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Charlie Karlsson

Börje Johansson

R.R. Stough

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By Charlie Karlsson*, Börje Johansson ** & R.R. Stough***

Abstract:

The purpose of this working paper is to provide a short overview of actual topics in contemporary research concerned with global, national, regional and local knowledge and innovation dynamics. In the text, we stress the importance to understand the current changes of the global and their implications for knowledge generation and innovation. Treating knowledge as a key resource for innovation shifts the focus from the innovation itself to the process of knowledge generation, transformation and diffusion, i.e. to knowledge dynamics. This necessitates integrating spatial aspects since knowledge generation and as a result, innovation exhibits a strong geographical clustering, which implies that innovation ability and innovation resources also are strongly clustered geographically in particular to urban regions. The role of interaction and proximity for knowledge generation and innovation is highlighted and instead it is stressed that relational, cognitive, organizational, social and institutional proximities are not substitutes or complements to spatial proximity but that they are all functions of the prevailing spatial proximity. Another important factor for interaction is social capital, which by fostering trust makes information and knowledge to diffuse faster.

Key words: Knowledge, innovation, proximity, knowledge economy, knowledge dynamics, knowledge networks, innovation ability, innovation resources, globalization, agglomeration, face-to-face interaction, urban regions, social capital

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Affiliation:

* Jönköping International Business School, Jönköping University, P.O. Box 1026
SE-551 11 Jönköping, Sweden. Charlie.karlsson@jibs.hj.se

** CESIS - Centre of Excellence for Science and Innovation Studies, Royal Institute of Technology, Lindstedtsvägen 30, vån. 6, 100 44 Stockholm, Sweden, borje.johansson@indek.kth.se

*** School of Public Policy, George Mason University, 4400 University Drive, MS 6D5
Fairfax, Virginia 22030, rstough@gmu.edu

1. Introduction

The contemporary world economy – here referred to as a knowledge economy – is characterized by the ascendance of knowledge as a major factor of production and renewal. This evolution is accompanied by an increased mobility and liquidity of capital and associated regulatory and liberalization reforms of large dynamic international economic sectors such as finance, advanced business services and information industries. Recent technical advances and institutional innovations in transport and communications are not only reducing time distances and eroding the barrier of borders, but are also at the heart of the evolution of the world economy into a knowledge-rich global production system. We can observe the emergence of a new international division of labour, which takes shape through the formation of a global system of metropolitan and large urban regions, where each urban agglomeration offers expertise in various functions and activities and plays specific roles in the globalization process (Sassen, 2006). These cities are increasingly becoming dominating i) centres of political power, international trade, and the banking and financial system, ii) centres that specialize in the creation, appropriation and dissemination of knowledge and innovations, iii) centres where information is concentrated and transmitted through the media sector, and iv) centres of creativity where the arts, culture and leisure activities are developed and consumed. They are today the main strategic hubs in the world economy as drivers of creativity, innovation and entrepreneurial activities and as a result, the dominant engines of economic growth.

The global knowledge economy that has emerged in recent decades is not only characterized by rapidly increasing investments in education, in particular higher education, software and R&D. It is also characterized by other underlying fundamental structural changes (cf. Cooke, et al., 2007):

1. Knowledge as an input in all kinds of production processes has become more important in terms of both quantity and quality.
2. Knowledge has become more important as a product, which is illustrated by the growth of knowledge-intensive business services and software and high technology industries.
3. Knowledge in the form of codified knowledge has become relatively more important than tacit knowledge, which is illustrated by the rapid expansion of science-based industries, such as biotechnology.[1]
4. Knowledge in the form of codified knowledge has become much more accessible due to the technological developments in and increased use of ICT.[2]

Today there is a widely spread acceptance that the displacement of old products and technologies by new ones in endogenously generated processes known as "creative destruction" (Schumpeter, 1942) serves as the basic engine for economic growth and structural change. Innovation is the application in the market place of novel and improved products and processes. Innovation activities, which generate and diffuse new knowledge, have become major research topics in the contemporary knowledge-based economy. Innovation, which most often is the result of combinations of heterogeneous existing knowledge (Pavitt, 2005) achieved through continued interaction between firms and other organizations (Nelson, 1993) as well as between different individuals and departments within firms and organizations (Grant, 1996). This implies geographical and cultural proximity tends to play a critical role for achieving in-

[1] We think it is important to stress that this statement does not imply that tacit knowledge has become unimportant.
[2] This implies that the spatial diffusion speed of new codified knowledge has increased in recent decades.

tegration of diverse knowledge elements in innovation processes. The connection, interaction and cooperation between a variety of heterogeneous economic actors and sources of codified and tacit knowledge trigger creativity and, thus, allow for the development of new ideas, knowledge and technologies that could not have emerged in isolation. Several theoretical and empirical works claim that innovation depends on investments in knowledge as well as interactive learning and the circulation of ideas (Coe & Helpman, 1995; Rallet & Torre, 1999).

A significant characteristic of the current global structural transformation towards knowledge economies and knowledge societies is the changing nature of innovation processes. However, innovations are still very unevenly distributed between countries and regions, and tend to be clustered in certain locations (Feldman, 1994). Geographical space and the characteristics of locations play a decisive role in the myriad of underlying processes that enable and support the generation, diffusion, spillover, exploitation and application of new knowledge. Of course, the innovative capacity of locations depends on the characteristics of the local economic milieus, which over time are reshaped by general evolutionary processes (Frenken & Boschma, 2007). However, the innovative capacity of locations depends also on the external knowledge inputs through innovation network links to other locations (Bunnell & Coe, 2001), since innovation processes are increasingly dependent upon the conjunction of internal and external knowledge, which requires cooperation with a variety of economic agents often located in different locations.

More than ever, innovation is about solving complex problems in multi-dimensional interactive and non-linear processes (Kline & Rosenberg, 1986; Malerba, 2005) under conditions of uncertainty, which makes it necessary to integrate highly specialized and globally distributed knowledge bases (Strambach & Klement, 2012) with a unique local knowledge base. Thus, innovating firms need to acquire knowledge from a variety of sources and economic actors at different spatial scales and to combine it with unique internal knowledge and competencies, which implies that they must build up, maintain and use different types of links for interaction and knowledge transfer.

The purpose of this working paper is to provide a short overview of actual topics in contemporary research concerned with global, national, regional and local knowledge and innovation dynamics. The paper is organised as follows: In Section 2, we discuss the changing global scene for innovative activities, while Section 3 is devoted to a discussion of knowledge and knowledge dynamics. The relationship between knowledge, innovation and agglomeration is the topic of Section 4 and in Section 5; we highlight the role of innovation ability and innovation resources. The role of proximity for knowledge generation and innovation is discussed in Section 6 and this discussion is followed up in Section 7 we an analysis of the role of interaction between economic agents for knowledge generation and innovation. The role of urban regions for knowledge generation and innovation is presented in Section 8 and in Section 9; we shortly discuss the role of social capital for knowledge generation and innovation. Section 10 concludes.

2. The changing global scene

Global markets with extensive outsourcing and ‘just-in-time’ deliveries are requiring strict timetables for on-time shipments of semi-manufactured products, components, spare parts and final goods between production and assembly centres scattered over the globe. As the ‘half-life’ of many new products in this knowledge economy becomes shorter and shorter, and the

spatial distribution of supply and demand points adjusts rapidly in the system, what is transported, how it is transported, and to where and from where – are all changing. The emerging global knowledge economy is thus a distributed system with a vast array of geographically dispersed economic operations. People, knowledge, capital, goods and services are increasingly mobile and constitute, in the interactive milieu of the global economy, a large number of networks embracing scientific knowledge, technology, production, service, finance, culture and so on. Communications technologies have opened the door to systems of global commerce and network interdependencies but faster and more reliable transportation systems are needed to support them. Investments in transportation, therefore, not only allow existing patterns of business interactions to be carried out more efficiently but also support the evolution of new and radically different patterns of commerce at the global scale.

The most critical nodes and links in the knowledge society are of course the knowledge networks through which transfer, diffusion and spillovers of knowledge take place. They are spatial networks, i.e. they connect spatially diffused economic agents and localities, and consist of a set of knowledge nodes and a set of different knowledge links connecting them by means of transportation and communication and personal links. At a coarse spatial resolution functional economic regions consisting of settlements, such as towns, cities and metropolitan regions represent the knowledge nodes. These knowledge nodes are characterized by their endowments of knowledge production capacities and related activities, including knowledge infrastructures such as universities, meeting and interaction facilities, stocks of knowledge and human capital, local knowledge networks, and so on. Such knowledge nodes are often called clusters, which are geographic concentrations of firms and associated organizations that are highly networked and interdependent with each other both internally and externally. While clusters are not defined in terms of a specific geography, they are often coincident with more general urban concentrations, i.e. cities and metropolitan areas.

At a finer geographical spatial scale, we have knowledge links within and between firms, research institutes and universities, and between individuals. The spatial perspective highlights the importance of spatial frictions as a factor limiting knowledge transfers and spillovers, and make it clear that excludability of knowledge is not only a result of patents, business secrets, and so on but also a consequence of limited physical accessibility and the time and money costs involved in spatial interaction (Karlsson & Nyström, 2011). In this picture of the global knowledge economy, we can identify a particular role played by intra-organization networks of multinational corporations (Almeida and Phene, 2012).

In the context of the described economic transformation, transportation and communications technologies and infrastructures, interact in complex ways. A superficial view holds that communications mostly substitute for transportation, as when a conference call, a video conference or exchange of documents via the Internet takes the place of a face-to-face meeting. However, the relationship is most often complementary. Preliminary interactions via electronic media eventually lead to an international shipment or passenger trip that would not have occurred otherwise. Furthermore, transportation and communication cannot be viewed as distinct processes. They are increasingly melded together, as in the cases of advanced logistical systems or intelligent transportation systems.

The transport and communication systems of today have evolved gradually alongside the development of trade and commerce, and the transformation of local, national and international markets. In today's globalized world, firms, cities and regions can only be competitive if the accessibility to the domestic and the international market is high enough. There exist major

differences between locations as regards nodes of communication, services provided by the transport system and networking possibilities. This is problematic, since the transportation and communication systems serve as a medium for conveying information and knowledge, and for developing and introducing innovations. These systems foster economic progress and welfare, while being vehicles that facilitate relations and interactions between economic agents.

3. Knowledge and knowledge dynamics

Knowledge exhibits very specific properties that are not shared by most other goods. Codified scientific and technological knowledge, such as published research results, patent applications, etc. have a public good character, since they are neither non-rival nor non-excludable. Thus, knowledge is available for whoever searches for it (Arrow, 1962) and can be utilized by many different users without any reduction of its utility as an input in future research. It is certain that knowledge accessibility varies among different locations. Furthermore, the transfer of knowledge within and in particular between locations is associated with costs and time delays also in a world where the use of ICT is widely diffused. Interaction processes among individuals within firms and other organizations, such as universities, are central to the generation and use of knowledge and its transformation into innovations with economic value added.

Treating knowledge as the key resource for innovation shifts the focus from the innovation itself to the process of knowledge generation, transformation and diffusion, i.e., to knowledge dynamics (Crevoisier & Jeannerat, 2009), which emerge through the interactions of individuals within firms and other organizations and within networks of firms and other organizations. Location and space are the two main dimensions that shape the knowledge micro-dynamics behind innovations. Locations are not equal and their economic milieu is shaped by evolutionary economic processes (Feldman & Kogler, 2010) that involve cumulative processes (Myrdal, 1957) with concentration of economic activities in space generating location-specific advantages knowledge micro-dynamics are not the least. The emergence of urbanization economies in larger urban agglomerations spurs diversity and variety, which foster cross-fertilization of knowledge and technologies.

There are, in particular, three factors that influence local knowledge dynamics in a generic way: i) the specific knowledge base of economic agents, ii) the competencies and capabilities of the economic agents (Dosi, Faillo & Marengo, 2008), and iii) the context of the local economic milieu. The cumulative aspects of knowledge implies that the generation of new knowledge builds upon currently existing knowledge (Antonelli, 2005), which suggests that local knowledge dynamics are path-dependent. Thus, what an economic agent and a location have done and experienced in previous time tends to govern the type of new knowledge developed and the direction of innovation processes as well as the ability to absorb new knowledge developed elsewhere (Patel & Pavitt, 1997). Organizational routines and organizational capabilities, which are the result of localized learning processes, are essential factors that govern, coordinate and integrate knowledge exploitation and knowledge exploration (Teece, 2010) within the framework provided by existing local institutions and social capital.

However, cumulative knowledge dynamics are complemented by a combinatorial knowledge dynamics focused on the use of spatially separated knowledge bases, which are accessed by means of outsourcing, and offshoring of knowledge-intensive business service activities and

R&D activities within global knowledge networks (Miozzo & Grimshaw, 2005; Guinet, et al., 2008). This implies that the spatial boundaries of knowledge used and generated in the innovation processes of economic agents can differ significantly according to the time distance to face-to-face contacts, knowledge and markets that are conducive to innovation (Andersson & Karlsson, 2005; McCann, 2007). Thus, different firms and different types of innovation activities require different types and levels of face-to-face interaction and will therefore chose to locate in different types of locations in relation to major metropolitan regions (Doloreaux & Shearmur, 2012), as firm-level innovation is impacted by a variety of slowly changing local cultural, institutional and economic factors (Moulaert & Sekia, 2003). Face-to-face interaction may promote innovation by increasing the possibilities of formal knowledge transfers and informal knowledge spillovers between firms and individuals (McCann & Simonen, 2007; Krugman, 1991). It achieves that by increasing i) the mutual transparency of competitor behaviour and thereby competitor responses, ii) the levels of cooperation between firms and individuals as well as the level of competition between firms, and iii) the inter-firm mobility of labour, where the latter represents both a clear mechanism for knowledge spillover and capacity building based on a recruitment strategy.

4. Knowledge, innovation and agglomeration

It is well established that innovation exhibits strong geographical clustering in locations where specialized inputs, services and resources for innovation processes are located (Asheim & Gertler, 2005). The importance of local input factors and of local inter-firm dynamics for a firm's ability to innovate and to gain competitive advantage is well documented in the literature on innovation and regional development (Wolfe, 2009). Thus, location and spatial concentration of firms that stimulate flows of knowledge between firms and between universities and firms and interactive learning are critical aspects of firms' efforts to generate new knowledge and innovations not the least because knowledge continues to be tied to certain locations (Liu, Chaminade & Asheim, 2013). Multinational firms take advantage of this by locating in those concentrations (clusters) in the world that have accumulated specific competencies and knowledge that is difficult to acquire elsewhere (Lewin, Massini & Peeters (2009), which gives opportunities to fully exploit the interaction between intra- and inter-firm knowledge networks (Coe, Dicken & Hess, 2008).

The initial foundations for understanding the microeconomic dynamics behind the agglomeration of innovation activities was laid by Marshall (1920). However, the analysis of the innovation-space relationship was renewed in the early 1990s with the launching of the so-called "new economic geography". A basic element of this relationship concerns the geographical reach of knowledge "spillovers". Krugman (1991) focusing on pecuniary externalities disregards geographical knowledge externalities. However, at the same time the role of innovation and processes of knowledge externalities linked to the diffusion of knowledge in growth dynamics is an essential element in modern theories of endogenous growth. But, a synthesis of new economic geography and endogenous growth theory brings the two perspectives together and generates a formalized analytical framework for understanding localized growth dynamics based upon innovations (Baldwin & Martin, 2004), where technological externalities are central for explaining the spatial concentration of innovative activities. Locations that benefit from substantial technological spillovers become more dynamic in terms of innovation and preferred locations for economic agents involved in innovation activities. Since these technological externalities are localized in space, those localities with even a slight technological head start in a given technological field will accumulate knowledge in that field more rapidly

than other locations. This, in turn, reduces the costs of innovation in such "leader" localities and thus attracts more resources for innovation and more economic agents involved in innovative activities in the pertinent technological field. The result is a cumulative agglomeration of R&D activities and innovative activities in this technological field in such localities.

The discussion above might be interpreted as if it is the clustering of R&D and innovation activities belonging to the same industry or closely related industries in a location that determines the intensity of knowledge externalities and knowledge dynamics in the locality. This would imply that knowledge externalities only are transmitted in localities, where there exist a certain technological proximity between economic agents, i.e., that the MAR externalities dominate (Marshall, 1920; Arrow, 1962; Romer, 1986). However, there are substantial theoretical and empirical evidences pointing in the direction that it is the variety and diversity of activities in a locality, i.e. the presence of many specialized clusters of activities including multiple supply chains supporting the specialized industry or industries among which knowledge can spill over – the so-called Jacobs externalities – , that matter for innovation (Jacobs, 1969). Using a more dynamic approach, such as an innovation cycle, it is possible to illustrate that both types of knowledge externalities might be critical but at different phases of the cycle (Duranton & Puga, 2001). During the emerging, experimental phase of a new activity, i.e. innovation, firms face many uncertainties concerning the most efficient production process and/or the most appropriate qualifications of its labour force. During this face, then, firms will seek out diversified localities that offer proximity to other firms in the experimental stage and to a diversified labour force. The need for a diversified environment ends once the firms have found the appropriate production procedure. Then they will opt for a change of location to a locality that specializes in their production and where the production costs are lower, i.e., the choice of new location will be governed by the extent of the MAR externalities in different locations.

5. Innovation ability and innovation resources

Innovation ability is the "ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments" (Teece, Pisano & Shuen, 1997, 516). Recent contributions to the resource-based view of the firm (Almeida & Phene, 2012) also suggest that firms generate innovations in a process that exploits knowledge inputs from the conjunction of internal and external knowledge sources (Cantwell & Zhang, 2012). Earlier contributions have tended to focus on either the internal properties of firms and how firm capabilities develop in an experience-based learning process (Klette & Kortum, 2004; Kortum, 2008) or the importance of the local and regional milieu of innovating firms in terms of providing options for knowledge flows and spillovers in different types of networks (Audretsch & Feldman, 1996; Feldman, 1999).

The resource-based view of the firm also assumes that different firms have different endowments on internal knowledge, i.e. of scientific, technological and entrepreneurial knowledge and different capacities to absorb external knowledge. They also differ in their capacity to discover, create, evaluate and exploit innovations, i.e. to create new combinations out of existing scientific, technological and entrepreneurial knowledge, and thus to be drivers of change in markets. One important reason for capacity differences among firms is differences in the degree of integration in the personal, social and professional networks that are major conveyors of external knowledge.

The combination of internal knowledge and external knowledge is cumulated within individual firms into knowledge of firm routines, product attributes, customers' preferences in different markets for product attributes, and routines for how to organize innovation activities (Karlsson, Stough & Johansson, 2009). When relying on their cumulated resource bases and associated knowledge assets, innovating firms are characterized by their capacity to exploit in-house knowledge in conjunction with both local and distant external knowledge sources (Johansson, Johansson & Wallin, 2013). It is obvious that the geographical proximity of firms to external knowledge affects the opportunities to acquire useful knowledge inputs to their innovation and renewal activities, since the larger the geographical distance between economic agents the larger the costs for interaction. Thus, we can conclude that the larger the geographical distance between economic agents, the lower the likelihood that they will interact.

Firms engaged in product innovation search both internally and externally for information and knowledge about product attributes, production routines and market conditions. It seems reasonable to assume that external knowledge is quite diversified, while internal knowledge might be very specialized. A particular aspect of the internal knowledge of firms is the education and experiences, i.e., competencies, of their employees, which is critical for the capacity to absorb new knowledge (Cohen & Levinthal, 1990). The internal knowledge of firms also encompasses i) know-how with regard to the orchestration of innovation efforts, ii) experience about accession of external knowledge, iii) know-how about approaches that facilitate the combination of internal and external knowledge, and iv) experience from interaction with external knowledge handlers.

Acquiring external knowledge is crucial for the success of firms, particularly in the creative and high technology industries (Pittaway, et al, 2004). In each location, firms can tap an external knowledge potential, which represents the richness of the knowledge opportunities of the location and which varies depending upon which industry the firms belong to. From the external knowledge potential, firms can find advice, purchase innovation support and establish innovation cooperation with other economic agents, and absorb general knowledge flowing around within the location. Many earlier studies have examined how aggregate knowledge sources and R&D activities inside urban regions generate knowledge flows and spillovers[3] via formal and informal (Saxenian, 1996; Keeble, 2000) knowledge networks and local "buzz" (Bathelt, Malmberg & Maskell, 2004; Storper & Venables, 2004) and affect innovation activities and innovation outcome of other firms located in the region (Jaffe, Trajtenberg, & Henderson 1993; Audretsch & Feldman, 1999). Not least, it is often argued that firms located in innovative clusters can benefit from other co-located economic agents who generate local knowledge spillovers (Audretsch & Feldman, 2003). The conclusion from these contributions is that knowledge flows and spillovers are spatially bounded. However, some knowledge flows and spillovers transcend cluster and regional borders and recent literature has stressed that knowledge linkages at multiple spatial scales are important (Bathelt, Malmberg & Maskell, 2004; Torre, 2008). Johansson, Johansson and Wallin (2013) illustrate how one intra-regional and one inter-regional knowledge potential can be calculated for each location and used in empirical analyses.

6. Knowledge, innovation and proximity

[3] Knowledge spillovers occur when knowledge created (or possessed) by one local economic agent is accessed and used by other economic agents without market interaction and financial compensation for the owner of this knowledge.

The convergence of increasing personal mobility and exchange of ideas, and growing interactions among diverse knowledge networks – made possible by the innovations and structural change in transport and communications – underlie the accelerating knowledge productivity and creativity as expressed in the production of new and improved economic, social and cultural goods and services. The continued growth of knowledge productivity depends thus on providing incentives that promote increasing ability for interaction among people in various knowledge networks ranging from the local to the global level, i.e., with varying degrees of geographical proximity. Interestingly, our understanding of the determinants on knowledge flows including so-called knowledge spillovers is still limited and many researchers seem not to have understood the implications of the second law of economic geography (Prager & Thisse, 2012), namely that what happens close to us often is more important than what happens far from us. This misunderstanding is clearly demonstrated by, for example, Mattes (2012). She remarks that proximity is not a purely spatial phenomenon, but also includes organizational, institutional, social and cognitive dimensions.

However, even acknowledging that proximity is a multidimensional and multifaceted concept, it is obvious that organizational, institutional, social and cognitive proximities are all to a certain extent functions of prevailing geographical proximities. Spatial frictions limit even the interactions within the same organization. This implies, for example, that relational proximity can never be a substitute for spatial proximity as claimed by Amin & Cohendet (2004). Relational proximity is among other things a function of the degree of spatial proximity. Spatial proximity works via cognitive, organizational, social, institutional and other proximities but is not a substitute or a complement to other proximities as claimed by Boschma (2005). Cognitive proximity implies that economic agents that share the same knowledge base can exchange information about new knowledge more easily and less costly. Organizational proximity implies that knowledge can be more easily transferred between economic agents because it reduces uncertainty and incentives for opportunistic behaviour. Social proximity reflects social ties, which lowers transaction costs for economic agents who want to share knowledge and cooperate on knowledge generation. Institutional proximity implies that the transmission of knowledge between economic agents is more efficient if they share a common institutional framework. Certainly, these different proximities are important for the interaction and cooperation between firms involved in knowledge generation and innovation but the extent of these non-geographic proximities is all a function of the time distances between the actual economic agents, since what is at heart, here is the interaction between individuals and economic agents.

Spatial proximity per se is of no value. Its value comes from the interactions, the cooperation, the learning, and the contacts that it makes possible (Strambach & Klement, 2012). For example, cognitive proximity has to do with relations between individuals and the value of such a relation increases with a decreasing time distance between the individuals. Individuals in close geographical proximity often share the same local culture, the same institutional milieu and social practices, which contribute to a certain degree of cognitive proximity, which facilitates effective interaction and communication and the development of a mutual understanding. Torre (2009) highlights the importance of time distances between economic agents in this context.

7. Knowledge, innovation and interaction

In principle, there are two ways to simplify and stimulate interaction between economic

agents and the exchange of associated information and knowledge (Johansson & Quigley, 2004). The first is the so-called proximity advantage, which occurs because the frequency of face-to-face interaction between economic agents increases as the time distances between their locations decreases. This implies that an innovating firm benefits from being located in an regional economic milieu with rich and diverse knowledge flows and with a multiplicity of relevant knowledge sources like R&D-intensive firms, research universities, knowledge-intensive business services, importers of knowledge-intensive products, etc., which can be accessed via face-to-face interaction. Face-to-face interaction is critical, since much (new) knowledge has a tacit nature, i.e. it has a local "stickiness" (von Hippel, 1994) and it is embedded in individuals (Gertler, 2003).[4] Thus, its economic value is in most instances difficult to evaluate (van Egeraat & Kogler, 2013) without rather intense face-to-face interaction. The relative importance of different mechanisms for local knowledge transfer and spillovers is still hotly debated (see the literature references in Huber, 2012).

The second way to facilitate the transfer and exchange of knowledge including tacit knowledge between economic agents is investments in economic links including knowledge links between economic agents. Thus, an economic agent can invest in links and entire interaction networks with other (distant) economic agents to reduce the spatial frictions and the costs of communication of longer distances and thereby create a network advantage. This implies that when a proximity solution of the need to access external knowledge in a given location does not exist, an economic agent can chose to stay in the location and instead invest in links to more distant economic agents (such as suppliers, customers, knowledge-intensive business firms, industry associations, and research universities) as a means to compensate for the lack of feasible proximity options. Analyses of knowledge networks can lead to a better understanding of knowledge generation, innovation and general regional economic development (Ter Wal & Boschma, 2008).

In many cases, investments in long-distance links complement investments in links for short-distance interaction. Economic agents have a double link investment advantage of being located in an urban and in particular in a large urban agglomeration: i) the need for lumpy investments is smaller in an urban agglomeration, and ii) interaction links are at the same time more easy to establish inside an urban agglomerations. In particular, when two economic agents are located in the same functional region, the costs of forming interaction links should generically be smaller than when the same economic agents are more distant from each other due to the high density of knowledge-generating activities in urban agglomerations (Scott, 2006). This is the *sin qua non* value of being located in industrial clusters and functional regions.

8. Knowledge, innovation and urban regions

Large urban regions and in particular metropolitan regions offer better conditions for knowledge generation and innovations than smaller regions due to the presence of strong and competitive businesses, appropriate research and education facilities, labour markets with a large and varied supply of qualified labour, well-developed infrastructures and supportive policy environments. They also function as major knowledge hubs in different global innovation networks (Chaminade & Vang, 2008). In particular, there are four factors that explain why large urban regions offer better conditions for innovation (Doloreux & Shearmur, 2012):

[4] The transfer of tacit knowledge is facilitated by high levels of trust, low cultural and/or cognitive distance, including a common language and a shared scientific field (Gertler, 1995).

i) they host several dynamic industrial clusters, especially in knowledge-intensive industries, ii) they offer superior access to knowledge and technology flows and spillovers (Gilbert, McDougall & Audretsch, 2008), iii) they offer an economic milieu where firms can benefit from various positive externalities, and iv) they enable intensive and diverse exchanges of unstructured, complex and tacit knowledge (Tödtling & Trippl, 2005).

The role of large cities for knowledge generation and innovation can be understood by applying a "systems economics" approach (Antonelli, 2011) focusing on three particular and distinct systems features (Stough, Stimson & Nijkamp, 2011):

1. *Density and proximity externalities*, which are of particular importance due to the high degree of concentration of socio-economic and cultural advantages in large cities including i) their large and diversified pool of skilled labour and knowledge handlers, ii) their concentration of ICT infrastructure, iii) their agglomeration economies that reduce the interaction and transaction costs for individuals and firms, and iv) their role as major nodes for knowledge transfers and spillovers, which generates an economic milieu conducive for knowledge generation, innovation and entrepreneurial activities.
2. *The physical and cultural resource base of cities*, which includes not only transport and communication infrastructures and their gateway functions but also their agglomerations of immaterial knowledge networks and their cultural capital.
3. *Interactive dynamics related to learning and creativity*, which are increasingly the "intangibles" in the form of institutions, culture and high degree of internal mobility of capital, codified capital and human capital that large cities offer and that are factors driving the economic growth in large cities. Learning here means the capacity to adapt to rapidly changing competitive circumstances, which requires institutional openness, dynamism and flexibility.

9. Knowledge, innovation and social capital

Social capital underlies any kind of social organization and for more than a decade, social capital has been a key concept in analyses of society, in particular at the local and the regional level (Karlsson, 2012). The supply of social capital varies substantially between different locations, and these supply differences bring about differences with regard to knowledge transfer and spillovers, knowledge generation and innovation. Social capital plays essential roles to foster networking and it contributes to understanding the inter-actability among people and social entities. Social capital refers to the formal and informal institutions and relationships, plus the values, attitudes and norms that shape the quality and quantity of a society's social interactions. A broader understanding of social capital accounts for both the positive and negative aspects it creates by including vertical as well as horizontal associations between people, and includes behaviour within and among organizations, such as firms, non-governmental organizations and politically governed bodies. The social and institutional context in locations functions to varying degrees as an enabling and supportive factor for interactive learning processes, knowledge exchange and innovation (Edquist, 2005).

The importance of social capital for innovation stems from its capacity by nurturing trust and shared values to i) reduce local frictions, i.e., local monitoring and transaction costs, considerably in market transactions in local economic systems, and ii) encourage all forms of local non-market interactions. Local frictions are reduced in at least three ways (Malecki, 1998, 11):

- the creation of a system of general reciprocity;
- the establishment of information channels, providing sorted and evaluated information and knowledge, so-called "buzz" (Storper & Venables, 2004); and
- the simplification of market transactions through norms and sanctions by which economic exchanges can be facilitated, bypassing costly and legalistic institutional arrangements associated with market transactions.

In line with Thornton & Flynn (2003) one can assume that social capital affects innovation at three different levels: i) social network ties between individuals, ii) social network ties connecting teams and groups, and iii) social network ties connecting firms and industries. Social networks make an important contribution to innovation, considering that such networks with cohesion in which trust is fostered are contexts in which information flows easily and provide characteristics that are central to reducing the risks of investments in knowledge and innovation. Social network ties also provide individuals and organizations with access to knowledge and other resources that are critical for innovation (Napahiet & Ghoshal, 1998) but as stressed by Granovetter (1973) not all social ties are equally valuable.

10. Conclusions

The purpose of this working paper was to provide a short overview of actual topics in contemporary research concerned with global, national, regional and local knowledge and innovation dynamics. In the text, we stress the importance to understand the current changes of the global and their implications for knowledge generation and innovation. Treating knowledge as a key resource for innovation shifts the focus from the innovation itself to the process of knowledge generation, transformation and diffusion, i.e. to knowledge dynamics. This necessitates integrating spatial aspects since knowledge generation and as a result, innovation exhibits a strong geographical clustering, which implies that innovation ability and innovation resources also are strongly clustered geographically in particular to urban regions. The role of interaction and proximity for knowledge generation and innovation is highlighted and instead it is stressed that relational, cognitive, organizational, social and institutional proximities are not substitutes or complements to spatial proximity but that they are all functions of the prevailing spatial proximity. Another important factor for interaction is social capital, which by fostering trust makes information and knowledge to diffuse faster.

References

Almeida, P. & A. Phene (2012), Managing Knowledge within and outside the Multinational Corporation, in Andersson, M., et al., (Eds.), *Innovation & Growth. From R&D Strategies of Innovating Firms to Economy-Wide Technological Change*, Oxford University Press, Oxford, 21-37

Amin, A. & P. Cohendet (2004), *Architectures of Knowledge: Firms, Capabilities, and Communities*, Oxford University Press, Oxford

Andersson, M. & C. Karlsson (2005), The Role of Accessibility for the Performance of Regional Innovation Systems, in Karlsson, C., P. Flensburg & S.-Å. Hörte (Eds.), *Knowledge Spillovers and Knowledge Management*, Edward Elgar, Cheltenham, 283-319

Antonelli, C. (2005), Models of Knowledge and Systems of Governance, *Journal of Institutional Economics 1*, 51-73

Antonelli, C. (2011), *The Dynamics of Knowledge Externalities. Localized Technological Change in Italy*, Edward Elgar, Cheltenham

Arrow, K.J. (1962), Economic Welfare and the Allocation of Resources for Inventions, in Nelson, R.R. (Ed.), *The Rate and Direction of Innovative Activity*, Princeton University Press, Princeton, N.J., 609-625

Asheim, B.T. & M.S. Gertler (2005), Regional Innovation Systems and the Geographical Foundations of Innovation, in Fagerberg, J., D. Mowery & R.R. Nelson (Eds.), *Oxford Handbook of Innovation*, Oxford University Press, Oxford, 291-317

Audretsch, D.B. & M.P. Feldman (1996), R&D Spillovers and the Geography of Innovation and Production, *American Economic Review 86*, 630-640

Audretsch, D.B.& M.P. Feldman (1999), Innovation in Cities: Science-Based Diversity, Specialization and Localized Competition, *European Economic Review 43*, 409-429

Audretsch, D.B. & M.P. Feldman (2003), Knowledge Spillovers and the Geography of Innovation, in Henderson, J.V. & J.-F. Thisse (Eds.), *Handbook of Urban and Regional Economics*, North Holland Publishing, Amsterdam, ?-?

Baldwin, R.E. & P. Martin (2004), Agglomeration and Regional Growth, in Henderson, J.V. & J.-F. Thisse (Eds.), *Handbook of Regional and Urban Economics*, vol. 4, Elsevier, Amsterdam, 2671-2711

Bathelt, H., A. Malmberg & P. Maskell (2004), Clusters and Knowledge: Local Buzz, Global Pipelines and the Process of Knowledge Creation, *Progress in Human Geography 29*, 31-56

Boschma, R.A. (2005), Proximity and Innovation. A Critical Assessment, *Regional Studies 39*, 61-74

Bunnell, T.G. & N.M. Coe (2001), Spaces and Scales in Innovation, *Progress in Human Geography 25*, 569-589

Cantwell, J. & F. Zhang (2012), Knowledge Accession Strategies and the Spatial Organization of R&D, in Andersson, M., et al., (Eds.), *Innovation & Growth. From R&D Strategies of Innovating Firms to Economy-Wide Technological Change*, Oxford University Press, Oxford, 88-111

Chaminade, C. & J. Vang (2008), Globalization of Knowledge Production and Regional Innovation Policy: Supporting Specialized Hubs in the Bangalore Software Industry, *Research Policy 37*, 1684-1696

Coe, D.T. & E. Helpman (1995), International R&D Spillovers, *European Economic Review 39*, 859-887

Coe, N.M., P. Dicken & M. Hess (2008), Introduction: Global Production Networks – Debates and Challenges, *Journal of Economic Geography 8*, 267-269

Cohen, W.M. & D.A. Levinthal (1990), Absorptive Capacity: A New Perspective on Learning and Innovation, *Administrative Science Quarterly 35*, 128-152

Cooke, P., et al., (2007), *Regional Knowledge Economies. Markets, Clusters and Innovation*, Edward Elgar, Cheltenham

Crevoisier, O. & H. Jeannerat (2009), Territorial Knowledge Dynamics: From Proximity Paradigm to Multi-Location Milieus, *European Planning Studies 17*, 1223-1241

Doloreaux, D. & R. Shearmur (2012), Collaboration, Information and the Geography of Innovation in Knowledge Intensive Business Services, *Journal of Economic Geography 12*, 79-105

Dosi, G., M. Faillo & L. Marengo (2008), Organizational Capabilities, Patterns of Knowledge Accumulation and Governance Structures in Business Firms: An Introduction, *Organizational Studies 29*, 1165-1185

Duranton, G. & D. Puga (2001), Nursery Cities: Urban Diversity, Process Innovations and the Life-Cycle of Products, *American Economic Review 91*, 1454-1477

Edquist, C. (2005), Systems of Innovation. Perspectives and Challenges, in Fagerberg, J., D.C. Mowery & R.R. Nelson (Eds.), *The Oxford Handbook of Innovation*, Oxford University Press, Oxford, 181-208

Feldman, M.P. (1994), *The Geography of Innovation*, Kluwer, Boston, MA

Feldman, M.P. (1999), The New Economics of Innovation, Spillovers and Agglomeration – A Review of Empirical Studies, *Economics of Innovation and New Technology 8*, 5-25

Feldman, M.P. & D. Kogler (2010), Stylized Facts in the Geography of Innovation, in Hall, B.H. & N. Rosenberg (Eds.), *Economics of Innovation*, Elsevier, Amsterdam, 411-427

Frenken, K. & R.A. Boschma (2007), A Theoretical Framework for Evolutionary Economic Geography: Industrial Dynamics and Urban Growth as a Branching Process, *Journal of Economic Geography 7*, 635-649

Gertler, M.S. (1995), 'Being There': Proximity, Organization, and Culture in the Development and Adoption of Advanced Manufacturing Technologies, *Economic Geography 71*, 1-26

Gertler, M.S. (2003), Tacit Knowledge and the Economic Geography of Context, or the Undefinable Tacitness of Being (There), *Journal of Economic Geography 31*, 75-99

Gilbert, B.A., P.P. McDougall & D.B. Audretsch (2008), Clusters, Knowledge Spillovers and New Venture Performance: An Empirical Examination, *Journal of Business Venturing 23*, 405-422

Granovetter, M. (1973), The Strength of Weak Ties, *American Journal of Sociology 78*, 1360-1380

Grant, R. (1996), Toward a Knowledge-Based Theory of the Firm, *Strategic Management Journal 17*, 109-122

Guinet, J., et al., (2008), *The Internationalization of Business R&D: Evidence, Impacts and Implications*, OECD, Paris

Huber, F. (2012), Do Clusters Really Matter for Innovation Practices in Information Technology? Questioning the Significance of Technological Knowledge Spillovers, *Journal of Economic Geography 12*, 107-126

Jacobs, J. (1969), *The Economy of Cities*, Random House, New York

Jaffe, A.B., M. Trajtenberg & R. Henderson (1993), Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations, *The Quarterly Journal of Economics 108*, 577-598

Johansson, B., S. Johansson & T. Wallin (2013), Internal and External Knowledge – Innovation of Export Varieties, *CESIS Working Paper No. 297*, Centre of Excellence for Science and Innovation Studies, Stockholm and Jönköping

Johansson, B. & J.M. Quigley (2004), Agglomeration and Networks in Spatial Economies, *Papers in Regional Science 83*, 165-176

Karlsson, C. (2012), Entrepreneurship, Social Capital, Governance and Regional Economic Development: An Introduction, in Karlsson, C., B. Johansson & R.R. Stough (Eds.), *Entrepreneurship, Social Capital and Governance. Directions for the Sustainable Development and Competitiveness of Regions*, Edward Elgar, Cheltenham, 1-26

Karlsson, C. & K. Nyström (2011), Knowledge Accessibility and New Firm Formation, in Desai, S., P. Nijkamp & R.R. Stough (Eds.), *New Direction in Regional Economic Development. The Role of Entrepreneurship Theory and Methods, Practice and Policy*, Edward Elgar, Cheltenham, 174-197

Karlsson, C., R.R. Stough & B. Johansson (2009), Introduction: Innovation and Entrepreneurship in Functional Regions, in Karlsson, C., R.R. Stough & B. Johansson (Eds.), *Entrepreneurship and Innovations in Functional Regions*, Edward Elgar, Cheltenham, 1-20

Keeble, D. (2000), Collective Learning Processes in European High-Technology Milieux, in Keeble, D. & F. Wilkinson (Eds.), *High-Technology Clusters, Networking and Collective Learning in Europe*, Ashgate, Aldershot, 199-229

Klette, T.J. & S. Kortum (2004), Innovating Firms and Aggregate Innovation, *Journal of Political Economy 112*, 986-1018

Kline, S.J. & N. Rosenberg (1986), An Overview of Innovation, in Landau, R. & N. Rosenberg (Eds.), *The Positive Sum Strategy: Harnessing Technology for Economic Growth*, National Academy Press, Washington, DC, 275-305

Kortum, S. (2008), Exploring Innovation with Firm-Level Data, *The Conference Board, Economics Program Working Paper Series 08-11*

Krugman, P. (1991), *Geography and Trade*, The MIT Press, Cambridge MA

Lewin, A.Y., S. Massini & C. Peeters (2009), Why Are Companies Offshoring Innovation: The Emerging Global Race for Talent, *Journal of International Business Studies 40*, 901-925

Liu, J., C. Chaminade & B. Asheim (2013), The Geography and Structure of Global Innovation Networks: A Knowledge Base Perspective, *European Planning Studies 21*, 1-18

Malecki, E.J. (1998), How Development Occurs: Local Knowledge, Social Capital and Institutional Embeddedness, paper presented at the Annual Meeting of Southern Regional Science Association, Savannah, GA

Malerba, S. (2005), Sectoral Systems: How and Why Innovation Differs Across Sectors, in Fagerberg, J., D. Mowery & R.R. Nelson (Eds.), *The Oxford Handbook of Innovation*, Oxford University Press, Oxford, 380-406

Marshall, A. (1920), *The Principles of Economics*, Macmillan, London

Mattes, J. (2012), Dimensions of Proximity and Knowledge Bases: Innovation between Spatial and Non-Spatial Factors, *Regional Studies 46*, 1085-1099

McCann, P. (2007), Sketching Out a Model of Innovation, Face-to-Face Interaction and Economic Geography, *Spatial Economic Analysis 2*, 117-134

McCann, P. & J. Simonen (2007), Innovation, Co-operation, and Labour Mobility, in Arauzo-Carod, J.M. & M.C. Manjón-Antolín (Eds.), *Entrepreneurship, Industrial Location and Economic Growth*, Edward Elgar, Cheltenham, 335-330

Miozzo, M. & D. Grimshaw (2005), Modularity and Innovation in Knowledge-Intensive Business Services: IT Outsourcing in Germany and the UK, *Research Policy 34*, 1419-1439

Moulaert, F. & F. Sekia (2003), Territorial Innovation Models: A Critical Survey, *Regional Studies 37*, 289-302

Myrdal, G. (1957), *Economic Theory and Underdeveloped Regions*, Duckworth, New York

Napahiet, J. & S. Ghoshal (1998), Social Capital, Intellectual Capital, and the Organizational Advantage, *Academy of Management Review 23*, 242-266

Nelson, R.R. (1993) (Ed.), *National Innovation Systems. A Comparative Analysis*, Oxford University Press, Oxford

Patel, P. & K. Pavitt (1997), The Technological Competencies of the World's Largest Firms: Complex and Path-Dependent, but not much Variety, *Research Policy 26*, 141-156

Pavitt, K. (2005), Innovation Processes, in Fagerberg, J., D.C. Mowery & R.R. Nelson (Eds.), *The Oxford Handbook of Innovation*, Oxford University Press, Oxford, 86-114

Pittaway, L., et al., (2004), Networking and Innovation: A Systematic Review of the Evidence, *International Journal of Management Reviews ?*, 137-168

Prager, J.-C. & J.-F. Thisse (2012), *Economic Geography and the Unequal Development of Regions*, Routledge, London

Rallet, A. & A. Torre (1999), Is Geographical Proximity Necessary in the Innovation Networks in the Era of the Global Economy, *GeoJournal 49*, 373-380

Romer, P. (1986), Increasing Returns and Long Run Growth, *Journal of Political Economy 94*, 1002-1037
Sassen, S. (2006), *Cities in the World Economy*, Sage Pine Forge, London
Saxenian, A.L. (1996), *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*, Harvard University Press, Cambridge, MA
Schumpeter, J. (1942), *Capitalism, Socialism and Democracy*, Harper, New York
Scott, A.J. (2006), Entrepreneurship, Innovation and Industrial Development: Geography and the Creative Field Revisited, *Small Business Economics 26*, 1-24
Storper, M. & A.J. Venables (2004), Buzz: Face-to-Face Contact and the Urban Economy, *Journal of Economic Geography 4*, 351-370
Stough, R.R., R.J. Stimson & P. Nijkamp (2011), An Endogenous Perspective on Regional Development and Growth, in Kourtit, K. P. Nijkamp & R.R. Stough (Eds.), *Drivers of Innovation, Entrepreneurship and Regional Dynamics*, Springer, Berlin, 3-20
Strambach, S. & B. Klement (2012), Cumulative and Combinatorial Micro-Dynamics of Knowledge: The Role of Space and Place in Knowledge Integration, *European Planning Studies 20*, 1843-1866
Teece, D.J. (2010), Technological Innovation and the Theory of the Firm: The Role of Enterprise-Level Knowledge, Complementarities, and (Dynamic) Capabilities, in Hall, B.H. & N. Rosenberg (Eds.), *Handbook of the Economics of Innovation*, Elsevier, Amsterdam, 679-730
Teece, D.J., G. Pisano & A. Shuen (1997), Dynamic Capabilities and Strategic Management, *Strategic Management Journal 18*, 509-533
Ter Wal, A. R.A. Boschma (2008), Applying Social Network Analysis in Economic Geography: Theoretical and Methodological Issues, *Annals of Regional Science 43*, 739-756
Thornton, P.H. & K.H. Flynn (2003), Entrepreneurship, Networks and Geographies, in Acs, Z.J. & D.B. Audretsch (Eds.), *Handbook of Entrepreneurship Research: An Interdisciplinary Survey and Introduction*, Kluwer, London, 21-34
Torre, A. (2008), On the Role Played by Temporary Geographical Proximity in Knowledge Transmission, *Regional Studies 42*, 869-889
Torre, A. (2009), Retour sur la notion de proximité géographique, *Géographie, Économie, Société 11*, 63-75
Tödtling, F. & M. Trippl (2005), One Size Fits All? Towards a Differentiated Regional Innovation Policy Approach, *Research Policy 34*, 1203-1219
von Egeraat, C. & D.F. Kogler (2013), Global and Regional Dynamics in Knowledge Flows and Innovation Networks, *European Planning Studies 21*, 1-6
von Hippel, E. (1994), Sticky Information and the Locus of Problem Solving: Implications for Innovation, *Management Science 40*, 429-439
Wolfe, D. (2009), Introduction: Embedded Clusters in the global Economy, *European Planning Studies 17*, 179-187