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How Do Geographical and Organisational Proximity Influence the Relational Pattern of MNCs' Global Innovation Networks: An In-depth Case Study

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JEL codes: D85, F23, L62, L63

Keywords: Global innovation network, MNC, Geographical proximity, Organisational proximity, Social network analysis

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Abstract: This paper explores the influencing mechanism of geographical and organisational proximity/distance on the intra-firm relations and external linkages in multinational companies' (MNCs) global innovation networks (GINs). It adopts an in-depth case study method and employs social network analysis to study the relational pattern of the case GINs and to understand how the relations are organised and why they are organised in a certain pattern. It is found that the intra-firm relations of both case MNCs' GINs are similarly organised in a global way. The external linkages in the two case GINs are organised in different ways (global vs local) which depend on the dominant knowledge is science-based or engineering-based. Two influencing mechanisms, namely complementary effect and conditional reinforcing effect, are found and discussed. Evidences in practice are identified.

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1. INTRODUCTION

Networks at all geographical scales, ranging from the local, the national, to the global, have been promoted as new modes of governance to boost innovation by economic geographers, organisational researchers, as well as policy makers (Cooke and Morgan 1993; Amin and Thrift 1995; Sheppard 2002; von Hippel and von Krogh 2003). Nevertheless, our understanding of how global innovation networks (GINs) are organised and why they are organised in certain patterns still remains limited.

Globalisation is characterised by extensive geographical spread of activities and high degree of integration of functions which was traditionally organised within the boundary of an organisation (Dicken 2007). This implies that globalisation of innovation is not only a geographical phenomenon but also an organisational occurrence, particularly when it comes to multinational companies' (MNCs) global innovation activities. To understand how GINs are organised and why they are organised in certain patterns, we need an inter-disciplinary thinking based on the theories of both economic geography and organisation science.

Literatures both in economic geography and organisational research recognise the importance of proximity for explaining the globalisation of organisations and their economic activities. Proximity is in general considered as a precondition of knowledge sharing, knowledge transfer, and technology acquisition (Gertler 1995), or in other words, the most conducive condition of interactive learning (Oinas, 1999) which is a key factor of explaining successful innovation process and regional economic development. There are several different types of proximity that draws researchers' attention, namely geographical proximity, organisational proximity, cognitive proximity, social proximity, cultural proximity, technological proximity and institutional proximity. Among all the five proximities, cognitive proximity is a prerequisite for interactive learning process while the other proximities provide mechanism for networking within and across organisational boundaries (Boschma 2005). Among the other four proximities which provide mechanisms to bring actors together, geographical and organisational proximity are the two that highly important when explaining the economical and spatial dispersion of the individual or collective agents endowed with various resources in the context of globalisation (Torre and Gilly 2000; Dankbaar 2007).

In this paper, geographical proximity is defined as 'the spatial or physical distance between economic actors, both in its absolute and relative meaning' (Boschma 2005) while organisational proximity refers to the extent to which relations are shared in the same organisational hierarchy. This means actors belong to the same organisational hierarchy, such as the organisational structure of a MNC, enjoy organisational proximity rather than with those actors who do not belong to the same organisation, such as customers and suppliers¹. Geographical proximity accounts for learning and innovation facilitated by spatial closeness while organisational proximity addresses learning and innovation at all spatial scales supported by shared belief, rules, routines, understanding and language (Meister and Werker 2004; Lorentzen 2008).

A great number of literatures in both economic geography and organisational science give

¹ This definition is strictly based on what Torre and Gilly (2000) called the adherent logic and similarity logic. According to adherent logic, the organisationally proximate actors shared in an organisational arrangement (Boschma 2005) which is in the form of a firm (Schamp, Rentmeister et al. 2004). The paper excludes other form such as community (Brown and Duguid 1991) and a network (Kirat and Lung 1999). According to the similarity logic, the organisationally proximate actors are alike in terms of having the same reference space and share the same knowledge. Even though similarity occurs between actors from different organisations but actors belong to the same organisation share more similarity in terms of organisational knowledge and routines.

great attention to proximities and their influence on firms' innovation networks. But empirical studies with balanced approach to look into both organisational and geographical aspect of proximity and their influencing mechanism on the relations in the GINs are still rare.

Empirical studies on global dispersion of innovation activities in economic geography literature focus more on the role of geographical proximity rather than that of organisational proximity. The organisational side of firms' GINs is sometimes simplified or even ignored. When firms are taken as black boxes or as domestic-verses-foreign entities (as Oslo Manual 3rd edition (2005) for Community Innovation Survey suggests) in the innovation networks, organisational proximity existing among different units within the firm is completely or partially ineligible in the analysis. For quite a long time global network literature in the field of economic geography excessively focused on external linkages between focal firm and other stakeholders. Intra-firm relationships which play a critical role in how global networks operate and have their impact (Dicken and Malmberg, 2001) are almost completely neglected (Coe et al., 2008). Discussion on MNCs' intra-firm relations has been mainly in management literature (e.g. Nobel and Birkinshaw 1998; Mudambi and Navarra 2004; Boehe 2007; Ciabuschi, Dellestrand et al. 2011; Meyer, Mudambi et al. 2011). Such external-linkage-bias may lead to insufficient understanding of networking as a process with both internal and external aspects and may result in a blurry or even wrong picture of how the networks are organised (Liu, 2012). To clearly understand how a GIN is organised and why it is organised in a certain pattern, it makes sense to conceive the firm as a relational intra-firm-network embedded in wider networks of external actors (Coe et al., 2008). Therefore, it is reasonable to take into account the organisational proximity and distinguish intra-firm relations and external linkages of a MNC's GIN.

Empirical studies on globalisation of firms' innovation activities in organisational literature usually focus more on organisational proximity rather than geographical proximity. Even though location has been in the core of the globalisation discourse among organisational researchers, their main arguments are built upon transaction cost theory, competitiveness advantage theory, organisational behaviour theory, and resource-based view, such as the OLI model or eclectic paradigm (Dunning, 1980, 1988, 1995), the business strategy approach (Reid 1983; Root 1987), the LLL model (Mathews, 2006), and the bundling model (Hennart 2009). Geographical proximity is not considered as an independent influential factor. The only exception is the Uppsala model (Johanson and Vahne, 1977) in which physical distance is taken as an explanative factor of the incremental development of firm's internationalisation based on experiential knowledge. GINs are globally spread networks, geographical proximity obviously plays a big role in the organisation of GINs. It is important to address both geographical proximity and organisational proximity when studying how the GINs are organised and why they are organised in certain patterns.

This paper investigates the influencing mechanism of both geographical and organisational proximity on the patterns of intra-firm relations and external linkages in MNCs' GINs. The pattern of relations reflects how the relations are organised and suggests 'possible ways in which we could exploit it to achieve certain aims' (Newman, 2003:180). Using case study method, the paper explores the pattern of intra-firm relations and external linkages in case MNCs' GINs. Based on analysing primary data and in-depth details, the paper tries to answer the research questions as follows.

1. How and why do patterns of intra-firm relations and external linkages in the case GINs vary according to different combinations of geographical proximity/distance and

organisational proximity/distance?

2. What is the mechanism that geographical proximity/distance and organisational proximity/distance influence the relational pattern of intra-firm relations and external linkages in the case GINs?

The paper selected two multinational companies operate in two different industries as case firms. The author collected primary data of the two case companies' intra-firm relations and external linkages of all geographical levels, namely local, national, and international through key informants. Social network analysis is employed to study the patterns of relations in the GINs. Interviews, archives, internal reports, websites, academic publications of case studies in the case firms are used to get in-depth insight about the influencing mechanism of geographical and organisational proximity on the relational pattern of both intra-firm relations and external linkages of the case MNCs' GINs. It is found that both case's intra-firm relations are globally-organised. One case's external linkages are globally organised while that of the other case are locally-organised. The influencing mechanism of geographical proximity/distance and organisational/distance on the relational pattern of case MNCs' GINs is 1) through the complementary effect between knowledge advantage generated by geographical and organisational distance and learning advantage generated by geographical and organisational proximity, 2) through the reinforcing effect between the knowledge advantage created by geographical and that by organisational distance under the condition of overcomeable accompanying learning disadvantage. In this case, the applicability and transferability of dominant knowledge base in the industry works as mitigating factor to the negative effect of learning disadvantage, which comes with geographical and organisational distance, on innovation.

The paper will be organised as follows. The second section discusses literature review and theoretical background. The third section elaborates methods. The fourth section presents main findings. The fifth section discusses the main findings and the theoretical implications. The last section concludes the paper.

2. LITERATURE REVIEW AND THEORETICAL BACKGROUND

Geographical proximity and organisational proximity provides mechanism to bring actors together and form innovation network (Boschma 2005). They influence the way that the innovation network is organised, or in other words, the pattern of relations in the network. This section will discuss the impact of these two proximities on the relational pattern of innovation networks based on literature review in both economic geography and organisational literature.

2.1 Geographical proximity, organisational proximity, and their combination

Geographical proximity has traditionally been argued to be beneficial to collaboration for innovation (e.g. Torre and Gilly 2000; Howells 2002; Morgan 2004) since it facilitates face-to-face interactions and consequently fosters knowledge exchange and knowledge creation. Nevertheless, economic geographers also pointed out that geographical proximity per se is not a prerequisite for collaboration (Boschma 2005; Knoben and Oerlemans 2006) and the selection of collaborators for innovation is mainly based on other factors (Drejer and Vinding 2007; Moodysson and Jonsson 2007; Laursen, Reichstein et al. 2011). At the same time too much geographical proximity can also be unfavourable to innovation thanks to the lock-in in limited local knowledge and competences (Boschma 2005).

Organisational proximity facilitate knowledge exchange and learning among individuals within the same organisational (e.g.Kogut and Zander 1992) and among the different units within the same corporate or business group (e.g.Lam 2003). Organisational proximity, which is strictly defined to reflect the ownership-based intra-firm ties that exist between the MNC headquarters and subsidiaries of all geographical scales, is related to the degree of autonomy of the actors and control in the network relations. The facilitating effect of organisational proximity on interactive learning is explained by its provision of strong control mechanisms to ensure intellectual property rights, sufficient rewards for own investment in innovation, and persistent effort in innovation collaboration within the organisation (Boschma 2005). It is also based on the fact that organisational proximity offers shared values, beliefs, rules and routines of behaviour which effectively smooth interaction within the same organisation (Torre and Rallett 2005). Nevertheless, too much organisational proximity can also hinder innovation because of the homogeneity of the knowledge and competences exist in the same organisation and the inflexibility of the organisation (Boschma 2005).

The combination of geographical and organisational proximity and its impact on knowledge and innovation has been empirically studied and theoretically discussed (e.g.Torre and Rallett 2005; Lagendijk and Lorentzen 2007; Aguilera, Lethiais et al. 2012; Mattes 2012; Capaldo and Petruzzelli 2014). This strand of literature emphasises the complementary and substituting effect of these two dimensions of proximities. For example, Torre and Rallett (2005) uses MNCs' internal networks as the example to explain how big organisations manage the global disperse of their units in which organisational proximity is mobilised to overcome the drawbacks of the presence as well as the absence of geographical proximity. Aguilera et al. (2012)'s findings also endorses the thesis that organisational proximity can substitute for geographical proximity in the coordination between remote partners. Capaldo and Petruzzelli (2014) similarly conclude that geographic distance and organisational proximity are contingent upon on another in their effect on innovation and knowledge creating and proximity/distance in one dimension can be bridges by distance/proximity in another dimension.

2.2 Intra-firm relations and external linkages in MNCs' GINs and their association with geographical and organisational proximity

Distinguishing between intra-firm relations and external linkages is of theoretical importance when studying the impact of proximities on the patterns of relations in MNCs' GINs.

A GIN is defined in this paper as a set of relations of the focal firm aiming at technological innovation including product and process innovation. A MNC's GIN is considered as an intra-firm network embedded in external networks.

Intra-firm relations of a GIN refers to the relations between headquarters' departments and firm's subsidiaries which are located in the headquarters area (local level), the rest of the home country (national level), and the host countries (international level). Intra-firm relations enjoy organisational proximity as defined in the paper but their association with geographical proximity depends on the specific actors' locations. For example, the relation between a headquarters department and a local subsidiary enjoys geographical proximity while the relation between a headquarters department and an international subsidiary does not.

External linkages of a GIN refers to the connections between the firm's internal units (both headquarters' departments and subsidiaries) and the outside actors (customers, suppliers, competitors, government agencies, universities, etc.) at different geographical levels (local,

national, international). External linkages by definition in this paper do not enjoy organisational proximity because the actors do not belong to the same organisational entity. Their association with geographical proximity depends on the specific actors' locations. For example, the relation between a local subsidiary and a local university enjoys geographical proximity while the relation between a local subsidiary and a foreign university does not.

According to the definition of geographical and organisational proximity as well as that of the intra-firm relation and external linkages of MNCs' GINs, the paper identifies four categories of relations (see Figure 1) which enjoys different combination of geographical and organisational proximity or distance. They are Relation GO, Relation Go, Relation gO, and Relation go. The capital letter 'G' associates with geographical proximity while the small letter 'g' associates with geographical distance. This rule applies to organisational proximity too. Intra-firm relations include Relation GO and Relation gO. External linkages refer to Relation Go and Relation go.

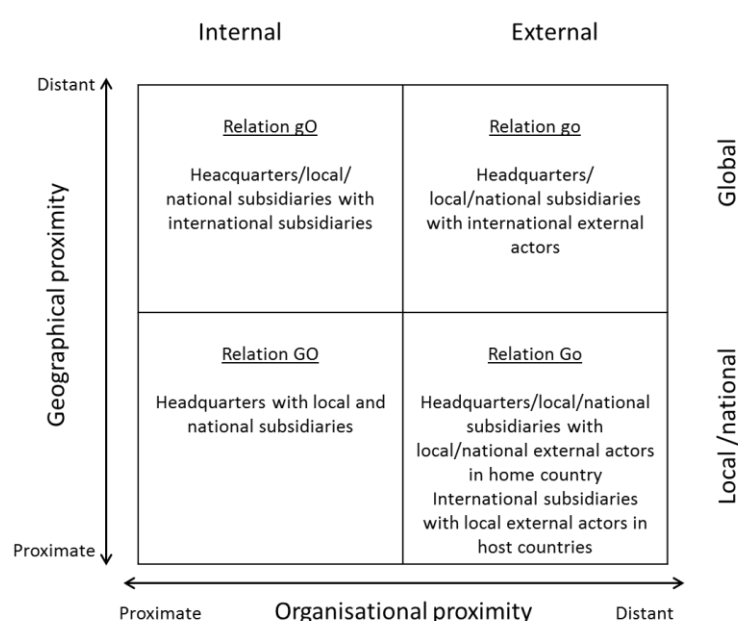


Figure 1 The four categories of relations with different combination of geographical and organisational proximity or distance

(G= geographical proximity, g=geographical distance, O= organisational proximity, o=organisational distance)

2.3 The impact of geographical and organisational proximity on the pattern of intra-firm relations and external linkages

It has been well accepted that knowledge is the most important resource for innovation and interactive learning is the most important process for innovation (Asheim and Isaksen 2000; Jensen, Johnson et al. 2007; Morgan 2007; Lundvall 2010). Innovation comes from the effective interaction among actors with heterogeneous knowledge (Feldman 1994; Lundvall 2004; Cassiman and Veugelers 2006). Innovation needs heterogeneous knowledge which may only be available outside of the firm and outside of the area where the firm is located. Thus firms need to reach out regionally, nationally, and increasingly, globally to acquire the heterogeneous knowledge needed (Cantwell 1995; Gertler 1995; Zander 1999; Bathelt, Malmberg et al. 2004; Gertler and Levitte 2005; Moodysson and Jonsson 2007). One of the

main incentives of globalisation of innovation is acquiring heterogeneous knowledge (Brusoni, Prencipe et al. 2001) which can be product or process knowledge embedded in local market of hosting countries (Patel and Vega 1999) or local intellectual output of the local research system (Florida 1997). Global knowledge pool may serve the need of firms' innovation but learning and acquiring the knowledge from other organisations, particularly those from abroad, can be very costly. The availability of heterogeneous knowledge does not guarantee effectiveness and efficiency of learning. The effective and efficient learning not only depends on organisational characteristics such as absorptive capability (Cohen and Levinthal 1990; Lane, Salk et al. 2001) but also depends on inter-organisational factors such as mutual trust (Dodgson 1993; Inkpen and Tsang 2005), communication, visit and meeting (Almeida and Kogut 1999; Bresman, Birkinshaw et al. 1999), and the support from partners (Lyles and Salk 1996).

It is clearly known that neither geographical proximity nor organisational proximity per se hold any explanatory value on innovation as they are in lack of substance or process (Coenen et al 2004). Geographical and organisational proximity only provide mechanisms to bring actors together (Boschma 2005). Economic actors form networks for innovation because they want to take use of the knowledge that the others have and learn from them. We can expect that the actors tend to connect with each other in a way that they can take full use of the heterogeneous knowledge that the partners have and efficiently learn at the same time. Thus how geographical and organisational proximity/distance influence the relational pattern of an innovation network is related to the way how geographical and organisational proximity/distance create knowledge advantage and learning advantage.

Geographical proximity has the tendency of creating advantage in learning rather than in knowledge

Geographical proximity is in favour of learning. It increases the efficiency of interactive learning thanks to spatial closeness (Meister and Werker 2004) which enable face-to-face interaction. On the one hand, face-to-face interaction is the most efficient way to exchange tacit knowledge (Johnson, Lorenz et al. 2002; Storper and Venables 2004) which is considered to be crucial for innovation. On the other hand, face-to-face interaction foster trust (Lane and Bachmann 1996; Lublinski 2003) which can only be built up by regular interaction over time (Morgan 1997) and which is the most demanded for interactive learning (Lundvall 1996). This is considered to be the main reason why geographical proximity has positive influence on innovation in knowledge spillover literature (Jaffe, Trajtenberg et al. 1993; Maurseth and Verspagen 2002; Sonn and Storper 2008) and industrial cluster literature (Baptista and Swann 1998; Keeble and Wilkinson 1999; Iammarino and McCann 2006).

Geographical proximity is not necessarily in favour of the availability of heterogeneous knowledge. On the contrary too much geographical proximity may undermine the availability of heterogeneous knowledge which is the so called 'spatial lock-in' particularly in some highly specialised regions. The reason is not because of geographical proximity per se but the convergence of knowledge and competence of firms who are geographically too proximate (Boschma 2004). When such homogenisation of knowledge and competence happens in a region, firms has to go global for heterogeneous knowledge thanks to the unavailability of such knowledge and technology competence in the geographically proximate area (Cantwell 1995; Gertler 1995; Zander 1999; Bathelt, Malmberg et al. 2004; Gertler and Levitte 2005; Moodysson and Jonsson 2007). In this case, geographical distance tends to favour the heterogeneity of knowledge.

Organisational proximity has the tendency to increase advantage in learning rather than

in knowledge

Organisational proximity facilitates interactive learning in four ways. Firstly, organisational proximity existing in a hierarchical organisational structure, such as a MNC, nourishes trust (Casson and Singh 1993) which further facilitates transactions by reducing transaction costs, such as information searching, negotiation, monitoring, and enforcing transactions according to transaction cost economics (Williamson 1981). Secondly, organisational proximity existing in a hierarchical organisational structure allows coordination without having to define beforehand how to do so. It ensures coordinated behaviour in accordance with the shared organisational routines, values, beliefs, language, performance measurements system and so on (Rallet and Torre 1999; Meister and Werker 2004). Thus it may mitigate the conflicts in coordinating. Thirdly, organisational proximity enables strong control mechanism to reduce uncertainty and opportunism (Boschma 2005), which are the common risk of innovation, to ensure intellectual property rights, sufficient rewards for the R&D investment of the firm, as well as persistent efforts to collaborate for innovation. Fourth, organisational proximity promotes intra-firm learning process, such as learning through job rotation (Edström and Galbraith 1977) and inter-unit training, trips and visits, transnational teams and task forces (Björkman, Barner-Rasmussen et al. 2004) (Subramaniam and Venkatraman 2001; Persson 2006).

Organisational proximity does not necessarily favour the availability of heterogeneous knowledge. On the contrary too much organisational proximity may lead to unavailability of heterogeneous knowledge. This is because of the 'organisational lock-in' thanks to strong ties (Granovetter 1985). First, intra-firm relations in the form of strong ties may evolve to a self-closed system where knowledge and competence becomes homogeneous and incentives to search for external knowledge becomes weak (Gargiulo and Benassi 2000). Second, in an organisation, even though there is a certain degree of heterogeneity in terms of knowledge, but facing the rapid change of technology, such heterogeneity is still very limited. That is the reason why firms collaborate with customers, suppliers, universities outside of the company for acquiring the heterogeneous knowledge which is not available within the organisation (Tsai 2001; Cassiman and Veugelers 2006). In other words, organisational distance tends to favour the heterogeneity of knowledge.

The different advantages that created by geographical and organisational proximity/distance are presented in Figure 2.

To Relation GO, organisational and geographical proximity both have the tendency to facilitate interactive learning and therefore both lead to learning advantage. But in this case organisational and geographical proximity tend to lead to knowledge disadvantage thanks to the lock-in effect. To Relation gO, organisational distance and geographical distance both have the tendency to increase the availability of heterogeneous knowledge, thus both lead to knowledge advantage. But with organisational distance and geographical distance learning is disadvantaged. Since in these two types of relations geographical and organisational proximity create same advantage, the advantages are mutually reinforced. Given the reinforced advantage, the challenge to this group of relations is how to overcome the accompanying disadvantage.

To Relation gO, organisational proximity facilitates interactive learning while geographical distance increases availability of heterogeneous knowledge. The learning advantage created by organisational proximity and the knowledge advantage created by geographical distance are complementary. It is the same to Relation GO that the related geographical proximity and organisational distance create complementary advantage in both

knowledge and learning.

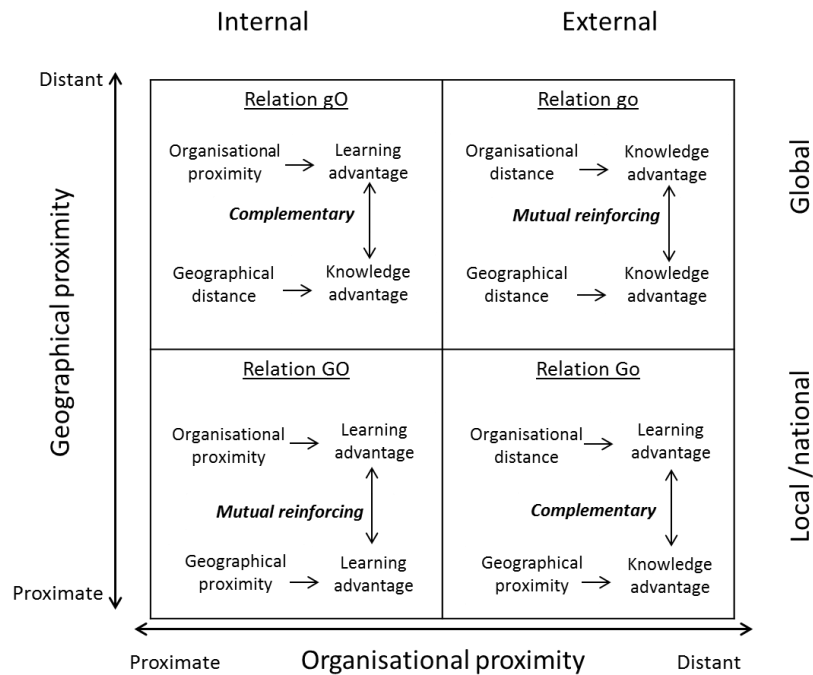


Figure 2. The complementary and mutual reinforcing advantages created by different degree of geographical and organisational proximity based on literature

Successful network relations should be organised in a way where knowledge advantage meets learning advantage. Thus synergy between knowledge advantage and learning advantage will be created for innovation. Therefore, as shown in Table 1, we expect that MNCs' intra-firm relations, who enjoy the learning advantage created by organisational proximity, are globally organised in order to leverage the knowledge advantage offered by geographical distance. We also expect that MNCs' external linkages, who enjoy the knowledge advantage created by organisational distance, are locally organised in order to take use of the learning advantage provided by geographical proximity.

Table 1. The expected pattern of intra-firm relations and external linkages in a MNC's GIN

Relations in a GIN			Presence of proximity/distance and related advantages		Expected pattern of relation
Intra-firm relations	Relation GO	Headquarters with local/national subsidiaries	Organisational proximity (learning advantage)	Geographical proximity (learning advantage)	Globally organised
	Relation gO	Headquarters/local subsidiaries with international subsidiaries		Geographical distance (knowledge advantage)	
External linkages	Relation Go	Headquarters/local/national subsidiaries with local/national external actors in home country	Organisational distance (knowledge advantage)	Geographical proximity (learning advantage)	Locally organised
		International subsidiaries with local external actors in host countries			
	Relation go	Headquarters/local/national subsidiaries with international external actors		Geographical distance (knowledge advantage)	

3. METHODS

The paper adopts a case study method in order to explore how the intra-firm relations and external linkages of MNCs' GIN are organised and to gain in-depth details for understanding how strong and weak geographical and organisational proximities influence the relational pattern of these two groups of relations in a MNCs' GIN. In-depth case study method offers great opportunities for understanding the mechanism of the formation of a certain pattern in reality (Eisenhardt 1989; Whitehead and Yin 2003).

3.1 Selection of case MNCs

Case selection is based on both the MNC's geographical spread and its organisational characteristics. The paper selected two multinational companies.

The two MNCs have very similar geographical spread. Both companies are headquartered in the same region of Scandinavia and have strong global presence in most of the countries and regions in Europe, Asia and Pacific, North and South America, as well as some countries in Africa. The reason why to choose firms with strong global presence is that it is easier to observe and collect data on their global distribution of and innovation activities compared with those have low global presence.

The two MNCs operate in different industries. One is in telecommunication industry and one in automobile safety industry. Thanks to the anonymous request from both companies, the paper uses TELE to name the telecommunication case company and AUTO to name the mobile safety case.

Both case MNCs have strong innovation capabilities. TELE is a world-leading provider of telecommunications equipment. Its patents comprise one of the industry's strongest portfolios. AUTO is also a world-leading automobile component company. Its patent portfolio is very extensive, ranking at the top of the automobile components industry. Both firm are large companies.

3.2 Mapping case MNCs' GINs

The case companies' GINs are weighted and undirected ego networks. GIN in this paper refers to a set of relationships of the case company aiming at technological innovation including both product and process innovation. Provision of services and innovation of services are both excluded in this research.

Actors of GINs are identified into two groups. One is the actors of the intra-firm network which refers to the set of relations among the functional departments or groups within the company's headquarters. These functions are production, R&D, marketing, financial, human resource, and purchasing/sourcing of which the taxonomy follows Porter's (1985) value chain analysis. The others are the actors of the external network which refers to the set of relations among the focal firm and the outside firms and organisations. The paper identified three geographical levels, namely local, national, and international levels. Local level refers to the region where the case companies are headquartered. National level refers to the rest of the country excluding headquarters' region. International level refers to the rest of the world excluding the home country. There are two types of actors at the local, national and international level. One is the outside firms and organisations namely customers, suppliers, competitors, universities and research institutes, and government agencies. This taxonomy follows the literature of Lundvall (2007) and the OECD (2001) taxonomy about the actors in innovation system. The other is the case companies' subsidiaries for production, R&D, and

marketing that locate in headquarters' region (local), other regions in home country (national), and other countries in the world (international). These three groups of subsidiaries are the main types of subsidiaries for the case companies' global operation.

The names and abbreviations of the actors of GINs are shown in Table 2. The paper used one initial letter to distinguish the different geographical locations of external actors. L, N, and I represents Local, National, and International respectively. For example, the actor LCST refers to Local CuSTomers in Stockholm region. NGOV refers to National GOVERNment agencies. ISRD refers to International Subsidiaries for R&D who locates in other countries.

Table 2. Name and abbreviation of inside and outside actors in a MNC's GIN

Internal Actors		External Actors	
R&D	R&D Department	CST	Customers
PRD	Production coordinator ²	SPL	Suppliers
HR	Human Resource Department	CPT	Competitors
MKT	Marketing Department	U&R	Universities & research institutes
FIN	Financial Department	GOV	Government agencies
PCH/SOC	Purchasing / Sourcing Department		
SPD	Subsidiaries for production		
SRD	Subsidiaries for R&D		
SMK	Subsidiaries for marketing		

The ties of the GINs are both formal and informal relationships for:

1) Access to openly available information without the need to pay for or with marginal fee for the access, such as membership in trade associations, attendance at conferences, and subscriptions of journals;

2) Acquisition of technology and knowledge without active cooperation with the source, such as purchasing machinery, equipment, hiring people, or using contract research and consultant service; and

3) Active participation in joint innovation projects.

The relational data of the ties were collected through a roster recall method (Wasserman and Faust, 1994). Each case company was presented with a complete list (roster) of the actors in the network and was asked the following questions:

Q1: Do the following actors contact each other for your company's innovation activities?

Q2: How is the strength of these connections in terms of the intensity they contact each other, the frequency they contact each other, and the trust between each other? Please give a score to represent the strength of the connections:

Strength	Very strong	Strong	Normal	Weak	Very weak	No connection
Score	5	4	3	2	1	0

3.3 Collection of data

Data sources of this paper include interviews, questionnaires, archives, websites, internal reports, internal documents, press news, and academic publications of case studies on the

² In both case companies' headquarter, there is not a department of but a person who act as the coordinator. We still consider it as a function of the headquarter even though there is just one or several persons are in charge.

same case firms. Multiple data sources provide more accurate information and improve the robustness of the results (Jick, 1979).

For collecting relational data, one questionnaire was developed and administered to elicit responses from the middle managers and top management team members, namely the VP for research in these two companies. In total, 4 interviews were conducted. Each interview lasted from one to three hours. All the interviews were recorded. The interviews were done between 2010 and 2011 in both the headquarters in Stockholm and their branches in Gothenburg and other locations. The interview started by asking informants background questions about their company and the industry, such as the history of the company, the organisational structure of the company, their strategy of innovation, the technology nature and competition in the industry, etc. Then the questions went to the relationship between the functional departments or groups in the headquarters, the relationships between the headquarters functional departments/groups, the subsidiaries of the company, and the relationships among the outside firms and organisations. The informants were reminded constantly that all the relationships should be relevant to the companies' technological innovation activities. At the end of the interview, open-ended questions were asked to identify the purpose of the companies' strategy of going global for innovation. Potential informant bias is addressed in three ways. First, the author selected highly knowledgeable informants from multiple hierarchical levels of the firms. Top management team, namely the VP of Research or the VP of R&D operations were interviewed. Both informants have worked for their company for nearly 20 years. They are both familiar with the innovation networking activities in the company at local, regional, national, and international level. The data collected was triangulated with published information when available. Second, the author used "courtroom questioning" technique to focus on factual accounts (Lipton, 1977; Huber and Power, 1985). The author asked the informants to specify what kind of activities have been carrying on in each specific relationship so as to ensure that the informant did not mix the relationship for innovation with any other activities. It was also helpful for informants to avoid the confusion between what had happened and what should happen. Third, the author gave anonymity to the informants and their firms on request to encourage candour.

For collecting in-depth details to understand how innovation in the telecommunication industry and automobile safety industry works and how the case MNCs organise their GINs, the author had informal talks to engineers and managers in the case companies and their competitors. The author also studied archives such as annual reports in the company websites, articles in industrial association websites, internal reports, news from the case company websites as well as in social medias, and academic publications of case studies on the same case firms. Thanks to the confidentiality agreement that we reached with the case firms, the sources of these materials are not able to be presented in the paper so as to avoid revealing of the case firms' names.

3.4 Analysing the relational pattern of different categories of relations in the MNCs' GINs

Based on the primary relational data of the case MNCs' GINs, the paper uses social network analysis to analyse the relational pattern of both intra-firm relations and external linkages of the two MNCs' GINs. The tool of NetDraw multidimensional scanning (MDS) with principal component layout³ is used to visualise the relational pattern of the networks.

³ Using the principal component option in the software of Netdraw to visualise the similarity of structural

MDS is a set of techniques of visualizing the level of similarity of individual cases of a dataset, in particular to display the information contained in a distance matrix. The MDS method arranges the nodes in such a way that the distances between pairs of nodes in the map correspond to the distances between individuals in the data matrix (Freeman 1999). In the maps of the network visualised by this method, when a group of nodes are close to each other, it means they are structurally equivalent nodes who have similar pattern of ties. They are connected with the same nodes and they have similar geodesic distance to all other nodes. By analysing who are structurally equivalent actors in the network one can reveal the information about how the actors are connected in the network and how the network is organised. By analysing the geographical location of the actors who are structurally equivalent, one can see if the network relations are globally or locally organised.

4. MAIN FINDINGS

After mapping and analysing the pattern of the intra-firm relations and external linkages which enjoys different combination of geographical proximity/distance and organisational proximity/distance (see Figure 1), the paper has the main findings as follows.

4.1 Relational pattern of intra-firm relations and the influencing mechanism of geographical and organisational proximity/distance

In both case MNCs' GINs, it is found that *intra-firm relations are globally organised* (see Figure 2).

Intra-firm relations include the relations among headquarters' departments, local, national, and international subsidiaries. It is found that, first, the headquarters departments have similar connections to each other. Second, the subsidiaries for marketing, research, and production of all geographical level, namely local, national, and international, are closely located in the map drawn by MDS method. This means they are similarly connected and organised in the network. It can be clearly seen in the map that the aggregated actors serve the same function, such as R&D, production, and marketing. This implies no matter the subsidiaries are located in headquarters region (local level), in the rest of the home country (national level), or in foreign host countries (international level), as long as they serve the same function (such as R&D or production or marketing facilities) they have similar connections and thus are organised in a similar way in the intra-firm innovation network. In other words, the intra-firm relations in the GINs are globally organised.

The globally organised intra-firm relational pattern was explained by the VP of both case MNCs. The VP of TELE says:

“We globalise product development. We have some special sections where people from the whole group participate (it is) called pre-development activities from the research idea to whatever product trying to prove that it works. Moreover, if somebody comes up with an idea and if the idea is core then we centralise the process.....if an idea is developed in a subsidiary, it is usually sent to the headquarters where the core research is. The headquarters therefore takes the control...this idea is starting to be spread worldwide. The

characteristic of actors can be found in bibliometric research, such as Yang, Liu et al. (2010), and Park and Leydesdorff (2013), etc.

demand there. For example, the two developing centres we have in Asia are good examples of how the presence in this type of emerging economies has generated new ideas for new product. ”

In both case MNCs, it is also found that besides of the positive effect of shared value, beliefs, and routines on interaction within the firm which has been found in many literatures, *organisational proximity facilitates interactive learning through 1) central controlled R&D system, 2) globally-shared IT platform for innovation, and 3) intra-firm learning programs in particular.*

Both cases have a central controlled R&D system. Even though two case MNCs have R&D centre all over the world, the core technology development and basic research are still in the hand of the headquarters. New ideas generated in different locations are requested to pass over to the headquarters for investigating the potential of spreading to other places. Such central control system ensures the ownership of intellectual property rights, ensures persistent effort to collaborate across countries for innovation, lowers the R&D costs by leveraging the company’s heterogeneous competence all over the world, and thus maximizes the return of the R&D investment.

The globally-shared IT platform plays an important role in sharing new ideas and developing new products and processes in both case MNCs GINs. Both MNCs implemented ERP (Enterprise Resource Planning) system. ERP is a business management software for managing information across the entire corporation all over the world. One of the advantages of ERP is that it provides a communication platform for employees and creates more opportunities for collaboration. Besides of this, the two case MNCs has implemented shared IT platform particularly for innovation. TELE implemented a system for collaborative idea management called IdeaBoxes. It uses a shared IT platform to develop new ideas. The system is open to employees of TELE globally. The bottom-up shared IT platform has been broadly adopted across all business units, market regions and group functions. Similarly AUTO has a standardized product development system APDS to coordinate the product development involving internal actors in different geographical locations.

Intra-firm learning program with the purpose of transferring knowledge and skills as well as enhancing management skill for smoothing communication with people from different sites is an important internal mechanism facilitating knowledge transfer. For example, AUTO has a strong and long tradition of providing opportunities for employees to work in other countries (comments by the VP of AUTO). To encouraging job rotation and mobility across regions Auto strengthens its global networks and overall knowledge sharing (AUTO’s annual report 2013). The VP of AUTO says:

“For countries where there are no engineers be able to manage product solutions, we send expatriates trying to raise the competence (that) we have in these countries hoping the engineers there will take over later.”

For developing future R&D leaders who can cope with a global working environment, TELE launches its R&D Global Graduate Program which offers an 18 month technology and management training to R&D personnel who have potential to be future leaders in its international locations in order to place a foundation in international R&D management. One of the participants says:

“.....the most important lesson I learned in the program is the importance of clear communication and honesty to avoid conflicts

and misunderstandings there by maximizing productivity among members have very different backgrounds.”

AUTO also has similar program called Global and Regional Training Program for training employees to work globally.

4.2 Relational pattern of external linkages and influencing mechanism of geographical and organisational proximity/distance

External linkages of the two MNCs’ GINs are found to have different pattern of relations. *TELE’s external linkages are globally-organised while AUTO’s external linkages are locally-organised.*

External linkages refer to the linkages cross organisational boundary. They are the relations between a MNC’s headquarters departments/subsidiaries at all geographical levels, and external actors at all geographical levels. The relations among external actors at all geographical levels are also included.⁵

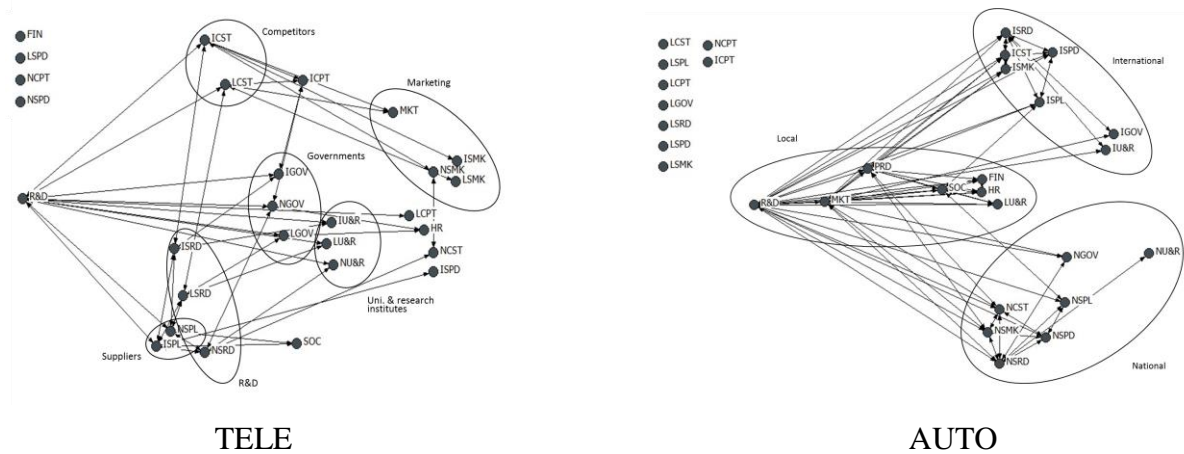


Figure 3 Pattern of external linkages in the case MNCs’ GINs

For TELE, a functionally aggregated pattern is clearly shown in the left map of Figure 3. There are six clusters of actors aggregating together. These six groups of aggregated actors are actually six functional groups, namely R&D facilities, marketing facilities, suppliers, competitors, government agencies, and universities and research institutes. In the network map drawn by MDS method, aggregated actors have the same or similar connections with the same other actors. This means no matter the actors are located in headquarters region (local level), the rest of the home country (national level), or foreign host countries (international level), as long as they serve the same function as R&D or marketing facilities, or they are suppliers or competitors or government agencies or universities and research institutes, they are globally organised in a similar way.

The globally-organised characteristic of TELE’s external linkages in its GIN is explained by the VP.

⁵ The paper does not distinguish the geographical location of different actors within a host country or between different host countries. Nevertheless, when talking about the international subsidiaries and the international external actors, the paper refers to those in the same host country.

“Taking the relationship between R&D and the suppliers as an example, our suppliers are global. So it is “all-talk-to-all”. An R&D branch in the headquarters will talk to all levels of suppliers within their product line. If they are responsible for that machine, then they need to form their own network (...) it becomes the same thing for any R&D site regardless if it is in the European headquarters or in Beijing. If they are responsible for product development, they need to talk to, for example, all the marketing units at all levels who can provide relevant information. That’s why it becomes a global ‘mess’.”

To globalise the innovation generated from a specific location, TELE implemented a *decentralised decision making process* combined with *cross-regional sub-networks* for innovation. TELE has an *internal innovation market*. Regional offices have the autonomy to decide what new products or services to develop for the local customers even though their innovative ideas are not selected at the corporate level. When developing new products and services for local market, the R&D staff are required to make it as much as possible to be replicable in other regions. Thus they need to contact relevant internal and external users and suppliers. The newly developed innovation can be sold internally to other regional offices. This innovation developed by the ‘seller’ in a region will be used by the ‘buyer’ in another region as ‘*the core* of the concept’ to add on new ‘*wrapper*’ to localise it according to the different context of that region. The ‘core’ keeps the same across different regions while the ‘wrappers’ are customised in different regions. Many new innovations developed in African, Asia, and South American countries have been successfully expanded to other regions.

For AUTO, a geographically aggregated pattern can be seen in the right map of Figure 3. This means geographically co-located actors have same or similar pattern of relations with the others. It suggests that no matter what function the actors serve (e.g. an R&D facility, or a production factor, or a customer, or a university, or a government agency), as long as they are co-located in the same area, they have same or similar pattern of relations and are locally organised in the same or similar way. This implies that the external linkages of AUTO are locally organised.

The locally-organised characteristic of external linkages in AUTO’s GINs is also verified by the VP. He gave an example of such localisation of external linkages in the global innovation of AUTO.

“For innovation, Sweden is not the only centre, particularly for development and engineering of new product and process. If we have a production facility, we have application engineers there. For example, we have a technical centre in China to better understand this fastest growing car market and to build up competence in this experience-based industry(...). We have redone our management team. We have an executive management team. That basically consists of people from all the functions. (...). We have one for Asia, one for North America and one for Europe. The management team is a (localised) global team because the managers are from Asia, North America or Europe. (...)We have an internal supply chain. For example, a seat belt has different parts, the metal parts, the plastic parts, (and) the fabric parts. We have our own weaving facilities where we weave them. There are other internal suppliers working for seat belt production. The same is for the air bag. We have our own

facilities for weaving the bag and for making the inflator. These connections are mainly in some regions. If you look into the map of our locations, you will see we have a bag facility in North America which supplies the needs of North America. We have a bag facility in China and Taiwan. They supply their region. We have the same in Europe. One is in UK and one in Poland. Then we have production facilities for different customers in Germany, France, Sweden, and some in Spain. They are buying from their internal suppliers in their regions. We have more consolidated production for the key components. There are subsidiaries for production which are also in a vertical line organized as tier one, tier two, and tier three. The tier one suppliers are our main supplier and they are the closest to the customers.”

Why do two cases have different pattern of external linkages? This is an interesting question. Is it because they have different capabilities of managing external linkages worldwide? The answer seems to be a no. If we look at the practice of global innovation management in these two cases, we found that both of them have built up *IT supported infrastructures* and have implemented procedures and protocols for knowledge sharing and transferring with external actors worldwide. For example, TELE and AUTO both implemented ERP (Enterprise Resources Planning) system. One of the primary objectives of implementing ERP system is to manage external linkages with outside actors. Besides of ERP, AUTO has TGMS (Trading Grid Messaging Service) system to facilitate information exchange with global external partners. It also implemented APDS (Auto product development system)--- a systematic procedure for developing new ideas to new products with R&D and engineering personnel in the technology centres and testing centres as well as customers and suppliers all over the world. TELE have a program called ConsumerLab to collect and exchange knowledge for innovation with external actors particularly global end-users. It also launched a Collaborative Idea Management program worldwide to foster bottom-up innovation in cooperation with employees as well as external actors. Evidently, both case MNCs are able to globally integrate the external actors at all geographical levels into their innovation process. Nevertheless they do it in a different way. TELE’s external linkages for innovation are organised in a global way while AUTO’s are organised in a local way.

By studying the characteristics of the dominant technologies and knowledge in the two case MNCs, it is found that these two companies have very different technology profile.

TELE is a telecommunication equipment manufacturer. The dominant knowledge in telecommunication industry is more *science-based*. Technologies that are dominantly used in this industry, such as digital communications technology, program-controlled switching technology, information transmission technology, communication networks, data communications and data networks, are mainly based on scientific knowledge. It is more codifiable and transferable not only because of the science-based nature of the technologies but also because of the well-developed + of the industry. According to an internal report, TELE has a strategy of turning local innovation into global technologies. The decentralised decision making process for innovation and the internal market for innovation link internal and external actors worldwide. Many new innovations developed in African, Asia, and South American countries have been successfully expanded to other regions. It is evident that the ‘core’ of the locally developed innovation is applicable in other locations in the world. Thus a globally all-talk-to-all pattern is observed.

AUTO is an automobile safety product producer. The dominant technologies in this industry are more *engineering-based* technologies. According to an empirical research conducted in AUTO (Lövsund and Spiegelberg 2002), when describing the characteristics of the knowledge that the company use most, the most of the respondents in AUTO referred it to ‘something that you have learned through past *experiences* and something that is *difficult to codify* thanks to the strong relation with the complicated context’. This does not mean that science-based knowledge is excluded the in the industry. Automobile safety industry has many science- based technologies such as radar and vision technology for monitoring the environment and pretension and load limiting technology for improving the performance of seat belt. But what is fundamentally important in this industry is engineering-based learning process by which scientific knowledge is integrated with applied, problem-solving related knowledge for innovation. For example, in an active safety system, the radar and vision technology for monitoring the environment would not work well without deep understanding of the traffic environment and the kinds of accidents that take place within the real world environment of a specific place. The traffic situation refers to the vehicle condition of the cars and trucks in the roads, the driving habit of drivers, the moving pattern of pedestrians, the traffic regulation in the country, the climate of the region, etc.. The knowledge related to these situations and conditions can be very different across countries and regions. It is context-specific and has a strong tacit component which is mainly transferred through face-to-face interactions with local customers and suppliers. This implies that in automobile safety industry, locally developed innovation, which has strong relation with the local context, is less applicable and transferable to other global locations. Different than the traditional terminology of R&D in many companies, AUTO names its innovation activities as R&D&E which emphasises the importance engineering to R&D. Such engineering process usually happens locally together with the local actors.

Therefore we understand *the different pattern of external relations in the case MNCs’ GINs is due to the different nature of the dominant knowledge and technologies in their industry*. For transferring science-based knowledge, TELE’s external linkages are globally organised while for exchanging engineering-based knowledge AUTO’s external linkages are locally organised.

5. DISCUSSION AND CONCLUSION

This paper is a case study exploring the influencing mechanism of geographical and organisational proximity/distance on the intra-firm relations and external linkages in the case MNCs’ GINs. It employs social network analysis to study the relational pattern of the case GINs. It analysis in-depth details of the case GINs for understanding how the relations are organised and why they are organised in a certain pattern provided different combination of geographical and organisational proximity/distance.

It is found that the intra-firm relations of both case MNCs’ GINs are globally organised while the external linkages of the telecommunication case firm’s GIN is globally organised and the automobile safety case firm’s is locally organised. The different pattern of the intra-firm relations and external linkages in the two case MNCs’ GINs reflect the way how network actors take use of the different combination of knowledge advantage and learning advantage that is generated by different combination of geographical and organisational proximity and distance.

The influencing mechanism of geographical and organisational proximity on the relational

pattern of intra-firm relations is that 1) geographical distance favours the heterogeneity of knowledge owned by intra-firm units in different regions and countries, 2) organisational proximity facilitates interactive learning among intra-firm units, and 3) the globally-organised intra-firm relations leverage the complementary effect of the knowledge advantage created by geographical distance and learning advantage created by organisational proximity to foster innovation. Three distinctive practices are found to improve interactive learning among intra-firm units. They are central-controlled R&D system, globally-shared intra-firm IT platforms, and intra-firm learning programs.

The influencing mechanism of geographical and organisational proximity on the relational pattern of external linkages is intermediated by the nature of the dominant knowledge in the industry.

To telecommunication case firm dominated by science-based knowledge which enjoys high applicability and transferability, the external linkages are globally-organised in order to leverage the mutual reinforced knowledge advantage created by geographical distance and organisational distance. The learning disadvantage comes from geographical and organisational distance is overcome by internal innovation market, turning-local-innovation-into-global strategy, and globally-shared IT platform with external actors. Innovation is designed at an early stage to be as much as replicable so as to be globalised in the later stage.

To automobile safety case firm dominated by engineering-based knowledge which is difficult to apply and to transfer over distance, the external linkages are locally-organised in order to leverage the complementary effect of the knowledge advantage created by organisational distance and learning advantage created by geographical proximity. Organisational distance favours the heterogeneity of knowledge owned by external actors in different regions and countries. It is found that collaboration with external actors in developed country with long experience in the industry are to access the local competences and market related knowledge while collaboration with external actors in emerging countries are to better understand local market though local connections. Even though in this case firm, research is centrally done in the home country, a big part of innovation which is application and engineering is done globally because it need close collaboration with local customers and suppliers in a specific region or country. Geographical proximity facilitates interactive learning with in a region. Long distance learning is hindered by the low applicability and low transferability of dominant knowledge in the industry. The discussions are summarised in Table 3 as follows.

Table 3. Summary of the findings and discussions

Relational pattern		Influencing mechanism		Evidences in practice
Intra-firm relations	Both cases globally organised	Knowledge advantage created by geographical distance and learning advantage created by organisational proximity complement each other for innovation	Geographical distance favours the heterogeneity of knowledge owned by intra-firm units in different regions and countries	<ul style="list-style-type: none"> • Globally dispersed intra-firm units have access to local competences of different regions and countries • Globally dispersed intra-firm units have access to local market-related knowledge of different regions and countries
			Organisational proximity facilitates interactive learning among intra-firm units	<ul style="list-style-type: none"> • Central controlled R&D system ensures the ownership of IPR and persistent effort to collaborate across countries for innovation, lowers the R&D costs by coordinating innovation all over the world • Globally-shared intra-firm IT platforms play an important role in sharing new ideas and developing innovations. • Intra-firm learning programs improve internal knowledge transfer and smoothen internal

				communication
External linkages	TELE's globally organised	Knowledge advantage created by geographical distance and created by organisational distance reinforces each other. Thus knowledge advantage is expanded to a great extent.	Geographical distance and organisational distance both favour the heterogeneity of knowledge owned by external actors in different regions and countries	<ul style="list-style-type: none"> Decentralised decision making process and customer-oriented innovation approach leverage globally spread R&D competences and knowledge from external actors in different regions and countries IT platform, such as ConsumerLab, bridges the company and the external actors for innovation in different regions and countries
		(The accompanying learning disadvantage is mitigated by the high transferability and applicability of the dominant science-based knowledge)	Geographic distance and organisational distance both create difficulty for interactive learning but such difficulty is mitigated by the high transferability and applicability of dominant knowledge in the industry	<ul style="list-style-type: none"> Internal innovation market plus high applicability and transferability of science-based knowledge encourages and enables interactive learning over distance Successful practice of turning local innovation into global technologies by 'core-wrapper' approach (locally developed 'core' can be applied globally after developing localised 'wrapper') The emphasis on replicability at the early stage of R&D requires local developers to talk to any relevant internal and external actors
	AUTO's locally organised	Knowledge advantage created by organisational distance and learning advantage created by geographical proximity complement each other for innovation	Organisational distance favours the heterogeneity of knowledge owned by external actors in different regions and countries	<ul style="list-style-type: none"> Collaboration with external actors in developed country with long experience in the industry are to access the local competence and market related knowledge Collaboration with external actors in emerging countries are to better understand local market through local connections
			Geographical proximity facilitates interactive learning with in a region. Long distance learning is hindered by the low applicability and transferability of dominant engineering-based knowledge in the industry	<ul style="list-style-type: none"> Even though research is centrally done in home country, a big part of innovation which is application and engineering is done globally because it need close collaboration with local customers and suppliers in a specific region or country.

The theoretical implications of this case study are as follows.

The influence of geographical and organizational proximity/distance on the relational pattern of GIN is *not* through the *substitutive effect* between the geographical proximity and organisational proximity. Geographical proximity substitutes organizational proximity because they can both create learning advantage. Relations that enjoy both geographical proximity and organizational proximity, such as relations among headquarters and local subsidiaries, do not necessarily have good innovation performance because geographical proximity and organizational proximity reinforce learning advantage but both of them lead to knowledge disadvantage thanks to lock-in effect. A strong learning advantage plus a strong knowledge disadvantage will not lead to knowledge-learning-synergy but further lock-in. Thus it will not favour innovation.

The influence of geographical and organisational proximity/distance on the relational pattern of GIN is through two mechanisms. The first mechanism is the *complementary effect* between organisational proximity and geographical distance as in the case of intra-firm relations, as well as between geographical proximity and organizational distance as in the case of AUTO's external linkages. This fits the notion that innovation will be fostered when knowledge advantage meets learning advantage. The second mechanism is the *conditional*

reinforcing effect between organisational distance and geographical distance as in the case of TELE's external linkages. In this case, the reinforced knowledge advantage created by geographical and organizational distance will be fully leveraged only under the condition when the accompanying reinforced learning disadvantage is overcomeable. For science-based knowledge, the learning disadvantage created by geographical and organisational distance can be overcome through, for example, global knowledge-sharing IT platform and global innovation management tools such as internal innovation market in the telecommunication case. For engineering-based knowledge, the learning disadvantage is difficult to overcome because of the low applicability and transferability of this kind of knowledge. Thus the GIN of the company who is dominated by engineering-based knowledge can hardly take advantage of the conditional reinforcing effect because the condition does not match.

The limited number of the cases to a great extent restricts the generalisation of the findings and results. The way that firms organise their GINs is influenced by many determinant that geographical proximity and organisational proximity are just part of them. The paper just discovers the mechanisms apply to the cases and thus develops implications for theory. More cases in different industries should be studied in the future.

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