge distance in other dimensions is topic of the fourth section. The fifth section concludes.

Approaching Proximities

Different strands work with the notion “proximity”. The most prominent is the French proximity school. In the beginning of the 90s, French economists introduced a distinct approach on this topic that intended “to explain the nature of the effects of proximity and to contribute to the indigenization of the space variable in economic theory” (Torre and Gilly 2000: 170). Their point of departure is the interaction between agents and how this interaction is influenced by proximity relations between them (Torre and Gilly 2000, Torre and Rallet 2005, Rallet and Torre 1999). The intention of the French proximity school compares the differences in network externalities between co-located and distant actors. For this comparison the protagonists of this group elaborated two different kinds of proximities. One is geographical proximity and the other is organizational¹ proximity:

While organizational proximity deals with economic separation and relations in terms of the organization of production, *geographical proximity* deals with the separation in space and relation in terms of distance (Torre and Gilly 2000: 176).

In contrast to the French approach that is confined to geographical, organizational and in some cases institutional proximity, other contributions have altered the proximity concept and elaborated several new proximities. Examples are relational, internal, virtual, technological and cognitive proximity (Boschma 2005, Zeller 2004). This enlargement and the application of the term “proximity” to different aspects beyond a purely interplay point to the manifold forms of relations and the variety of factors that affect interaction.

The prime intention of the approach is to describe knowledge transfer and coordination between disperse and co-located actors at a particular point in time. As a rule, proximities are elaborated to illustrate comprehensively the interaction between actors. In these approaches, the proximities serve as explanans for a particular setting: proximities are the independent variables and explain the existence of interaction as dependent variable. This conceptualization often leads to the result that one proximity is influenced by other

¹ In recent publications, the term „organized proximity“ instead of organisational proximity is applied. Yet, both terms refer to the same aspects. For the sake of coherency the term “organisational proximity” is used in this paper.

proximities (see Knoben and Oerlemans 2006). Accordingly, if actors are close in one dimension, they are probably also close in one or more other dimensions.

The overlap of boundaries becomes a conceptual problem, when the proximities are applied to changing relations. The following example may illustrate this effect. The taxonomy of Zeller (2004) comprises institutional, cultural, organizational, relational, technological, virtual, internal, and external proximity. In his taxonomy, “cultural proximity is interrelated with institutional proximity” (ibid., 88) and bases upon “mutual knowledge” (ibid.). The “mutual knowledge” as basis for cultural proximity resembles the statement that actors “share the same knowledge” (ibid.), which is the basis of organizational proximity. Cultural proximity, additionally, goes together with “relational proximity [that] is shaped by cultural affinity” (ibid.) and influences “technological proximity [that] depends mainly on institutional and cultural proximity” (ibid.). Therefore, the enhancement of cultural proximity would lead to a direct increase of organizational, relational, institutional and technological proximity. Yet, cultural proximity not only is part of, but also influenced by, other proximities. Concluding, an increase of cultural proximity would not only influence other proximities, but the increase of the other proximities would lead to an increase in cultural proximity that again affects other proximities. In the end, actors are proximate in all dimensions.

Knoben and Oerlemans (2006) analysed the existing literature on proximities with the intention to reduce the ambiguity of the concept, to avoid overlaps between the different proximities and to elaborate the relevant proximity for inter-organisational collaboration. They found out that three dimensions are sufficient: geographical, organizational and technological proximity. But their conceptualization also aggravates a dynamization. Their dimensions, indeed, have little overlap. This proximity is a kind of residuum for everything that is neither technological nor geographical. Organizational proximity comprises knowledge embodied in organizational routines and culture as well as the organizational structure where interaction takes place. And the change of firm culture follows different logics than the change of firm structures.

Despite these ambiguities, there are several applications of the proximity concept to describe changing relations. Rallet and Torre (1999) described changing network configurations in three French regions. Zeller (2004) illustrated how Novartis and Roche established different research facilities to establish proximities to regional knowledge and to its competitors in an oligopoly market. Gilly and Wallet (2001) described the conversion of the aerospace defence industry in Bordeaux that was accompanied by a change of institutional, organizational and

geographical extension of proximities between actors. The given examples grasp temporal dynamics by a comparison of the setting of relations at time t and with that in t' . In doing so, these approaches enable an understanding of different settings at particular points in time, they do not explain how the setting at t' results from t . The causality of change between t and t' is part of another theory in Gilly and Wallet (2001), the result of factors exogenous to the proximities like governmental action in Rallet and Torre (1999) or corporate strategy in Zeller (2004). However, both empirical studies (Gulati and Gargiulo 1999, Grabher 1993) and theoretical explanations (Glückler 2007, Barabasi 2003) show that relations follow path dependencies, i.e. proximities between actors at time t bear an influence on the proximities at time t' . These processes must be considered in a dynamic conceptualization of proximities. Therefore, the proximities that are able to describe dynamic relations must fulfill qualifications that distinguish them from existing approaches. Proximities are not only the basis for interaction, but also change during interaction. To be dynamic, the proximities must inherent a logic of change. To avoid mutual reinforcement, the proximity dimensions should be orthogonal to each other, i.e. it must be possible to change one proximity without another. These criteria require a reconceptualization of proximities. The elaboration starts with the element that unites all proximity concepts, namely the exchange of knowledge during interaction.

Constructing Proximities

The result of an interaction cannot be forecasted in advance. However, actors start an interaction with a particular intention like coordination of economic activities, acquisition of knowledge, generation of novelty, and exchange of goods and an expectation of a possible result. The expected result is the logic behind contact establishment and, accordingly, behind the underlying theory. Like in other proximity versions, a knowledge-based approach is applied in this paper. Actors interact with the intention to generate novelty or to co-ordinate their actions. Both intentions require the exchange of knowledge (Torre and Rallet 2005, Boschma 2005, Kirat and Lung 1999). Therefore, the starting point to elaborate proximities is the interaction within a dyadic relation and how interaction changes the relation.

Cognition

Interactions lead to a recombination of knowledge from different sources and new application of previously acquired knowledge. It is a social process that takes place between individuals. Nonaka and Takeuchi (1995), for example, termed Japanese firms “knowledge creating companies” because they institutionalized the recombination of knowledge by circulation of

employees. They emphasise that the crucial units to analyse knowledge generating processes are individuals and their interactions.

During interaction, knowledge is exchanged. Knowledge exchange implies that knowledge not only is articulated and transmitted, but also absorbed. Absorption requires a certain degree of mutual understanding between the sender and the receiver of knowledge, which depends on their cognitive categories. Every actor has a distinct perception of the world that originates from its personal history. The perception of the single actor depends on their mental models (Johnson-Laird 1983) that are “the internal representations that individual cognitive systems create to interpret the environment” (Denzau and North 1994: 4). When actors communicate, they depend on the compatibility of their interpretation of their environment, i.e. on their mutually *shared* mental models (Nonaka and Takeuchi 1995, Denzau and North 1994). Shared mental models describe a similarity of certain areas of knowledge. In doing so, shared mental models form a "common language" or a “platform” as a basis for communication. Shared mental models are both preconditions of meaningful communication. Denzau and North (1994) developed a sender/receiver - model to describe this process. The sender of an information, or an “idea” as Denzau and North (1994) call it, articulates and encodes the information on the basis of its mental models into a language. The receiver decodes the information and integrates its particular comprehension of the information it into its mental models. The more the idea matches to the mental models of the receiver, the easier it is to decode the idea (Mathieu et al. 2000). Concluding, “[i]f different individuals have similar models they are able to better communicate and share their learning” (Denzau and North 1994, 4).

While Denzau and North (1994) describe how actors efficiently communicate with each other, Nooteboom's (1999a) “cognitive distance” explains the result of interaction as a function of their communicability. Nooteboom's (1999b) central argument is that there is an optimal cognitive distance for innovation.

For learning, partners should have on the one hand sufficient ‘cognitive distance’, i.e. possess different cognitive categories, to be able to capture knowledge that one could not have captured oneself, but on the other hand must be sufficiently close, in cognition and language, to enable meaningful communication (Nooteboom 1999b, 14).

The closer the actors in cognitive terms, the better they are able to communicate, while their communicability decreases with cognitive distance. In contrast, the degree of novelty depends on the differences between the respective knowledge. Interaction in large cognitive distance results in more radical novelties than in small cognitive distance, whereas a high

communicability is accompanied by a low degree of novelty. With the cognitive distance, Nooteboom (1999a) adds a relative element to the knowledge generating process, as the degree of novelty, respective the knowledge exchanged, depends on the cognitive distances between actors. Actors are in cognitive proximity, when their mental models are similar. The larger the differences in the mental models are, the larger is the cognitive distance.

Mutual learning and knowledge exchange works on the cognitive distance. Basis for the cognitive distances are the shared mental models that can be influenced by knowledge exchange (Denzau and North 1994). Which knowledge is transferred and the degree it influences the cognitive proximity between actors depends on the actors themselves. Nonaka and Konno (1998) point to the influence of knowledge exchange on actions. In their model, the knowledge is explicated by articulation. This “explicit knowledge has to be embodied in action and practice” (Nonaka and Konno 1998, 45) to become active. Subsequently, the knowledge of the different actors adjusts, the actors become more proximate and communication becomes more efficient (Nooteboom 1999a).

The degree of adjustment and what kind of knowledge adjusts depends on two factors. The first factor is the topic of the interaction, or the “idea” as Denzau and North (1994) would call it. During interaction only particular knowledge is activated, according to the topic of interaction. For example, an adjustment of technological knowledge requires the exchange on technology related issues. The second factor is the respective proximity between actors. The larger the distance between actors is, the larger the potential to decrease the distance and, accordingly, the larger the possible learning effects. There are few possibilities for further approximation, if actors are already close. In this case, interaction rather contributes to sustain the already achieved degree of proximity than enhances it.

The cognitive distance comprises several kinds of knowledge (Wuyts et al. 2005). But only particular knowledge is of relevance in innovative activities, namely the kind of knowledge upon that novelty emerges. This kind of knowledge is termed technological knowledge in this paper. Technological knowledge comprises two aspects. The first aspect regards the technology itself and encompasses the technical and technological abilities to develop a certain product or to apply a certain process. The second aspect refers to the context of the technology, i.e. the environment in which new products are developed that also affects product development like knowledge about potential customers and markets. Shared technological knowledge comprises the common technological knowledge that enables a communication with the aim to generate novelty. The communicability depends on the

complexity of the respective knowledge. For less complex technologies, less shared knowledge is necessary whereas highly complex technologies require a larger common basis (Sorenson et al. 2006). Consequently, not the pure amount of shared knowledge is important for mutual intelligibility, but the proportion of the shared knowledge in relation to the remaining non-shared knowledge. Actors are hence technological distant, if a respective understanding is not possible or would require additional learning processes. Technological distance decreases with the amount of different knowledge and the growth of shared knowledge.

Beside technological knowledge, Interaction as social process also comprises other factors than that enhance both mutual understanding and willingness to interact. Maskell and Malmberg (1999: 180) note on this topic:

To communicate tacit knowledge will normally require a high degree of mutual trust and understanding, which in turn is not only related to language but also to shared value and 'culture'.

This quote indicates that factors outside technological knowledge can create commonness between actors and influence the transfer of technological knowledge in spite of distance in another dimension. Often, interaction even depends and is shaped by factors outside a technological dimension. An example may clarify this. If a firm diversifies and goes in new markets, it has to acquire knowledge on new technologies. This knowledge is initially located in technological distance. Therefore, the technological knowledge on its own does not suffice to bridge the technological distance and communication with the aim to generate innovation is hardly possible under this condition. A substitution process exists between the technological knowledge necessary for novelty and knowledge that can facilitate mutual understanding independent of technological knowledge. Ettlinger (2003) gives an illustrative example for the substitution of different kinds of knowledge. She described in a thought experiment that employees transform emotional trust into a person into trust in the capacity of the person. In her example, knowledge from one area contributes to interaction in another area, i.e. proximity in one dimension can substitute distance in another dimension. Substitution illustrates that despite distance in one dimension interaction can take place because of proximity of another dimension.

These other dimensions can be of another than the technological realm. Direct and continuous contact between actors can result in advanced understanding between them. Common experiences and knowledge of the behavior of the other actor generate trust and facilitate communication. Working colleagues, members of the same club or fellow students are

respective examples. In addition to this social knowledge that bases upon personal relations, common experiences and direct interaction and thus refers to the particular relation between actors, commonness can also emerge without a previous contact, for example by socialization. Different actors grow up with a comparable background although their socialization happened independently from each other. This common background facilitates interaction between people with comparable socialization. Saxenian and Hsu (2001) describe the effect of a common background on contact establishment with Taiwan-Chinese people in Silicon Valley. Members of this community immediately benefit from a large degree of mutual trust simply because of compatriotism. Additionally, the literature on industrial districts in the Third Italy emphasizes that the same traditions and the confidence that opportunistic behavior is penalized is a central feature of the interaction patterns within the districts (Piore and Sabel 1984). This trust is confined to the actors in the district and it applies even if the collaborators did not previously know each other. The same effect can be observed in corporate cultures: similar corporate cultures may facilitate collaborations between firms, whereas different cultures can prevent collaboration, even if it was beneficial from an economic and technological perspective (Lane and Lubatkin 1998, Ferner et al. 2001). In addition, also emotional factors can hinder or facilitate communication. Emotional factors even enable actors to decide (Loasby 2001). Emotional factors cannot be subsumed under the notion “knowledge”. Nevertheless, they contribute, even if not to mutual understanding, to the willingness to interact and comprehend the other.

While interaction results in an adjustment of the shared mental models they can also develop apart. When a particular interaction between two actors is cancelled, the “mental models would tend to diverge [...] if there were not ongoing communication with other individuals with a similar cultural background.” (Denzau and North 1994:14). Continual adjustment is especially necessary when the respective knowledge changes rapidly. Additionally, when actors cancel a particular interaction, other interactions can still take place. The continued interactions lead to an adjustment of the shared knowledge between the respective actors. Previously shared knowledge can be transformed in a new context and lose its old connotation.

Connection

Apart cognitive abilities and properties, action is shaped by the relational context. Network theories describe how actors get in contact according to the structure of the network and their network position (Watts 1999), and the governance of the network (Granovetter 1985, Uzzi

1997). Burt (1992) emphasises the importance to bridge structural holes between otherwise not connected networks. Actors that are positioned at structural holes form non-redundant ties. They connect networks that would have been separated otherwise, or connected by detour. Actors at structural holes profit from their position as they overview information flowing in different networks which gives them information advantage. They can profit from arbitrage between these networks, become attractive for other actors to connect to and in doing so can easily expand their own network, and they have a higher risk to create “good ideas” (Burt 2004).through synthesising knowledge from different networks.

While social network analysis focuses on the importance of structure of networks and position in networks, graph theory additionally describe how the structure of the network and the rationale behind its evolution affects the change of its single parts (Watts 2004, Barabasi 2003).² The overall structure of a network is normally situated between two extremes. The first extreme is the highly clustered network. This network consists of clusters of nodes, where every node is connected to every other node in the cluster, while the different clusters are separated. The average distance between each node within the cluster is small, but the average degree according to the whole network is endless, as the clusters are not connected. The second type of network is the random network. In this network, the connection between each node is chosen randomly. Accident connects every node to all other nodes in the network with the smallest possible degree of distance (Watts 1999). An intermediate type of network is the “small world” network (Watts 1999, Watts 2004, Baum et al. 2003). It consists of clustered nodes, but a few additional links between the clusters considerable reduces the average tie length. Thus, “a very small fraction of long-range shortcuts can lead to the coexistence of high local clustering and a small global length scale“ (Watts 1999: 524). The properties of „small world networks” both enable easy contacts within clustered parts of the network and connects each node through few steps with all other nodes in network.

There are several mechanisms of tie establishment in networks.³ In the clustered networks, new contacts emerge mostly within clusters. If node A is connected to B and C, it is highly probable, that a new contact emerge between B and C and that thus new contacts do not emerge randomly. This regularity is empirically proven by many case studies, for example for

² In its analytical reach, graph theory describes a connection between social and natural science as their protagonists argue that such different systems like economy, cells, the internet etc. all follow (at least to a certain extent) the same fundamental logics (Barabasi 2003, Watts 2004).

³ Ties can also decay. Burt (2000) show in a longitudinal study that the speed of decay depends on the change of surrounding.

inter-firm alliances by Gulati and Gargiulo (1999) and for the establishment of embedded ties in the New York apparel industry by Uzzi (1997). Obstfeld (2005) argues that actors profit from introducing otherwise unconnected actors to each other. In the random network, new ties emerge randomly, i.e. when A is connected to B and B to C, a connection between A and C is as probable as to any other node in the network.

The “rich getting richer” rule assumes that new ties connect to the most connected hubs. One reason for this pattern is first mover advantage. Each new node connects to the existing nodes. As the oldest nodes took part in the most number of rounds of tie selection, they took part in more rounds and thus have more chances to get a new link than younger nodes. This phenomenon is aggravated, when new nodes prefer to attach to nodes that already have the most ties. As a result, hubs in the network grow stronger than the rest. Preferential attachment introduces a path dependent element in graph theory, as the nodes that became hubs in an early stage of network evolution will represent the hubs at later stages. The result is a network with a few highly connected hubs and a lot of un- or scarcely connected nodes.

The lock in to a particular structure of hubs and peripheral nodes is broken up when new nodes not only connect to nodes according to their connections but also according to the fitness of nodes. As a result, fittest nodes grow more quickly than older but less fit nodes. However, the formation of social networks seems to be far more complex. Powell et al. (2005) analyse network establishment and alliance forming in between biotechnology firms. They could not prove the “rich getting richer” thesis for networks. Older nodes get considerably less new ties than younger nodes. They argue that firms form new ties to diversify their network

Network governance approaches (Uzzi 1997, Granovetter 1985) emphasise that not only the structure is important for the network and the generation of new contacts but also the character or “quality”, as Uzzi (1997) put it, of the network. One example is the distinction between weak and strong ties. Weak ties are loosely connected nodes. Connections are often diffuse, yet quite flexible. Strong ties, in contrast, are often long lasting relations or connections with a high degree of formalisation (Storper and Venables 2004). Owen-Smith and Powell (2004) found out that network position is not important to get access to the knowledge that flows through weak ties while it is essential with respect to the knowledge that flows in strong ties.

In a relational perspective, firms are considered as “network within networks” (Dicken and Malmberg 2001). The firm is a particular form of network (Dicken and Malmberg 2001) that governs interaction. Firms represent strong ties, especially regarding employees in the same working group or between departments of an organisation. Kogut and Zander (1992) argue that the firm is the appropriate structures for combining different types of knowledge. Cohen and Levinthal (1990) as well as Lane and Lubatkin (1998) emphasise that the organisational structure of companies influences the absorptive capacity of a firm. Additionally, the literature about tacit knowledge suggests that the organisation as a context of interaction strongly affects the transfer of tacit knowledge (Amin and Cohendet 1999, Gertler 2003, Breschi and Lissoni 2001). In multinational enterprises for example, a continuous interaction between different departments occurs despite their geographical dispersion. Such an interaction would not take place, if the multinational enterprise as a framework did not exist.

Concluding, the network influences the contact between actors in two kinds. The first is by the structure of the network. New ties do not form randomly but follow particularities. The probability for ties between actors that are only a few degrees distant is higher than between actors that have a large distance in degrees. The second influence of the network is the quality of the tie that affects the intensity of interaction. Ties become stronger with increasing institutionalisation as it is the case in long lasting relationships, formal collaborations or within firms. This institutionalisation is weaker with accidental, sporadic or stand-by contacts. The structure of the network and its governance both influence the connection and is therefore subsumed under connective proximity. Connective proximity describes how the structure of the network and the quality of its ties influence contacts and interactions.

Co-location

Spatial proximity is not a value per se. Spatial proximity becomes an important factor when economic activities require face-to-face interaction. Storper and Venables (2004) mention four effects of face-to-face-interaction is important: the transfer of knowledge, the generation of trust whereby knowledge is transferred that would not be transferred by other means of communication, screening and socialization within “informal networks, in which members of the network develop and share a pool of knowledge about members’ competence” (Storper and Venables 2004: 356) and motivation of people.

Face-to-face interaction requires physical proximity. It takes an effort to generate physical proximity between otherwise distant actors. The effort depends on the time and cost it takes to bridge the spatial distance and is affected by means of transport and communication (Glückler

2007). Being co-located or connected by appropriate means of transport reduces the effort for face-to-face-interaction. But, as Torre and Rallet (2005: 49) state, “the need for geographical proximity (to realize cooperation, for instance) does not necessarily imply that actors should be located near each other”, and face-to-face interaction is not confined to actors that are steadily co-located. This implies, in turn, that spatial proximity is only necessary where steady face-to-face interaction is required (Glückler 2007). Torre and Rallet (2005) mention some of the activities that depend on face-to-face interaction, namely

in the phase of negotiation a transaction, the definition of guidelines and the organizational framework of cooperation, the realization of its initial phase in the case of a technological alliance, the necessity to share equipment in the experimental phase of a common research project or to exchange knowledge and, above all, to know personally the researchers (colloquium) belonging to a scientific community (ibid. 54).

Spatial proximity is often necessary, and temporarily generated, with the start of a project or collaboration which requires intense face-to-face interaction (Gallaud and Torre 2005). But its importance decreases during the progress of the project as cognitive proximity is developed. The continual face-to-face interactions with partners in actual spatial distance may be regarded as such important that firms decide to establish a subsidiary or re-locate to generate steady spatial proximity.

The generation of proximity for face-to-face interaction concerns mainly the effort it takes to bridge spatial distances. Spatial proximity becomes another notion, when the view is changed from the dyadic to the aggregate level, where a number of actors are in spatial proximity. In agglomerations, actors are close to many other actors without any direct intention and necessity for being close. Spatial proximity to many actors facilitates the access to diverse knowledge and can provoke haphazard contacts. Glaeser (1999) argues that people learn by contacts with other agents and that these contacts are more easily established in agglomerations than in the periphery. Additionally, both the speed and the diversity of contacts are higher in urban areas than in the hinterland. Malmberg and Maskell (2006: 5) describe localised learning as follows:

All kinds of inter-firm learning are enhanced because spatial proximity provides them with an arsenal of instruments to obtain and understand subtle and complex information of possible relevance. The ability to benefit fully from knowledge heterogeneity among firms or individuals is, consequentially, closely related to spatial proximity through cognitive correspondence, but also by sharing a common history, identical jurisdictional order and equivalent factor costs.

The peculiarity of localised learning is not transaction costs or in the efficiency of knowledge transfer. It is rather the type of knowledge that is transferred and the different knowledge sources that actors have access to. Storper and Venables (2004) use the word “buzz” to

describe the informal, often diffuse but steady and pervasive stream of information within a region or a cluster. Grabher (2002) calls the same effect “noise”. Steady interaction, informal exchange of knowledge, monitoring and collaboration decrease the cognitive distance between actors.

Spatial proximity is also generated between more and diverse actors for a particular time. Examples are conferences or industry fairs where actors strive for spatial proximity for a certain time. Conferences and workshops are other occasions where “temporary clusters” (Maskell et al. 2004) form. These examples illustrate how spatial proximity can be intentionally created between actually distant actors. The same actors can be close at one point in time and distant in another point in time. Therefore, spatial distance changes whenever actors move in space.

Bridging Distances

The previous chapters elaborated three dynamics of change in proximity relations. Cognitive proximity describes the content of interaction between actors that result in novelty. In addition to cognitive proximity that affects the interaction itself, spatial and connective proximity set the context in which the interaction takes place. Spatial proximity describes the distance at a particular point in time, whereas connective proximity describes the influence of the network on interaction. Regarding connectivity and space, the term ‘proximity’ serves as a measurement for the degree of mutual correspondence. However, connective and spatial proximity differ in one important aspect from cognitive proximity. They are not a measurement for a certain amount of shared knowledge between actors as a basis for interaction but describe the context for interaction. The characteristics of this context can facilitate or prevent interactions.

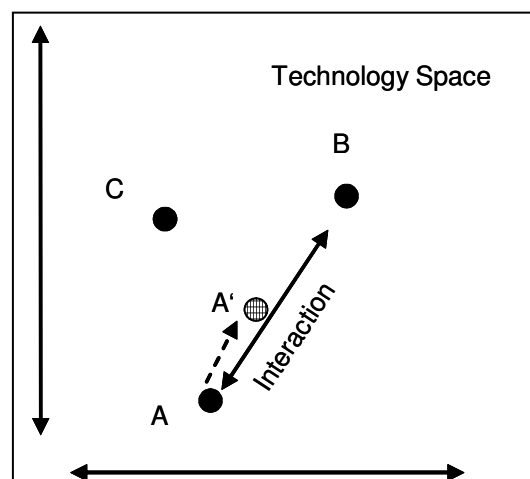


Figure 1: Indirect Change of Proximities

The change of proximities always influences the proximity relation to other actors that do not take part in the interaction. Figure 1 illustrates this process with the example of technological proximity. As exemplified above, interaction can alter the knowledge of actors. In the course of interaction, not only their commonly shared knowledge changes, but also the shared knowledge with other actors outside the interaction. The interaction on a technological issue of A and B changes their shared technological knowledge and technological proximity. As a result, A moves through the technology space to A'. During this movement to A', A does not only approach B but also C. Therefore, not only does the change of their knowledge base effect the relation between A and B, but also the proximities to other actors like C. This indirect influence of the interaction to relations refers to all proximities. If a firm establishes a branch in spatial proximity with a particular institution, e.g. a research institute or a university, the branch is also in spatial proximity to other firms and organizations in that locality. When a firm develops connectivity proximity with a second firm, it also becomes more proximate to the respective network partners of the second firm.

Distances can be easily bridged when they are small. Network positions change slightly according to inherent positions, learning is easy when the knowledge resembles the already acquired knowledge and face-to-face contact is facilitated by a small spatial distance. Distances can also be bridged indirectly. Larger distances are more difficult to bridge than smaller ones. But the three dimensions have interdependent effects during interaction. Thus being proximate in one dimension can contribute to bridge distances in another dimension. The proximity dimensions were designed as orthogonal as possible. Actors can be proximate in one dimension and distant in another. Individuals can be in cognitive proximity but in spatial distance when they contribute to the same technological trajectory (Dosi 1988); they can be in spatial proximity but connectivity distance when they belong to different regional network structures (Owen-Smith and Powell 2004, Giuliani 2007); and they can be in connectivity proximity but in spatial and cognitive distance like actors in diverse organisations like the Japanese keiretsu. The character of mutual influence differs according to the type of proximity. Cognitive proximity changes during interaction. Through knowledge exchange, actors learn from each other and adjust their mental models. Unlike cognitive proximity, connective and spatial proximity do not contain knowledge and hence do not improve mutual understanding. They facilitate interaction by reducing the transaction costs that arise from establishing and maintaining a contact and can contribute to an intensification

of interaction processes which accelerate the adjustment of mutual knowledge, and thereby the generation of cognitive proximity. Spatial and connectivity proximity can be changed through deliberate action. They increase when actors intend to continue or intensify an interaction, for example to accelerate learning processes.

The next three sections illustrate the mechanisms of how distances are bridged. The questions that are put forward are: who interacts, i.e. how cognitive and spatial proximity contribute to reduce connectivity proximity; what is the result of the interaction, i.e. how spatial and connectivity influence the bridging of cognitive distances; where do actors interact, i.e. when co-location is required.

Who Interacts - Bridging Connective Distance

Contact establishment is the precondition for interaction. New collaborations and networks form by actors who have not been in direct contact before. A contact is established when the network distance between two actors becomes one degree. While network theories give examples how nodes are connected by incrementally shorten their network distance, the question arises how are larger distances bridged? Network models often assume these bridging contacts to emerge randomly (Watts 1999). But people, when they bridge structures, often have a particular intention in mind (Watts 2004). Following the argument of the paper at hand, connective distances can be bridged through proximities in other dimension, i.e. spatial or cognitive proximity.

Cognitive proximity can contribute to bridge connective distances in different ways. The aim of interactions is often not only that of acquiring new knowledge but also of improving network positions. Grabher (2002) depicts with the advertising industry in London that communication does not only take place with the aim to exchange knowledge, but also to get access to other actors, thereby building connectivity proximity.⁴ Another possibility to bridge structural distances is when people seek to interact with other people with a particular purpose, for example searching for a certain competence. If the actor with this competence is known, actors bridge network distances to directly contact the other actors, even when they have a distance of several degrees. McPherson et al. (2001) emphasize the importance of homophily for the establishment of network. They argue that networks form because of resembling characteristics of people.

⁴ It must also be held in mind that actors not automatically try to build up connective proximity. Fierce competition through technological proximity can even cause structural distance between firms, when the competing firms develop distinct network structures.

A lot of literature point out that place has an influence on the establishment of networks (Camagni 1991, Powell et al. 2005). Owen-Smith and Powell (2004) show that a central network position is not important to participate in the knowledge flows of the network, when the network partners are in spatial proximity. Spatial proximity between actors can compensate connectivity distance. Powell et al. (2005: 1178) show that firms in spatial proximity collaborate twice as likely as distant firms. Additionally, spatial proximity between actors provokes haphazard contacts (Stoper and Venables 2004, Malmberg and Maskell 2006). In doing so, actors are directly connected that previously have been in several degrees distance. Literature on industrial districts and regional clusters (Saxenian 1994, Camagni 1991) even assumes that spatial proximity, connected with a regional milieu, institutional thickness etc. directly results in bridging of connectivity distances and dense networks where everyone has access to. However, more recent contributions like Giuliani's (2007) description of Chilean wine clusters show that regional networks are not pervasive but selective, and that this selectivity persists over time. This implies that connectivity distances are not compellingly bridged when actors even in the same technological field are in spatial proximity, but that also other factors are important.

Connective and spatial proximity both contribute to bridge cognitive distances. Yet, the types of networks that result are different. While bridging through cognitive proximity results in homogenous but spatially disperse networks, bridging through spatial proximity results in diverse, but spatially concentrated networks.

Why Interacting - Learning by Bridging of Cognitive Distances

Efficient learning takes place when actors are in optimal cognitive distance to each other (Wuyts et al. 2005). Qualitative change, an important process in economic development, (Martin and Sunley 2006), requires the acquisition of knowledge from sources in comparably large technological distances. For example, when a firm diversifies into new fields, actors have to learn from distant sources. Through learning and knowledge acquisition, they literally move towards the new knowledge and in doing so bridge the distance.

Connective and spatial proximity can facilitate learning processes and, in doing so, contribute to bridge cognitive distances, but in different ways. Entities like companies can exhibit strong pressure for connective proximity upon its single parts. Through this pressure, firms can connect actors, groups and knowledge that otherwise would develop separately and affect their interactions. Kogut and Zander (1992) argue that the firm provides a framework for interaction that facilitates the recombination of different kinds of knowledge. Fleming (2002)

describes how the most important invention for Hewlett-Packard's ink-jet technology was made by an "odd couple" (Fleming 2002: 1064). The structural proximity between them which was generated by Hewlett-Packard led to the invention in spite of distances in other dimensions. Cohen and Levinthal (1990) as well as Lane and Lubatkin (1998) emphasize that apart from the prior technological knowledge the kind of organizational structure also influences the absorptive capacity of a firm. Additionally, the literature about tacit knowledge suggests that the organization as a context of interaction strongly affects the transfer of tacit knowledge (Amin and Cohendet 1999, Gertler 2003, Breschi and Lissoni 2001). However, in many cases, the question of how connective proximity can reduce cognitive distances does not arise as they are in accord. Actors with a strong connective proximity, for example a one degree distance which is further enhanced when they belong to the same organizational structure, regularly have to interact.

Many empirical studies found out that spatial proximity between actors fosters innovative activity (Cooke 2001, Jaffe et al. 1993). Fewer studies consider the role of spatial proximity for bridging of cognitive distances through learning. Sorenson et al. (2006) compare the transfer of complex, less complex and highly complex knowledge. The transfer of complex knowledge is facilitated when actors are able to meet regularly. In contrast, the transfer of both less complex and highly complex knowledge does require spatial proximity: the less complex knowledge because it is easy to absorb, the highly complex knowledge due to its strong dependence on cognitive proximity, as often only few people are able to understand that knowledge. Zeller (2004) gives another example with the Swiss pharmaceutical firms that establish research facilities in the worldwide distinct knowledge centres to bridge cognitive proximity to the regional embedded knowledge. Torre and Gilly (2000) mention that spatial proximity is necessary when the knowledge differs strongly between actors, but it subsequently loses its importance. These studies indicate that being in spatial proximity contributes not only to innovative activities in general, but that being proximate makes diverse knowledge accessible.

Connective and spatial proximity both contribute to bridge cognitive distance. Their influence can hardly be separated as bridging of large cognitive distances depends on both regular interaction, which is framed by strong connective proximity, and face-to-face interaction which requires spatial proximity. Yet, connective proximity is often correlated with cognitive proximity. Obstfeld (2005: 123) emphasize that incremental innovation takes place dense networks and radical innovation sparse. Furthermore, distant network positions can better be

bridged in spatial proximity. Therefore, the spatial dynamic contributes to a larger extent to connect different kinds of knowledge flows than the connective dynamic.

Where Interacting – Bridging Spatial Distance

The above mentioned processes let assume that spatial proximity is an important variable in bridging connective and cognitive distances. This section analyses the spatiality of interactions, i.e. when spatial proximity is not necessary and when spatial distance has to be bridged. Lissoni and Pagani (2003) show that employees build epistemic communities that are qualified by a strong cognitive proximity. This cognitive proximity persists even when members of the community move to different places, which reduces possibilities for face-to-face interaction. The once established cognitive proximity can be sustained without regular face-to-face interaction. Spatial proximity can also be substituted by the organisations or formal alliances. In multinational enterprises, for example, a continuous interaction between different departments occurs despite their geographical dispersion. Such an interaction would not take place, if the multinational enterprise as a framework did not exist. Additionally, a lot of research points to the fact that knowledge exchanges within regions differ from an exchange between actors in different regions. Regional knowledge flows are often diffuse (Storper and Venables 2004, Grabher 2002), while interactions between actors in different locations are rather focused and take place through “pipelines” (Bathelt, et al. 2004). Strong connective proximity in the form of “pipelines” substitutes for spatial proximity.

Being in spatial proximity can have advantages for actors when they intend to bridge connective and cognitive distances. But applying other proximities to bridge spatial proximity would imply that bridging of spatial distance is a value per se. Being not of own generic character, yet biasing the other dimensions marks the character of spatial proximity.

Conclusion

The paper started with the observation that the existing proximity approaches though describe the dynamics within networks, but they do not explain how these dynamics actually change the networks. Three different dynamics were elaborated that influence the change of proximity relations: a cognitive dynamic for learning processes; a connective dynamic for changes in the position, structure and governance of networks; and a spatial dynamic that describes the need for face-to-face interactions. The intensities of each of these dynamics are described by proximities: cognitive proximity for the commonly shared knowledge as a basis for interaction; and spatial and connective proximity for the framework in which interaction

takes place. The three proximities of this paper differ in several aspects from existing proximities. They are not dichotom, but continual, as they do not explain relations with the existence or missing of a particular proximity, but with the continual change of proximities. Another difference is that the three dimensions are orthogonal, which is a necessary condition to distinguish their influence on interaction.

It was argued that the bridging of distance in one dimension requires proximity in other dimensions. The interdependencies of the different proximities have been important aspects in many studies: technological development shapes places like in the concept of the newly industrialised spaces; technological development constitutes network formation like in the technological trajectory; spatial proximity fosters learning processes like in the knowledge spill-over literature. The added value of the proximity approach at hand is the recognition that these dynamics are not unidirectional but interdependently influence each other; and that the intensity and direction of influence depends on the distance and proximity in the single dimensions. Interaction that is dominated by cognitive proximity enables the transfer of highly complex knowledge. This knowledge often flows in academia or in industries of new technologies. The places where this knowledge diffuses have a potential to be the seedbed for a new cluster. Interaction that is dominated by connective proximity is highly regulated and implies routinised knowledge exchange, which is necessary for incremental innovations. The more the knowledge is integrated in such processes, or ubiquitous (Malmberg and Maskell 2006), the lesser it is dependent on single places. Interaction that is dominated by spatial proximity is highly fuzzy and unstable. Yet it provides the actors with access to diverse knowledge sources. Being in spatial proximity contributes to bridge different networks and may contribute to networks of the “small world” type. In doing so, interaction between co-located actors can connect different kinds of knowledge. In doing so, interaction by co-location influences the trajectory of the respective industry. In fact, the elaboration of dynamic proximities highlights one of the crucial processes in localised learning. Localised learning not only depends on diverse actors that get in contact due to spatial proximity. Another factor is equally important, namely that spatial proximity facilitates face-to-face interaction, whereby the cognitive distance of diverse actors can be reduced. It is this reduction of cognitive distances, which marks the central process of qualitative change. And this reduction requires two aspects, namely that actors in cognitive distance get in contact, and that they are able to reduce this distance. Both are processes that are strongly influenced by co-location.

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