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Title **The Internet as Enabler for New Forms of Innovation: New Challenges for Research**

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The Internet as Enabler for New Forms of Innovation: New Challenges for Research

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Abstract: *The paper analysis the role of the Internet for different types of innovation not only focusing on the traditional set of product, process, organizational and marketing innovation, but also extending to innovation in the public sector. In addition to the role of the Internet for various types of innovations, it has also implications for new forms of innovation, especially for the new paradigm of open innovation, which involves collaborative efforts of numerous partners often with a heterogeneous background. The Internet reduces geographical distance, but its moderating effect on other forms of 'distance' relevant for innovation success, like institutional, organizational, technological, and relational distance is also elaborated. Finally, the implications for innovation at the regional level are derived. The paper concludes with a set of research questions and an integrative approach to measure Internet-enabled innovation at the regional level.*

Introduction

The information and communication technologies ICT and especially the Internet has not only changed the economy, but also the society including the political system worldwide. Consequently, the Internet is not only the consequence of innovation in ICT, but also enabler for various types of innovation not only in the private, but also in the public sector, and for more broader and complex innovation processes.

Due to the ubiquitous character of the Internet, all regions worldwide can benefit from the enabler function of the Internet. Consequently, the division of labour worldwide has increased and the value chains not only of manufacturing, but also service industries have been differentiated, e.g. by outsourcing. Nevertheless, the importance of the regional dimension and the role of distance for innovation remained strong or are even strengthened due to the role of tacit knowledge and trust between the partners which builds on close personal face-to-face interactions over time. In order to exploit the benefits of the Internet, optimal adoption, but also adequate human resources are required. Therefore, we face an increasing tension, but also complementarity between globalization and the role of the region for innovation. In order to find new insights in this complex trade-off, comprehensive empirical evidence has to be collect.

Besides the interrelationship between local and global dimension of innovation process, innovation has become more and more relevant not for companies' competitiveness in the private sector, but also for the performance and even the survival of public organizations. The innovativeness of the latter crucially depends on the input from and the collaboration with the private sector. Consequently, the Internet has developed to a platform for innovation processes and the delivery of innovative products and services for both the private and the public sector. The methodological challenge is the mapping of Internet enabled

innovation on a very detailed level both related to the various types of innovation and processes and regional differences.

The remainder of the paper is structured as follows. In a first conceptual chapter, the various types of innovation not only focusing on the traditional set of product, process, organizational and marketing innovation, but also extending to innovation in the public sector are presented. In addition, the Internet has also implications for new forms of innovation, especially for the new paradigm of open innovation. Secondly, the Internet itself provides only the infrastructure. Complementary investments by companies, but also households are required in order to exploit its potential for the economy and society, but also for innovation. Thirdly, the Internet overcomes geographical distance, but how does it affect other forms of 'distance' relevant for innovation success, like institutional, organizational, technological, and relational distance? This dimension is also elaborated, before the available findings of the relation between the Internet and innovation are summarised. Based on this overview, the paper concludes with a set of research questions focused on Internet-enabled innovation especially at the regional level.

Conceptual Dimensions

Forms of Innovation

Based on the first elaboration of Schumpeter (1911), the OECD started to define innovation in the so called Oslo Manual for the first time in the 1990ies. The most recent third edition of the Oslo Manual defines innovation as the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations (OECD-Eurostat, 2005). This

definition, reflecting measurement requirements, covers the following four types of innovation:

- Product innovation: the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics.
- Process innovation: the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software.
- Marketing innovation: the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing.
- Organisational innovation: the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations.

Innovation activities vary greatly not only between sectors, but also between firms in the same sector. Some firms focus their activities on the development and introduction of new products, whereas others primarily make continuous and rather incremental improvements to their products, processes and operations. Both types of firms are innovative, because an innovation can consist of the successful implementation of a single significant change, or of a series of smaller incremental changes that together constitute a significant change. By definition, all types of innovations must contain a degree of novelty. The Oslo Manual distinguishes three types of novelty: an innovation can be new to the firm, new to the market or new to the world. The first category is focused on the

implementation of an already existing innovation to a specific firm, whereas the innovation may have already been realised by other firms, but it is new to the firm. Innovations are new to the market when the firm is the first to introduce the innovation on its relevant market. An innovation is new to the world when the firm is the first to introduce it in reference to all markets and industries.

Innovation is not only the outcome of firms' activities, but in general a continuous process which challenges its measurement. Firms constantly make changes to products and processes and collect new knowledge. With the objective of capturing these processes, the Oslo Manual (OECD-Eurostat, 2005) focuses on measurable indicators such as expenditures, linkages, barriers and objectives which influence innovation activities.

Innovation, thus defined, is clearly a much broader concept than research and development (R&D) see OECD 2002) and is therefore influenced by a wide range of factors. Innovation can occur in any sector of the economy, including government services like health or education. However, the current Oslo Manual applies only to innovation within firms, even though innovation is also important for the public sector (Flash Eurobarometer 305 2011, Hughes et al. 2011), but can also be driven by the public sector (OECD 2011a) via public procurement (Lorenz et al. 2009) or public-private partnerships. Currently, it is discussed to extend the concept of innovation and related measurement approaches to public sector innovation and social innovation. This would respond to the reality that innovation covers not only a wide range of activities, but also of actors both in the private and public domain.

Not only more actors are involved in innovation, innovations are meanwhile being developed within interactive collective or collaborative processes (e.g. OECD 2010), which involve a range of rather heterogeneous actors. Firms or better organizations must identify, access and integrate a wide set of

knowledge and competencies often only available beyond their own boundaries, because nowadays a broad range of knowledge from different sources are needed to bring a good, service or process successfully to the market.

Consequently, innovation is clearly not just about the generation of own new knowledge, but on the one hand more about the use and integration of already existing knowledge and the other hand about the wide diffusion of newly combined and further developed knowledge. Raising the absorptive capacity (Cohen and Levinthal 1990) to understand and make use of knowledge generated elsewhere within firms can have dual benefits, not only helping to profit from the existing stock of knowledge but also to contribute to the creation of new knowledge.

Traditionally companies tried to retain their core capabilities (in technology and markets) and develop these internally, to the greatest extent possible. However, companies recognise open innovation as a tool to explore new growth opportunities at a lower risk, because it offers companies a higher flexibility and responsiveness without necessarily incurring huge costs. Consequently, a major motivation (OECD 2008) to engage in the use of external sources of innovation is to increase the speed of innovation, especially by sourcing knowledge from research institutes, companies and adjacent markets. When companies look for external sources of innovation, they tend to focus on searching for specific technologies or products, rather than searching to collaborate with specific partners. Other motivations to use external sources of innovation were to increase the number of ideas for new projects, to attract and retain talent and to increase external funding of ideas and technology developments.

Open innovation, however, also has disadvantages for companies, such as additional costs of managing co-operation with external partners, the lack of control over knowledge provided and generated, the restricted flexibility, the

dependence on external parties and the potential opportunistic behaviour of partners. A crucial requirement for open innovation is human resource management as well as the management of different partners, since success often depends on involvement of the external partners in the company's innovation activities. Open innovation can make the management of innovation more complicated and may result in the loss of some competencies, including own Intellectual Property Rights (IPR), and an increasing dependency on other external actors and their knowledge and IPR.

Meanwhile, open innovation is also discussed in the context of public organisations, e.g. by providing public or better open data as one input by government. The objectives are the generation of innovations in the public sector, but also higher satisfaction of citizens and basis for new business models and companies in the private sector.

In summary, both the range of innovation has expanded to the non-technical area of marketing and organisational innovations and new forms of collaborative open innovation processes complement and in some areas substitutes former closed intraorganisational innovation processes.

The Internet

For a comprehensive analysis of Internet-enabled innovation it is not sufficient to focus on the ICT or narrower the Internet use of companies. We need a much broader view which takes into account that companies can exploit the benefits of the Internet much more effectively and efficiently the higher the general and even more relevant the ICT related skill levels of their employees. However, not only the skill level of employees is decisive for the general and especially the innovation related impacts of the Internet, but also well qualified consumers are helpful for the early and broad adoption of Internet-enabled innovations.

In contrast to the clear and broadly accepted OECD definitions of innovation, the demarcation of ICT and its various dimensions has been only started within the last decade at an international or OECD level (OECD 2011b). Still, there is no agreed comprehensive conceptual and empirical framework of the information society. The OECD (OECD 2011b) uses a conceptual model, which encompasses the widely agreed elements of ICT supply, ICT demand, ICT infrastructure, ICT products and 'content'.

The ICT products have been defined at the beginning of the definition efforts based on a sector approach, but then complemented and developed further via product and service classifications. More relevant for our research objectives is the ICT infrastructure and the related ICT use both by companies or organizations and by users and consumers.

More important for our objective are the efforts and achievements to measure the Internet as an infrastructure technology, which substituted the classical telecommunication networks. The Internet Protocol based networks increasingly provide any service that might once have needed a specialized or dedicated infrastructure. Consequently, services are no longer tied to specific platforms. Besides the various approaches to differentiate between the different types of networks, e.g. wireless vs. fixed networks, the available speed is crucial for the possible applications and therefore innovations. There is no standard definition of the threshold speed for broadband. Therefore, recently new indicators distinguish broadband connections according to five different ranges of speed (ITU 2010).

In addition, the Internet, by its very nature, enables data to be collected about itself through online surveys of computers and servers connected to it and interactive exchanges between applications. Examples include surveys of Internet hosts, secure servers and permanent connections. Programs such as anti-virus

software and firewalls can also remit information to provide information on security of networks. An increasing area of information in the realm of Internet statistics lies in the collection of domain names registered. These in turn provide an insight into the growing ubiquity and diffusion in Internet usage all over the world. These categories primarily relate to the use of identifiers such as domain names or IP addresses. ICANN and most organizations with responsibility for country code domain names make statistics available on registration.

In contrast, there are in general no data recording the 'national total' for traffic carried by networks using the Internet protocol. Australia is one of the few exceptions. In other countries, data may be available for individual operators. Data are also sometimes, e.g. in Japan and the United States, available about which networks have direct traffic exchange relationships.

The Internet as an infrastructure is a necessary condition and therefore its availability also the basis for the construction of indicators for potential Internet enabled innovations. In addition to the availability of the Internet as infrastructure, companies themselves have to invest in hard- and software in order to exploit the functionalities of the Internet. Furthermore, the actual Internet use by businesses, e.g. measured by the percentage of broadband connected employees (Eurostat, 2008), and by individuals is a further necessary condition to assess and measure the innovation enabling function of the Internet. Therefore, complementary to the technical functionalities of the Internet are e-commerce and e-business, including SCM (supply chain management), ERP (enterprise resource planning) or CRM (customer relationship management), activities as indicators for the breadth and depth of the implementation of the Internet in businesses. Recently, the use of e-government services has been included in business surveys in order to measure the diffusion of innovative e-government services. Similarly, ICT access and use, e.g. e-commerce and e-government services, by households

and individuals complements both the information of availability of the Internet as infrastructure and its use by businesses.

Finally, the functionalities of the Internet complemented by the ICT equipment of companies and individuals can only be fully exploited if the users, i.e. companies' employees and the private individuals, have the necessary skills. Consequently, information about ICT skills in primary and secondary education, but also in companies has recently be collected (Statistisches Bundesamt 2010).

Innovation and Distance[1]

As elaborated above, the speed of innovation in high-technology industries and its increasing knowledge breadth often motivates or even forces firms to access outside resources and capabilities through inter-organizational cooperation (Hess and Rothaermel, 2011; Leiponen and Helfat, 2010; Schoenmakers and Duysters, 2010, 2006; Hagedoorn, 2002, 1993; Larsen and Salter 2006). The incipient research in this field has identified different factors that impact the innovative performance of cooperation and networks, such as different governance forms (Mowery et al., 1996), the existence of previous ties (Wuyts et al., 2005), centrality in and density of networks (Gilsing et al., 2008), or, more recently, cognitive or technological distance (Gilsing et al., 2008; Nooteboom et al., 2006; Phene et al., 2006).

Lately, the geographic dimension has been added to cooperation and network analysis (Broström, 2010; Phene et al., 2006; Sydow, 2004). With regard to innovation cooperation, prior contributions have often stressed the meaning of geographic and institutional proximity to support the sharing of tacit knowledge and reduce relational risks (Asheim and Gertler, 2005; Koschatzky, 2001; Brown and Duguid, 2000; Cooke et al., 1997; Lundvall, 1988). However, latest empirical

[1] This section draws on Hartig and Blind (2011). See a specific application to cooperation in the biotechnology sector in Hartig (2011).

evidence challenges this argument (Bercovitz and Feldman, 2011; Laursen et al., 2011; Giuri et al., 2006). For example, Giuri et al. (2006) found a high share of non-local cooperation in a sample of European invention projects and conclude that the interaction with geographically close individuals in other organizations is the least important form of collaboration. This result is puzzling given the emphasis in the literature on the importance of geographical proximity for collaboration and knowledge transfer.

Against this background, Boschma (2005) concluded that "geographical proximity per se is neither a necessary nor a sufficient condition for learning to take place" (p. 62). As way of explanation, he refers to multiple forms of proximity which can substitute each other and even dominate the impact of geographic proximity. Extending these ideas, Boschma and Frenken (2009) and Broekel and Boschma (2009) recently introduced what they describe as a 'proximity paradox'. While proximity may be a crucial driver for agents to connect and exchange knowledge, too much proximity between them – again in different forms – might harm their innovative performance.

Hence, a more nuanced treatise of geographic distance, its impact on innovation performance as well as its interplay with other forms of distance or proximity is necessary to unravel the sources of superior learning and novelty generation in innovation cooperation.

Canonically, the meaning of geographic proximity for interactive learning and innovation has been ascribed to two factors: the ability to share tacit knowledge as well as risk reduction (Koschatzky, 2001). Geographic proximity is thought to not only determine the likelihood of cooperation formation but also its outcomes with regard to learning and innovation. However, the recent upsurge of international cooperation has evoked two points of critique in this argument: First, geographic proximity has been vastly used as an umbrella term often

comprising other forms of proximity, which it eventually produces or supports (e.g., intimate relationships); Second, this line of argument neglects the innovative potential of a partnership which can be derived from distance.

With respect to the first critique, it is currently suggested that geographic proximity is often used primarily, without reference to the underlying assumptions and effects. Hence, it is often not geographic proximity which supports tie formation as well as learning and innovation, but rather similarities in institutions, shared organizational structures, or close relational ties. Hence, to unravel the underpinnings of tie formation and the determinants of effective interactive learning and innovation, numerous contributions have emerged that distinguish different 'socio-economic' or 'socio-cognitive' forms of proximity from geographic proximity, among which are relational and cognitive forms of proximity (Rallet and Torre, 2009, 1999; Bouba-Olga and Grossetti, 2007, 2005; Bouba-Olga and Zimmermann, 2004; Boschma, 2005; Bellet et al., 1993).

With regard to the second argument, following the Schumpeterian tradition, innovation research highlights the benefits of a requisite level of variety of knowledge for innovation in order to create novel combinations (Bercovitz and Feldman, 2011; Leiponen and Helfat, 2010; Boschma and Frenken, 2009; Nooteboom, 2009; van de Ven, 1986). Similarly, Boschma and Frenken (2009) question the sole beneficial role of proximity, in what they call a 'proximity paradox'. Indeed, too much proximity – again in different forms – prevents the inflow of new ideas and the realization of novel combinations.

In particular, 'cognitive distance' between actors is recently promoted as a source for superior learning and innovation (Nooteboom, 2009; Gilsing et al., 2008; Nooteboom et al., 2006;Wuyts et al., 2005).

One outgrowth of this argument is again reference to geographic distance, which is recommended in order to access new ideas (Cooke, 2008; Gertler and

Wolfe, 2006). However – in line with the first argument – geographic distance itself is certainly not the source for novelty, but in turn the underlying assumptions of access to new ideas and approaches. Again, novelty is thought to be found in other forms of distance rather, such as distant knowledge bases or the accession of new ties. On the other hand, geographically distant partners need not necessarily be distant in knowledge and cognition, but may belong to a very narrow epistemic community (Breschi and Lissoni, 2001).

In the following, different forms of distance are introduced separately. Then, the argument of an indirect role of geographic distance respectively proximity is elaborated.

This contribution draws on a taxonomy of five forms of distance introduced by Boschma (2005), who distinguishes between geographical, institutional, organizational, cognitive, and social distance.

Geographic distance is defined as the 'spatial or physical distance between economic actors, both in its absolute and relative meaning.' (Bouba-Olga and Grossetti, 2005, p. 69). It is more than an absolute continuous metric, but includes a relative element defined by the accessibility of the partner as well as a personal judgment of the burden it takes to see the partner personally. It is to date claimed that firms might seek to leverage the 'best' partner or explore novelty in ideas and approaches by reaching out to geographically distant partners (Belussi et al., 2008; Lorentzen, 2008; Kim and Song, 2007; Nair et al., 2007; Shipilov et al., 2007; Lavie and Rosenkopf, 2006; Dahlander and McKelvey, 2005; McKelvey, 2004; Coenen et al., 2003). However, novelty is not directly linked to geography but rather to knowledge bases and cognition – if though geographic proximity might lead to closer and/or more frequent interaction which eventually produces cognitive proximity. Hence, geographic distance itself is expected to lead to a reduced frequency of interaction and a potential shift in communication means toward

less content and context-rich media which together renders knowledge sharing more challenging (Picot et al., 2003; Johnson et al., 2002; Daft and Lengel, 1984). Simultaneously, the costs of interaction and coordination increase. Moreover, geographic distance between the partners has been observed to reduce the level of trust in the partner (Rocco et al., 2000; Hildreth et al., 1999). In summary, the relationship between geographic distance and innovation success seems to be negative.

Institutional distance refers to 'the institutional framework at the macro level. [... It] includes both the idea of economic actors sharing the same institutional rules of the game as well as a set of cultural habits and values' (Boschma, 2005, pp. 67–68). Institutional frameworks are typically bounded to a certain geographic region and thus, institutional and geographic proximity are frequently used interchangeable; however, shared institutional frameworks can stretch over considerable geographic distance. Vice versa, geographically proximate actors can belong to different institutional frameworks. It has been observed that different institutional frameworks favor different technological paradigms and trajectories within them, leading to divergent technological paths in different institutional systems (Nelson, 1993; Lundvall, 1992; Freeman, 1987). Hence, institutionally distant partners might be sought in order to leverage excellence in specific scientific or technological areas, as well as new ideas and insights which promote novel combinations (Lange, 2009; Ferru, 2009; Narula, 2003). With different national systems favoring different technological specialisations and strengths, firms can profit from these by linking up with partners from the respective countries. Further, the diversity of ideas, approaches and contexts found in culturally mixed teams can yield novel combinations and creative solutions (Stahl et al., 2010; Schneider and Barsoux, 2003). On the other hand, differences in cognition and language are supposed to have a negative

impact on knowledge sharing with rising levels of institutional distance (Haworth and Savage, 1989). Furthermore, institutions provide stability and predictability of action. Hence, when the partners are institutionally distant, relational risks are higher, which can lead to a lack of trust and reduced openness in communication. Similarly, national belonging might favor group thinking which risks team coherence. Summarising the opposing effects leads us to the conclusion that the relationship between institutional distance and innovation success follows an inverted U-shaped relationship.

Organizational distance focuses on the rules of the game at the organizational level. It is defined as the extent to which organizations have adopted 'similar mental maps, organizational routines, corporate culture, and management style' (Wuyts et al., 2005, p. 291). Each organization develops own perceptions and assumptions as well as operational routines which guide the firm (Nooteboom, 2009; Nelson and Winter, 1982). While different views and perceptions are certainly a central driver for inter-organizational cooperation (Nooteboom, 2009; Das and Teng, 2000), increasing levels of organizational distance can impede effective cooperation through incompatibilities in goals and time lines, organizational routines or codes of communication and organization specific cultures (Cummings, 2003; Lane and Lubatkin, 1998; Tushman, 1977). Besides, social exclusion mechanisms manifest in a lack of motivation to share knowledge with and adopt knowledge from 'outsiders' have been discussed; all of which exert a negative impact on knowledge-sharing (Chesbrough, 2003). Consequently, the relationship between organisational distance and innovation success is negative.

Organizational distance thus defined is largely independent of geographic distance. Technological distance captures the amount of shared knowledge base and expertise (Boschma, 2005). Novelty creation is said to be contingent on new

combinations of knowledge and skills which are more likely realized with rising levels of technological distance (Nooteboom, 2009; Gilsing et al., 2008; Lubatkin et al., 2001; Schumpeter, 1997). Looking for novelty, technological distance is supposed to be the most influential form of distance, with all others being subordinate. Hence, some level of technological distance is purposefully sought in innovation cooperation. On the other hand, redundancy in knowledge is a direct predictor of the partners' abilities to share knowledge (Cohen and Levinthal, 1990; Nonaka and Takeuchi, 1995). Thus, increasing levels of technological distance have been suggested to hamper knowledge-sharing. These contrary effects lead to a trade-off between novelty value of knowledge and ease of communication which suggests an optimal level of technological distance that ensures novelty and at the same time supports communication (Nooteboom, 2009; Wuyts et al., 2005). It has further been assumed that the difficulties might rise particularly when differing basic knowledge areas are fused with no overlap in codes and basic approaches (Lane and Lubatkin, 1998).

Furthermore, when the people involved in cooperation come to their limits to share knowledge, this is supposed to have a negative motivational effect, leading to incorrect assumptions, irritations, impatience, and frustration. Besides, there might be hierarchies between different disciplines and the level of acceptance and respect for the other might decrease with increasing levels of technological distance (Leonard-Barton, 1992). From this discussion, we drive that the relationship between technological distance and innovation success follows an inverted U-shaped relationship.

Relational distance refers to 'socially embedded relationships between agents... Relations between actors are socially embedded when they involve trust based on friendship, kinship and experience' (Boschma, 2005, p. 66). In current network and innovation studies, there is a growing awareness that too close ties,

as manifest in enduring or repeated relationships, can prevent the in-flow of new ideas and lead to lock-in effects (Gilsing et al., 2008; Lorentzen, 2008). The more distant a partner in a network of relationships, the newer the ideas and approaches and the more likely novel combinations are to occur. However, this novelty comes at the expense of 'social capital' (Burt, 2001); i.e., at the expense of certain structural, cognitive and relational advantages which social capital conveys (Goerzen, 2007; Dyer and Singh, 1998; Nahapiet and Ghoshal, 1998). Through prior experience, the partners share knowledge, codes and inter-organizational routines, which supports their ability to share knowledge and co-ordinate the contributions of the partners. Moreover, close relational ties – also indirect through third parties – increase trust and the motivation of the partners to contribute. Otherwise, the costs of establishing shared knowledge, codes, inter-organizational routines and trust need to be carried within the cooperation, necessitating time and increased effort. Thus, it is expected that relational proximity is beneficial up to a threshold level when its novelty potential is exploited and new relationships are more likely to yield novel combination. Accordingly, the relationship between relational distance and innovation success follows also an inverted U-shaped relationship.

It is recently claimed that geographic proximity has an indirect, facilitative or substitutive, effect on interactive learning and innovation (Hartig 2011, Boschma and Frenken, 2009; Boschma, 2005). That is, geographic proximity between partners can facilitate learning and innovation in the absence of other of the above mentioned forms of proximity. Conversely, the absence of geographic proximity might be offset by proximity in other forms. However, it follows that the combination of high levels of distance in different forms will hamper cooperation and eventually exert a negative effect on innovation.

For example, the combination of geographic and institutional distance might intensify coordination problems, as trust building as well as knowledge sharing are even more hampered when the partners don't meet frequently in person. Consequently, the combination of geographic and institutional distance has a negative effect on innovation success.

Similarly, coordination problems due to organizational distance might become more critical when the partners don't meet frequently in order to develop an understanding of the language, routines and rules used by the partner. For example, Ponds et al. (2007) found that geographic proximity is of smaller relevance for research collaborations between academic organizations, as opposed to collaborations between academic and non-academic organizations. This finding suggests that differences in organization are better handled when the partners are geographically close. Hence, the combination of geographic and organizational distance has a negative effect on innovation success.

Breschi and Lissoni (2001) argued that epistemic communities share language and trust which unites them also when they are separated by large geographic distances. Singh (2005) provides first evidence as he found that inventors working in the same field incur on average longer geographic distances. Similarly, it can be concluded that geographic distance combined with technological distance will hamper the cooperation as technologically distant partners need more personal interaction to share and combine their (tacit) knowledge bases. Consequently, the combination of geographic and technological distance has a negative effect on innovation success.

Finally, Shipilov et al. (2007) provided first evidence on the negative effect of geographic distance when the partners are also relationally distant. They found that non-local ties had initially a negative effect on cooperation and only payed off with repeated interaction. This finding suggests that relational distance

combined with geographic distance has a negative effect on learning and innovation while closer relational ties support cooperation in the absence of geographic proximity. In summary, the combination of geographic and relational distance has a negative effect on innovation success.

The Internet and Innovation

Networked innovation processes, underpinned by the spread of broadband Internet connections, enable a much larger participation in the innovation process, opening it beyond customers, suppliers, competitors, government laboratories and universities to consumers. Tapping into this source of ideas offers a potentially important source of innovation and enhances the influence of the demand side for innovation.

Community engagement is another aspect of the uptake of innovation. In many countries, the public is more demanding of participation in decisions relating to the adoption of some new technologies, particularly when these challenge strongly-held values. The backlash witnessed against new technologies such as genetically modified foods especially in Europe is just one example of the role and influence of communities. Early-stage engagement with the public can play a key role in the acceptance of innovations, and can influence the specific applications derived from new technologies.

Drivers of public attitudes towards new technologies and innovative processes therefore need to be understood by technology developers, including perceptions of risks and benefits – which may differ greatly from the same perceptions of the technology developers. Public concern about the impacts of some technologies, which can more easily organised and promoted via the Internet, means that the application and diffusion of new technologies cannot be dominated by single experts or particular interest groups anymore.

Finally, the Internet is increasingly the platform of choice for the provision of public services. E-government investments have forced governments to rethink business processes and public service delivery. It has challenged them to reconsider responsibilities and organisation within and across levels of government in order to harvest comprehensively all public-sector benefits. Today, the further tightening of public budgets after the recovery from the financial and economic crisis has raised governments' attention to the need for realising long promised benefits, i.e. cost reductions, from e-government investments. This involves an equal focus on saving costs as well as improving quality of public services. Public sector use of participative web tools (such as wikis, blogs and social book-marking) is growing apace, both internally (to improve knowledge management and efficiency within government) and externally (to provide additional channels for interaction with citizens and business).

Against this background, the Internet or ICT in the wider sense has the potential to promote innovation via different channels. First, the Internet allows a more effective and more efficient access to the various sources relevant for innovation. This covers not only accessing databases, but also possible partners or networks for innovation, e.g. customer s and suppliers, which are located around the globe, but also traditional physical inputs via far reaching global supply chains. Second, innovation processes can become more efficient by the Internet by faster and more efficient communication of the actors involved including parallel and sequential developments including feedback loops. Finally, the Internet promotes a broader and faster diffusion of innovation, e.g. by global distribution systems. In addition, the opportunities of the Internet allows completely new business models and consequently the foundation of new enterprises by differentiating, but also broadening and extending existing value chains.

In the following, we will discuss and provide evidence of the enabling function of the Internet for the different types of innovations presented in chapter 2.1. Most studies on the impact of the implications of ICT, which include the Internet, focus on its productivity enhancing influence (e.g. OECD 2004, Eurostat 2008). Despite the broad impacts of the Internet on productivity, growth and employment, we focus on the specific impacts on different types of innovations, which are often interrelated.

Studies on the relationship between the usage of Internet-based technologies and different types of innovation support that Internet-based technologies were an important enabler of innovation. In general, ICTs are a valuable source of business innovation because they provide substantial efficiency gains. According to Gretton et al. (2004), ICT is a so called general purpose technology (Bresnahan and Trajtenberg 1995), which provides a platform upon which further product and process innovations can be based, e.g. a web presence sets the groundwork from which both process innovations, such as electronic ordering and delivery, can be easily developed, but also new products and services offered, i.e. product innovations.

On the conceptual level, the adoption of new technology, such as the Internet, can be viewed as an enabler of process innovations from the perspective of the adopter, if the implementation is successful, the complementary technologies and routines are changed, and the whole new system is actually utilized in practice. Newly adopted technology can also act as an enabler of product or service innovations from the perspective of the adopter if it is successfully used to offer a new products and services. If these are delivered to the customer in a way that is new to the enterprise, then also marketing innovations have been realized. Finally, if the organization of the enterprise has to be adapted even organizational innovations can be observed.

For example, a company that implements new online shop software usually changes the routine of how incoming orders are processed. This is a process innovation. Furthermore, the new online shop software may allow the firm to deliver its products to customers in a new way or to offer additional services, such as tracking orders online or getting immediate information about availability. This would be a service innovation (Koellinger 2008). Finally, if the software allows an extension of the company's product assortment, then it has also realized a product innovation.

In general, besides facilitating especially process innovations, efficiency gains enabled by the Internet provide also opportunities for product innovation. ICT systems and the Internet allow more streamlined internal businesses processes and allow staff to be more responsive to upcoming customer needs.

Empirical analysis confirms that ICTs play an important role in enabling innovation (see for the following the recent overview by Boselli 2011). Gago and Rubalcaba (2007) find that businesses which invest in ICT, particularly those which regard their investment as very important, are significantly more likely to engage in service innovation. A number of studies have provided valuable insights into the relationships among innovation and ICT linking firm level data related to innovation with information about ICT use. Abello and Prichard (2008) find for companies in Australia that different ICT technologies are associated to different types of innovations, e.g. the connection to the Internet via cable modem is significantly correlated with product innovations, while for organizational or managerial changes wireless connections are more significant.

In Europe, Van Leeuwen (2008) linked Eurostat firm-level data on ICT use and investment with firm performance and find that e-commerce and broadband use affect productivity significantly through their effect on innovation output. His approach is further developed by Polder et al. (2009). Their study finds that ICT

investment is important for all types of innovation in services, while it plays a limited role in manufacturing, being only marginally significant for organisational innovation. In contrast, the findings by Spieza (2010) support the hypothesis that ICT act an enabler of innovation, in particular for product and marketing innovation, both in manufacturing and services. However, ICT intensive firms have no higher capacity to develop innovation in-house or to introduce more innovative products, which are new to the market. Taking these results together, ICT obviously enable firms to adopt innovation, but they do not necessarily increase their 'inventive' capabilities, i.e. the capability to develop new products and processes.

Another line of literature proves the importance of ICT for organisational innovation (see the overview by Brynjolfsson and Hitt 2000). Case studies reveal that the introduction of ICT is combined with a transformation of the firm, investment in intangible assets, and of the relation with suppliers and customers. Electronic procurement, for instance, increases the control of inventories and decreases the costs of coordinating with suppliers, and ICT offers the possibility for flexible production, e.g. just-in-time inventory management or the integration of sales with production planning. The available empirical evidence at firm level shows that a combination of investment in ICT and changes in organizations and work practices facilitated by these technologies contributes to firm productivity growth, e.g. for UK companies Crespi et al. (2007) find a positive effect on firm performance of the interaction between ICT and organizational innovation.

In addition to the positive impacts of ICT on internal processes and the different types of innovation, ICT allows staff to effectively communicate and collaborate across wider geographic regions and to develop more flexible external relations, all of which involve different aspects relevant for innovative activity as proposed under the paradigm of Open Innovation (Chesbrough 2003). By

enabling closer communication and collaboration, ICT assists businesses to be more responsive to innovation opportunities and provides significant efficiency gains. For example, having ICTs such as broadband Internet, web presence and automated system linkages, assists businesses to keep up with customer trends, monitor competitor's actions and get rapid user feedback, thereby assisting them to exploit opportunities for all types of innovations.

Finally, Arduini et al. (2010) investigate the influence of ICT adoption for the provision of innovative services within e-government. They find that the range and quality of e-government services supplied by local public administrations tend to increase with their stock of ICT competencies and with their ability to organise efficient interfaces with end-users. Furthermore, the range and quality of e-government services offered correlates with the broadband infrastructure development in the area where public administration is located. More specific, Pons et al. (2010) investigate factors facilitating ICT innovation in schools in a comparative regional analysis. Their results indicate that the conditions that favour the innovative use of ICT in schools are mainly the positive attitude of the teaching groups, the management and the education community in general, the availability of space and resources to develop innovative projects, and the awareness and commitment of managers to incorporate ICT in the schools. The statistically significant differences found between the regions studied confirm the need for comparative studies of ICT policies in different geographical contexts.

Besides enabling networks among businesses, suppliers, customers, competitors and collaborative partners, in recent years, the idea has emerged that the diffusion of ICT, particularly Internet, has significantly reduced the geographic barriers to knowledge flows and innovation networks (Friedman, 2005). In the words of Friedman's bestseller, "the word is flat": information

travels around the globe at rapid speed so that ideas generated in one location spread all over the world through the Internet, conferences, telephone and other communication devices at an extraordinary rate, and geography plays little role. The diffusion and adoption of ICT, therefore, would have increased the opportunities to innovate for all countries, regions and firms.

There are, however, several counter-arguments that suggest that "the world is spiky" (Florida, 2005) and geographical proximity continues to have a strong influence over knowledge flows and innovation networks.

First, some recent studies have shown that the propensity to cite prior art and scientific knowledge is still correlated significantly with spatial proximity of inventors (Guellec and Thoma, 2008; Usai 2008; Criscuolo and Verspagen, 2008). Second, there is little evidence that distance has become any less important for trade flows (Disdier and Head, 2008; Leamer, 2007), and even that its importance may have actually increased (Evans and Harrigan, 2005). The deployment of these ICT networks can go with a reinforced need to face to face contact and there seem to be a certain form of complementarity between new means of communication and face to face contact (Gaspar and Gleaser, 1998). Distance still matters if face-to-face interactions are important, because parts of knowledge are still tacit and hard to codify and trust is a crucial requirement (Learmer and Storper 2001). Consequently, no evidence is found, that ICT use increases the capability of a firm to cooperate with other firms or institutions (Spieza 2010).

The discussion of the channels of knowledge flows cannot be dissociated from the analysis of the conditions underlying the ability of firms to benefits from these flows. Absorption capacities based on internal resources, human capital, diversity of competencies and extent of the technological gap between transmitters and receivers of knowledge may all play a role in describing

observed differences in knowledge diffusion efficiency (Autant-Bernard and Massard, 2009).

The Research Questions

Based on the existing body of scientific literature on the role of ICT for innovation and the relevance of distance for collaborative innovation plus the various necessary conditions to exploit the functionalities of the Internet, we are able to identify a series of research questions combining these two interrelated, but not yet well integrated research themes.

Although, recently various studies have investigated the influence of ICT on different types of innovations, it remains with a few exceptions rather opaque, what specific functionalities of the Internet are beneficial for the various types of innovation. For example, it is more relevant to access large amounts of data from various sources or to communicate easily with single or many individuals. Therefore, the first challenge is **to interconnect the different major characteristics of the Internet with the various dimensions of innovation**, which allows us to answer much more precisely the question of the impact of the Internet on innovation.

Closely related to this specification of the functionalities of the Internet is the general **question of causalities**. Despite several attempts to control for the endogeneity problem, that innovative companies are more likely to adopt ICT including new opportunities of the Internet, the causality question still is not definitively answered. Especially, whether **the timing of ICT adoption has an influence on successful innovation** has not yet been addressed. Furthermore, the role of the Internet as enabler of complex sets of innovation combining all different types of innovation has not yet been investigated.

In addition, to the interrelationship between the various functionalities of the Internet and the different types of innovation, the role of the **Internet for the further development of the Open Innovation** paradigm is a further challenge for further research. At first, the question is which influence the Internet has on the **selection of cooperation partners** for the development of various types of innovation. Obviously, the range of possible partners has increased, because identification, i.e. screening, has become much easier by the Internet. Consequently, the **signaling activities** have also been adapted by those interested or depending on cooperation, e.g. research organizations and universities. Furthermore, the signaling and profiling has been extended from the institutional to the individual level, e.g. via Facebook. The first question is not whether, **but into which direction the Internet has pushed the competition between research organizations and research**, but also other players involved in innovation processes, i.e. more specialized than broad profiles or more quantity than quality. The second question is whether the process in identifying and selecting potential partners for collaborative innovation has become more efficient.

Closely related to the partner selection is the issue of distance. Despite the reduction of the relevance of distance for the collaboration in innovation, some restrictions are still to be observed and need to be investigated. On the one hand, **worldwide collaboration is still experiencing some restrictions, if synchronous real time cooperation is required, whereas asynchronous access on common databases poses no problem**. On the other hand, geographic distance is positively interacting with other types of distances. The first challenge is to investigate which specific **functionalities of the Internet reduce the relevance of geographical distance for specific forms of collaboration in innovation processes**. Secondly, significant progress in science, technology and innovation can often only be achieved, especially if rather 'distant' partners, e.g. from very

different disciplines collaborate. Consequently, the question is **which moderating, i.e. distance removing, impact the Internet has for the different types of distances**, e. g. does the Internet facilitate and increase the productivity of research and innovation collaborations between partners of different disciplinary, institutional or organizational background?

In addition to the collaboration on the research and technology side, open innovation also covers the integration of the demand side, i.e. private, commercial, but also public customers. The Internet especially was the enabler for the development of open source software, but provides meanwhile also the platform for crowdsourcing. Whereas the phenomena of the development of open source software has be extensively analysed, research on crowdsourcing is still at its very beginning. Furthermore, the regional dimension has not been explicitly addressed in the analysis of open source software and not at all in the still emerging field of crowdsourcing. A first challenge is to take explicitly into account the **regional dimension in the investigation of the development of open source and crowdsourcing**. The research question is whether at all and which role does the geographic distance play for these Internet-based mechanisms of user and consumer involvement in innovation processes. Secondly, crowdsourcing is also considered by public organizations to improve the quality and the range of public services, but also the level of citizens' participation. Since public services are mainly provided by local or regional administrations, the regional dimension is crucial. This is also the case for public procurement and private-public-partnerships as instruments for government to become more innovative. Here, the Internet is meanwhile used e.g. as platform for public e-procurement. The challenge is to access and collect the relevant data and information in order to answer the research questions related to the **success factors of such approaches and their implications for the productivity, quality and innovativeness of**

public services, but. The question is again whether the regional dimension still plays a role or has lost its relevance.

Finally, new ideas are becoming only innovations after successful diffusion at the market. The Internet has a crucial role for the diffusion of digitalized products, like software, games or movies. Despite some existing studies the regional dimension has not been considered, i.e. whether the region plays still a role in the adoption and use of digitalized products. The research question is **whether and what role the regional dimension plays for the success or failure of different types of digitalized products distributed via different channels of the Internet**.

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