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Master Thesis

- Knowledge-Intensive Business Services as knowledge and innovation agents through client cooperation and labor mobility -

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Abstract

Using unique databases from Norway, this thesis investigates the role of KIBS in innovation through two distinct mechanisms of knowledge transmission, namely client cooperation and mobility of KIBS employees, as well as importance of technological proximity and geography in these processes. The analysis reveals that 1) cooperation with KIBS seems to be of higher importance for innovation than acquisition of KIBS employees; 2) related knowledge appear to contribute more to innovation than similar knowledge; 3) labor mobility is strictly bounded in space, while cooperation relations are evenly distributed geographically; 4) location of KIBS as cooperation partners does not matter for innovation in client firms; however KIBS firms gain more from their local KIBS counterparts.

Our findings extend the existent literature on the mechanisms of tacit knowledge transmission in general, on specific roles of KIBS in innovation processes, as well as on conditions that impact the success of knowledge transfer. Our results suggest a number of managerial and policy implications.

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Content

List of tables and figures

1. Introduction

The economy today is increasingly denoted as a knowledge-based economy (KBE), commonly understood as the economy "directly based on the production, distribution and use of knowledge and information"(OECD 1996, 7). As reported by OECD (1996, 18), the national economies "continue to evidence a shift from industrial to post-industrial knowledge-based economies…and…are more strongly dependent on the production, distribution and use of knowledge than ever before". Not surprisingly, "preparing the transition to a competitive, dynamic and knowledge-based economy" is stated as a priority for governmental policy in many developed countries (EuropeanCouncil 2000).

The KBE is not yet well understood, however several distinguishing features of it can be identified (OECD 1996):

First, knowledge is at the core of the KBE and is now promoted from being an external factor in production functions to a driver of productivity and economic growth. The non-depletable nature of knowledge makes the new economy not of scarcity, but of abundance, and creates potential for sustainable long-term economic growth.

Second, innovation as application of knowledge has now become a key performance indicator and a critical success factor at both the firm level and in the economy in general. Knowledge, learning and innovation determine sustainable competitive advantage for firms (Nonaka, Toyama, and Konno 2000) and are drivers of competitiveness for nations. Understanding of innovation has changed in the KBE: OECD (1996, 4) defines innovation as the "introduction of a new or significantly improved product (good or service), process, or method". Innovation also "entails investment aimed at producing new knowledge and using it in various applications" (OECD 2009, 4). Innovation has become a much broader concept with process, marketing, and organizational types of innovation added to the classic product innovation. Moreover, the innovation model is changed from the traditional linear one to the interactive model according to which "innovation requires considerable communication and exchange of both codified and tacit knowledge among different actors – firms, laboratories, academic institutions and consumers – as well as feedback between science, engineering, product development, manufacturing and marketing" (OECD 1996, 14).

Third, a new view on innovation emphasizes the importance of cooperation, interaction and networks between firms and organizations necessary for knowledge generation and knowledge diffusion. Innovation is now seen as a "result of ongoing collaboration and interaction between different economic actors" (Andersson and Karlsson 2004, 283). It is acknowledged that firms are no longer able to generate all the necessary knowledge for innovation internally, and therefore need to access the relevant stocks of knowledge externally (Aslesen, Isaksen, and Stambol 2008). In addition, external relationships also provide advantages of shared costs and risks associated with innovation, access to new research results and key technological advancements (Simonen 2007).

Another feature of the KBE is the increased demand for skilled workers on the labor market. Labor mobility is recognized as an important way of knowledge diffusion due to the fact that the most valuable knowledge is often tacit by nature and embodied in human beings, and thus can only be acquired as employees change their jobs (e.g. Breschi and Lissoni 2009; Song, Almeida, and Wu 2003).

Finally, the last feature to be mentioned and an absolutely crucial element of the KBE is Knowledge Intensive Business Services (KIBS), hereafter only referred to as KIBS. KIBS are generally defined as private service companies providing primary or intermediate knowledge-intensive input to other companies or public organizations (Miles 2005) and "involve economic activities which are intended to result in the creation, accumulation or dissemination of knowledge" (Miles et al. 1995, 18). The KIBS sector accompanies and signals the development of the knowledge-based economy and is now one of the most dynamic and strategically important sectors in the economy (Aslesen, Isaksen, and Stambol 2008). KIBS are believed to have a strategic role in stimulating innovation processes and facilitating the diffusion of knowledge in other firms and industries (Aslesen, Isaksen, and Stambol 2008). The emergence and growth of the KIBS sector is explained by a growing need for their services from firms in other industries. Due to increased competition most firms focus on their core competences, therefore rarely possess all knowledge necessary for innovation, and are looking for KIBS as external sources of information, advice and specialized knowledge (Aslesen, Isaksen, and Stambol 2008). Furthermore, by being integrated in their clients' innovation and production processes and influencing clients' performance KIBS have indirect impacts on the whole economy (Kox and Rubalcaba 2007).

Due to the fact that the knowledge-based economy is becoming a reality, the interest in its components and interplay between them is increasing among scholars and practitioners. In addition, the topic attracts attention due to its relative newness and therefore limited theoretical understanding and empirical evidence, as well as an array of unresolved research issues, questions and knowledge gaps that need to be investigated. Our thesis follows the tradition.

Due to particular importance of innovation, drivers of innovation, which are vaguely understood in KBE, have become the central theme in the literature. It is now a common fact that knowledge, and particularly tacit knowledge, is the key input to innovation (e.g.Gertler 2003; Simonen 2007). A significant interest in the recent literature has been dedicated to the mechanisms of how tacit knowledge can be sourced externally (e.g. Molina-Morales and Martínez-Fernández 2010). It is generally acknowledged that tacit knowledge transfer is mediated by face-to-face contact and therefore several channels satisfying the criteria exists with two major candidates in relation to KIBS: inter-firm cooperation and labor mobility (Simonen 2007; Zellner and Fornahl 2002; Tomlinson and Miles 1999). While it is recognized that these channels are qualitatively different, very little is known on their individual roles in innovation. In fact, according to Simonen (2007) it has rarely been attempted to separate the importance for innovation of these two distinct knowledge transfer mechanisms. Furthermore, there are reasons to believe that cooperation with clients and labor mobility can be particularly important channels of KIBS influence on innovation due to special features of the sector, such as its knowledge-intensive nature and the interactive modes of service delivery to clients (Aslesen, Isaksen, and Stambol 2008). However, to our knowledge no quantitative studies exist on the relative importance of these two mechanisms in the context of KIBS. This certainly points to a knowledge gap in the literature and therefore an exciting and promising area for investigation. Therefore, the key research question driving our study is:

To what extent do KIBS influence innovation in other firms through (1) cooperation with clients and through (2) labor mobility of KIBS employees as mechanisms of knowledge transmission?

Furthermore, as mentioned, the role of inter-firm cooperation and labor mobility in innovation is understudied in general, and in particular little is known about the conditions under which each of these mechanisms is more likely to result in

successful knowledge transfer (Song, Almeida, and Wu 2003). Two such conditions have recently gained attention among scholars, namely **the role of technological and geographical proximity in innovation** (Knoben and Oerlemans 2006; Eriksson 2009). It has reasonably been pointed out that acquired knowledge does not add value to recipient firm per se, because there are obstacles to knowledge appropriation and integration. One of the questions raised is whether related, similar or unrelated knowledge adds the most value to innovation performance (Eriksson 2009). Second, even though the relationship between geography and innovation is not a novel idea, the literature has been dominated by ideas of economic geographers on the advantages of agglomeration. Only recently scholars started investigating the relative importance of local and distant knowledge flows. However, very few studies looked at cooperation from a geographical angle and hardly any attempted to geographically disaggregate labor flows. This discussion points to yet another knowledge gap within the topic of our research interest and motivated us to investigate the impact of technological and geographical proximity on success of knowledge transfer and innovation through both the cooperation and the labor mobility channels.

To sum up, in our study we pursue several research objectives, which we believe will help us shed some light on a number of novel and under researched topics in the literature. The primary objective of this paper is to explicitly identify, isolate, measure and compare the roles of the two distinct mechanisms of the impact of KIBS on innovation in other firms, namely KIBS-client cooperation and mobility of KIBS employees. A second objective is to establish the importance of technological proximity for success of knowledge transfer by investigating whether KIBS have higher impact on innovation in firms from other industries than on other firms in the KIBS sector. Third, we aim to investigate the importance of geographical proximity on knowledge flows by looking at geographical patterns of KIBS-client cooperation and mobility of KIBS employees. Finally, we set a goal to explore the importance of geographic distance by comparing the relative importance of knowledge flows from KIBS located in the same region or outside the region in relation to a recipient firm.

However, there are reasons why it has rarely been attempted to separate the roles played by inter-firm cooperation and labor mobility in innovation as well as to investigate the roles relatedness and geography. The main reasons are first, the

difficulty to measure these constructs, and second, the lack of appropriate data (Simonen and McCann 2010). Therefore, in order to be able to reach our research goals we need to move beyond the majority of previous papers and overcome methodological difficulties. First, we capture knowledge transmitted through the two channels in two ways: R&D and innovation cooperation with KIBS is used to grasp knowledge flows coming from cooperation relations in general; and gross inflows of KIBS employees captures knowledge embodied in mobile human capital. Second, we access unique and detailed databases from Norway with firm-level data on different types of innovation, cooperation relations as well as detailed patterns of labor mobility, which allow us to collect all the data needed at a required level of sectoral and geographic disaggregation necessary for our research purposes.

With our thesis we aim to contribute both theoretically and empirically to the existent literature on the different knowledge transmission mechanisms and their role in innovation as well as specific role of KIBS in these complex processes through client cooperation and mobility of employees. We also hope to contribute with solid arguments to the nascent discussion on the role of relatedness and geography in innovation. We anticipate that our findings will bear interesting practical implications for managers and policy makers.

We believe that our research is relevant for several reasons. First, the fact that KBE is becoming a present and future reality and that complex innovation processes in KBE are not yet well understood signifies that our research topic is very up-to-date. Second, the growing importance of the KIBS sector in the modern economy leads to the necessity of better understanding the sector and its role. In addition, some authors indicate that studying the KIBS sector can provide a snapshot of a future state of the KBE and a better insight into knowledge development processes (Løwendahl, Revang, and Fosstenløkken 2001; Aslesen et al. 2004). Third, following Simonen (2007) we claim that hardly any studies have been able to simultaneously relate data on both inter-firm cooperation and labor mobility to different types of innovation in a manner as detailed and comprehensive as this thesis.

The rest of the paper is structured in the following way. In the next chapter we provide a comprehensive overview of the literature on the roles of inter-firm cooperation and labor mobility in knowledge diffusion and innovation in general,

argue for specifics of these processes with KIBS involved, discuss the importance of technological and geographical proximity in knowledge transfer, and end with a research model that summarizes our research ideas. In chapter three we elaborate on the methodology adopted and discuss the data employed. Chapter four reports the empirical results obtained and is followed by chapter five, which provides a thorough discussion of the results and places them in relation to existent findings. In the three subsequent chapters we list a number of theoretical contributions and practical implication that follow from our findings; acknowledge possible limitations of our research; and suggest promising areas for future research. The last section concludes the thesis.

2. Literature review and hypotheses

This section introduces the literature relevant to the topic of the thesis with the purpose to cover what is known and what is not known, and as a result locate a knowledge gap. Placing our research in existing literature helps us develop theoretical propositions and a theoretical model that guides the study. The importance of external knowledge to innovation is explained, theory on cooperation and labor mobility in general is investigated before we specifically look into the research on cooperation with KIBS and labor mobility from KIBS. Literature on the role of technological and geographical proximity in innovation is then reviewed. We end this chapter with a research model that summarizes our research ideas.

2.1 External knowledge as an important input in innovation processes

Recognizing innovation as "the application of knowledge to produce new knowledge" (Drucker 1993, 173) quoted in (Jiang and Li 2009, 359), it seems clear that the most important resource for innovation is knowledge. Furthermore, in KBE "innovations are the results of knowledge accumulation within firms, but also of information exchange between different actors of the economy" (Simonen 2007, 12). Thus, knowledge can be created and accumulated internally through education, learning-by-doing and learning-by-interacting (Eriksson 2009). However, as very few firms are able to build and maintain all the knowledge necessary for innovation internally, and as external knowledge frequently is less costly, faster and easier to obtain (Liu et al. 2010) firm look outside to gain new knowledge. Externally firms look for both codified and tacit knowledge, and

while it is certainly true that both knowledge types are necessary for innovation, it has been stressed that "tacit knowledge constitutes the most important basis for innovation-based value creation" (Gertler 2003, 79). The acquisition of codified knowledge, for example in the shape of books and reports, is quite straightforward. However the acquisition of tacit knowledge is more complicated as tacit knowledge is characterized as "sticky", meaning that it does not necessarily flow easily, making it difficult to transfer and absorb, both within and across firms (Szulanski 1996). Moreover, just as scholars distinguish between codified and tacit knowledge they also distinguish between knowledge as a public and private good, and between knowledge spillovers and knowledge transfers[1] as means to gain external knowledge (Gallouj 2002, 261). As external codified knowledge can be acquired rather easily, and the fact that tacit knowledge is considered more important for innovation we focus this thesis on the main channels of external tacit knowledge acquisition.

It is widely recognized that "non-codifiable knowledge is mainly transmitted by face-to-face contacts" (Simonen 2007, 24). Therefore, different authors distinguish several tacit knowledge transfer mechanisms that satisfy the criteria. Lundmark and Power (2008, 210) suggest that tacit knowledge can be acquired by firms through "regular business contacts; new star-ups; networking between firms; multiple affiliations and joint projects" in addition to labor mobility. Moreover, Zellner and Fornahl (2002) recognize three knowledge acquisition channels: "the recruitment of people; the external informal networks of employees; and formal cooperation of the firm with other institutional agents". Simonen (2007) largely agrees with this and argues that knowledge can be transferred between firms through inter-firm cooperation and interactions as well as through labor mobility. Furthermore, Tomlinson and Miles (1999), studying knowledge workers and KIBS, investigate knowledge diffusion through two channels: labor mobility and networks of collaborators. Finally, Aslesen, Isaksen, and Stambol (2008), investigating the role of KIBS on innovation, names two knowledge flows: client interaction and labor mobility. Recognizing that there is no complete agreement on external tacit knowledge acquisition channels, we focus on the two channels that are considered especially relevant for KIBS: inter-firm cooperation and labor mobility.

[1] Authors also use knowledge flow, knowledge transmission, transmission channel, knowledge acquisition, learning et cetera interchangeably

2.2 Inter firm cooperation as a knowledge transmission mechanism

As mentioned, inter-firm cooperation is recognized as one way to access existent and create new knowledge externally.

In modern innovation theory innovation is seen as a "result of ongoing collaboration and interaction between different economic actors" (Andersson and Karlsson 2004, 283). Due to the fact that knowledge is increasingly rich and complex, as well as tacit know-how and know-who is becoming ever so important, cooperation is often the preferred way to create innovations (Vinding 2000, 2-3). It is known that in an innovation system the actors "reinforce each other by promoting processes of learning and innovation or, conversely, combine into constellations blocking such processes" (Lundvall 2010, 2). Furthermore, it is also acknowledged that "the coordination of an innovative endeavor almost always requires a network of independent organizations with different competencies" (DeBresson 1999, 1).

Recognizing knowledge as the most important resource for innovation, access to and transfer of knowledge as well as knowledge creation and joint learning are two important gains from inter-firm cooperation (e.g. Inkpen and Tsang 2005; Powell and Grodal 2005; Zhang et al. 2010). Knowledge diffusion is complex and "successful transfer is often not easy to achieve" (Easterby-Smith, Lyles, and Tsang 2008, 677). Nevertheless, it has been suggested that social interactions between organizational actors facilitate knowledge transfer (Inkpen and Tsang 2005). Moreover, inter-firm cooperation can be seen as a source of "capabilities more divergent from its existing set" (Lane and Lubatkin 1998, 462), which are argued to be important for innovation (Simonen 2007). As a result, one advantage of cooperation is the pooling and exchange of knowledge (Powell and Grodal 2005) to "overcome constraints of narrow competence formation" (Simonen 2007, 46), as well as mitigate the liability of smallness and newness (Baum, Calabrese, and Silverman 2000). Powell and Grodal (2005, 75) emphasize the recombinative aspect of innovation and state that by combining existing knowledge firms can create innovation that they would not be able to do on their own. It has also been stated that cooperation involves an intentional learning and creation of new knowledge, but unintentional learning may also occur when (tacit) knowledge spills in the face-to-face interaction between actors adding extra positive effects of cooperation (Simonen 2007).

Cooperation can also be understood from a network perspective seeing firms as "embedded within networks of interconnected relationships that provide opportunities for and constraints on behavior" (Brass et al. 2004, 795). "Networks shape knowledge transfer and learning processes by creating channels for knowledge trade and reducing the risk of learning" thus affecting what type of knowledge that can be accessed and created (Uzzi and Lancaster 2003, 383). Moreover, network members will be exposed to many different kinds of knowledge which can be of value (Inkpen and Tsang 2005). This can also enable firms to keep their options open, see new opportunities and move fast, while keeping both risk and cost low, partly because they are shared with partners (Hagedoorn and Link 2000; Simonen 2007). Uzzi and Lancaster (2003) distinguish between arms length ties and embedded ties in a network, and argue that the arms length ties leads to transfer of public knowledge and exploitative learning whereas embedded ties leads to transfer of private knowledge and explorative learning. Lane and Lubatkin (1998) support this view arguing that the transfer of complex and tacit (private) knowledge is only possible through intensive face-to-face interactive learning between firms. Similarly Zhang et al. (2010, 76) argue that firms can acquire new external knowledge for exploitation, or create new knowledge through cooperative learning for exploration. Jensen et al. (2007, 684) also supports this by arguing that knowledge known as "know-how and know-who which is tacit and often highly localized" is best achieved through interactive learning[2].

The growing importance of knowledge and knowledge transfer has led to increased interest over the last decades of the role of so called intermediaries (brokers, third parties or bridgers) in innovation processes (Howells 2006). These are firms that, by spanning multiple domains, innovate by creating new combinations from existing ideas and knowledge by transferring ideas from where they are known and plentiful to where they are not known or scarce (Hargadon and Sutton 1997; Hargadon 2002). Thus, an inter-firm relation with a broker can give access to knowledge possessed by many indirect contacts, to which the firm lacks direct access. These firms are said to be positioned as brokers in structural holes: "a gap in the flow of information between subgroups in a larger network" (Hargadon and Sutton 1997, 717) which "expand the diversity of information that

[2] The authors refer to this as the Doing, Using and Interacting (DUI) mode of learning and innovating (Jensen et al. 2007).

the firm has access to but also increase the firm's exposure to potential malfeasance" (Ahuja 2000, 448). Ahuja (2000, 451) discuss the importance of context and argues that structural holes, and thus brokerage, will be advantageous when "speedy access to diverse information is essential" but not when opportunism needs to be overcome. Finally, it has been suggested that "for the economy as a whole a specific sector may become the one that through interactive learning with a diverse set of users generalizes local knowledge and diffuses it widely in the economy" (Jensen et al. 2007, 684).

Even though cooperation is generally looked upon as beneficial for firms, at the same time scholars acknowledge several potential downsides with inter-firm cooperation, of which the main one is underinvestment in internal competencies (Simonen 2007, 49). It has further been suggested that inter-firm cooperation is not suitable for the transfer all forms of knowledge, especially the transfer of tacit embodied knowledge is put forward as costly to achieve (Zellner and Fornahl 2002, 194.) Powell and Grodal (2005, 76) support this and explain that knowledge with a large tacit component will be difficult and costly to transfer, and that knowledge with a moderate complexity might present greatest benefit from transfer.

Empirical analyses have in general found support for the role of inter-firm cooperation and its effect on knowledge acquisition and innovation. For instance, Asheim and Isaksen (1997) demonstrated that the interactive innovation model is the most accurate description for how Norwegian manufacturing firms innovate. Jiang and Li (2009, 358) studying German partnering firms found that "knowledge sharing, knowledge creation and their interaction significantly contribute to partner firms' innovative performance". Supporting this Zhang et al (2010) found that inter-firm cooperation increase knowledge acquisition which in turn leads to knowledge creation and that both knowledge acquisition and knowledge creation enhance innovative performance. Baum, Calabrese, and Silverman (2000) showed that networks have positive effect on performance, and most effect on innovative performance, of startups in the biotechnology industry in Cananda. Uzzi and Lancaster (2003) found support for their hypotheses discussed above that different types of ties in a network leads to different types of transfer and learning. Moreover, Harabi (2002) found a significant impact of vertical R&D cooperation on innovation, but that informal cooperation seems to

be more important than formal. Finally, the meta study of intra- and inter-firm cooperation by van Wijk, Jansen, and Lyles (2008, 846) confirmed that firms may improve their "innovative capacity by leveraging the skills of others through the transfer of knowledge".

2.3 KIBS' impact on innovation through inter-firm cooperation

As established above, inter-firm cooperation has positive effects on knowledge transfer and creation. KIBS are by several scholars considered special, and particularly important, cooperation partners. This can largely be understood from the way KIBS influence "knowledge bases and competencies of agents through both the specific characteristic of their composite knowledge products and the way in which these are produced" (Strambach 2008, 166).

It is not just the fact that KIBS are knowledge-intensive that makes them especially important cooperation partners, but also the complexity of their knowledge. It has been stated that KIBS "offer a quality and range of expertise that far exceed the requirements of the simple 'externalization' by clients of their established functions. They often offer strategically significant technical or organizational knowledge that client staff do not possess, or could not exploit without consultancy support (Wood 2002, 994). Furthermore, Hertog (2000, 550) explains that KIBS "promote a fusion of generic and quasi-generic knowledge, and the more tacit knowledge, located within the daily practices of the firms and sectors they serve". Strambach (2008) explains the composite nature of KIBS knowledge products as including all types of knowledge[3]; spanning different sectors or industries as well as business functions; and involving all parts of what is referred to as the knowledge value chain: exploration, examination, exploitation. Because of this KIBS "are designed to make heterogeneous knowledge bases available to their clients in an integrated way with their composite knowledge products" (Strambach 2008, 162), and by this they complement and change the knowledge bases of their clients. Even though Strambach (2008) emphasize that KIBS use all types of knowledge, tacit knowledge is considered relatively more important for most KIBS due to "the inductive way of knowledge creation through the new combination of existing

[3] Strambach (2008) distinguishes between analytic; synthetic; and symbolic knowledge types.

knowledge parts based on experiences in learning by doing, using and interacting processes aimed at solving the user's specific problems" (Strambach 2008, 158).

The extensive cooperation and interaction between KIBS and clients, as well as the interactive learning processes KIBS engage in with both their clients and other actors in the innovation system, is often stressed in the KIBS literature (e.g.Hertog 2000; Gallouj 2002; Muller and Zenker 2001). "Client participation in the delivery process of the knowledge-intensive service product is a fundamental characteristic for KIBS and is very different from the production process in other industries" (Strambach 2008, 164). The services provided cannot be delivered without close cooperation between KIBS and client and this results in a dual process where innovation and learning take place in both the KIBS and in the client firm (Hertog 2000, 505-506). Interestingly, new knowledge and innovation can be created both intentionally as a purpose of service delivery and unintentionally as a "side effect" of service provision (Toivonen 2004, 95).

Strambach (2008) explains the roles of KIBS in terms of three processes that KIBS are involved in: In *contextualization* KIBS transfer, exchange, integrate and adapt knowledge to their clients' needs. In *de-contextualization* KIBS deliberately produce new knowledge from accumulated and experience- and procedural-based codified and tacit knowledge gained in client-specific context. This process will involve codification. However, in *re-contextualization* KIBS directly contextualize individual or collective tacit knowledge without it first being codified. It is argued that for projects-based firms, such as KIBS, codification is expensive, and new learning happens mainly in the interaction with clients in complex contexts. Therefore it is more attractive for KIBS to use and reinforce their tacit knowledge base, and use it directly in new projects leading to more learning, than investing in knowledge codification.

Hertog (2000) distinguishes three roles of KIBS in the co-production of knowledge and innovation in the interaction with clients based on the criterion of where the knowledge or innovation comes from. KIBS are seen as *facilitators* if the innovation comes from the client, and KIBS only support clients in their knowledge creation processes; *carriers* if the knowledge or innovation is transferred from third-party firms to the client; and *sources* of innovation if the innovation is initiated by KIBS. It is important to note that in all these roles the

knowledge or innovation is co-produced in close cooperation between KIBS and client.

Additional interesting frameworks addressing the KIBS-client interaction are *The hypothesis of a virtuous circle* by Muller and Zenker (2001); *Learning Through Client Interaction* by Fosstenløkken Løwendahl, and Revang (2003), and *The KIBS transaction as a form of knowledge processing* by Gallouj (2002). These frameworks all emphasize the highly interactive nature of KIBS, the importance of the participation of clients in this interaction, and the resulting learning in both KIBS and clients.

An additional particularity about the way KIBS produce knowledge is that they function as intermediaries or brokers through the multiple connections to other industries. It has been argued that "the dominant feature of the KIBS sector is its dynamic interconnections with other sectoral contexts" (Strambach 2008, 167), and that "one of the characteristics of KIBS is that their activities frequently cross the 'normal' borders between different industrial sectors" (Aslesen and Isaksen 2007, 327). As a result, "while 'shuttling' between different clients, KIBS also carry new ideas and best practices from one firm to another" (Smedlund and Toivonen 2007).

It was explained above that a specific sector may become the one that through its brokering function generalizes local knowledge and diffuse it to their partners and consequently to the wider economy. It has also been suggested by several authors that KIBS can develop into this sector (e.g. Jensen et al. 2007, 684). It has been argued that KIBS through their many and different types of contacts with stakeholders in the innovation system, such as partners, public institutions, and clients, KIBS form important nodes in the system (Toivonen 2004, 103; Hertog 2000, 519-521). "KIBS have come to play a central role in transferring and, in many cases, creating and combining, knowledge resources in innovation systems" (Hertog 2000, 518). Hertog (2000) has also argued that the KIBS sector is gradually developing into a 'second knowledge infrastructure' partly taking over and complementing the public knowledge infrastructure (research and education institutions). It has also been theorized that KIBS can act as orchestrators of innovation and even whole innovation system (Miles 2001, cited in; Toivonen 2004).

From the discussion above we can conclude that cooperation with KIBS appear to be more interactive and more intense than cooperation with other firms. As argued by several authors (e.g. Inkpen and Tsang 2005; Lane and Lubatkin 1998) the transfer of knowledge, and particularly tacit knowledge, is facilitated by intense face-to-face interaction. This intense interaction is also an important means not only to help clients adopt KIBS original tacit knowledge, but also to produce new tacit knowledge (Toivonen 2004). In addition, KIBS multiple contacts with actors in different industries make KIBS function as particularly important brokers. Thus, this suggests that cooperation with KIBS potentially promote more transfer and creation of (tacit) knowledge than cooperation with other firms.

Empirical evidence on KIBS has revealed that their innovativeness is strongly associated with intense cooperation as well as qualified employees (Muller and Doloreux 2009). For instance Nählinder (2005), confirms, from a survey to Swedish KIBS, that KIBS indeed work in close cooperation with their clients and that they have frequent contact. Moreover, Hipp (1999, 88) found evidence suggesting that KIBS "are able to make existing knowledge useful for their customers, improving the customer's performance and productivity and contributing to technological and structural change". Supporting this, Tomlinson and Miles (1999, 162) found that "collaborations with KIBS…have significant impact on the radical innovative performance of UK firms". In addition, Muller and Zenker (2001) also support this as they found supporting evidence for their theory about the virtuous circle. As interacting small manufacturing firms were more innovative than non-interacting competitors and that KIBS are not just contributing to innovation in their clients but are also innovative in their own right.

On the other hand, several authors point out that the theoretically claimed importance of KIBS for innovation often does not show up in empirical studies, and therefore may be overestimated. For instance, Aslesen, Isaksen, and Stambol (2008) refer to the findings of Cooke et al. (2000) and Isaksen (2000), who demonstrated that consulting companies are found to be less important sources of information and partners in innovation processes than other actors along the value chain, especially clients and customers. These results also correspond to the observations by Simonen (2007) looking into the importance of particular types of cooperation for innovation who found that cooperation with consultants were not

significantly related to innovation behavior. In their own study of importance of KIBS cooperation on Norwegian firms, Aslesen, Isaksen, and Stambol (2008) found from a survey that most firms assign rather low importance to consultants as information source and innovation agent. The authors concluded that KIBS do not usually drive innovation processes at clients, but play a supporting role in innovation by offering complementary knowledge, manage innovation processes and provide advice on direction and types of innovation.

Hence, with some important exceptions, we find that empirical evidence appear to support the role of KIBS cooperation in knowledge transfer and creation, and consequently innovation. Thus, on the background of theoretical reasoning and empirical evidence we expect:

Hypothesis 1: Cooperation with KIBS is positively related to the client firm's ability to generate innovations.

2.4 Labor mobility as a knowledge transmission mechanism

The mobility of labor is recognized as a channel of knowledge diffusion between firms, and therefore a determinant of innovation. According to Simonen (2007, 54) it is "generally agreed upon that geographical mobility of labour contributes substantially to innovation".

Labor mobility is usually understood as the movement of people across organizational boundaries. However, this definition is somewhat narrow. A broader term includes "migration from one local labour market to another; movement between firms or workplaces in the same area; changing from one position to another within the same organization" (Lundmark and Power 2008, 208). According to some authors (Dahl 2002; Franco and Filson 2006) start-ups should also be considered as a special case of mobility of personnel.

It can be argued that individual workers and their knowledge are crucial for innovation activity of firms in many ways.

First of all, learning-by-hiring, or "the acquisition of knowledge through the hiring of experts from other firms", is one way of complementing internal knowledge with external capabilities (Song, Almeida, and Wu 2003, 351). Hiring employees from competitors is also a strategic move as it enables firms to access knowledge developed by other firms without their approval (Teece 1982; Winter 1987) cited in (Song, Almeida, and Wu 2003).

Second, the nature of knowledge and knowledge generation processes explains why labor mobility is an effective way to facilitate and increase knowledge transfer. The logic behind the positive effects of labor mobility on knowledge transfer is that tacit knowledge is embedded in individual employees and follows them as they change jobs. "A growing knowledge-intensive production brings about a situation where departing workers cannot leave everything behind, because they carry vital information and experiences to their next workplace" (Eriksson and Lindgren 2009, 4-5). Furthermore, it is not only tacit knowledge alone that is transferred together with employees, even though it is clearly the most vital component of the innovation process. Individuals are also carriers of codified knowledge, and according to Gertler (2003) the balance of tacit and explicit knowledge brought by employees should not be underestimated. In fact (Zellner and Fornahl 2002) claims that recruiting is the only way to source all possible types of person-embodied knowledge compared to alternative channels that lead to less than perfect knowledge transmission. Consequently, "human mobility enables firms to overcome barriers in knowledge transfer and facilitate knowledge diffusion" (Liu et al. 2010, 343).

Third, in addition to knowledge transfer labor mobility is also one of the mechanisms through which knowledge spillovers or knowledge externalities can take place (Feldman and Avnimelech 2011, 155). The link between labor mobility and knowledge spillovers dates back to Arrow (1962, 615), who wrote that "no amount of legal protection can make a thoroughly appropriable commodity of something as intangible as information" and added that "mobility of personnel among firms provides a way of spreading information" . Breschi and Lissoni (2001, 991) add that spreading knowledge differs from merely transferring it from one place to another, and occurs when workers create "a common pool of knowledge from which all their previous employers are capable of drawing". A common understanding of spillover was also established by Geroski (1995): "spillovers occur when a researcher paid by one firm to generate new knowledge transfers to another firm without compensating the former employer for the full inventory of ideas that travel with him/her". Knowledge spillovers are thus impossible to control, often unintentional and obviously undesirable for firms they originate from (Breschi and Lissoni 2001). However, some scholars studying knowledge externalities on labor market found that spillovers are partially

internalized, which means that firms are partly compensated for knowledge leakages (Moen 2000).

There are also other positive effects associated with labor mobility in addition to knowledge transfer and knowledge spillover. Labor mobility leads not only to transfer or spillover of knowledge, but also contributes to new combinations and interpretations of knowledge through application of previously acquired knowledge in a new context (Rosenkopf and Almeida 2003). The mobility of employees does not simply provide a one-time transfer of information, but may also facilitate the transfer of capabilities, permitting further knowledge building (Kim 1997) cited in (Song, Almeida, and Wu 2003). In addition to knowledge new employees bring with them social contacts and networks, which as indicated by some studies, are often as important for innovation as the technical knowledge itself (Breschi and Malerba 2001; Molina-Morales and Martínez-Fernández 2010). Labor mobility is also important for companies' supplies of and access to skilled and specialized labor and it ensures the ability for adjustments to new technologies and new demands (Lundmark and Power 2008). Labor mobility also facilitates the process of structural transformation and adjustment in the economy, for example from declining to expanding sectors and firms. This is "basically a matching process where resources and competences are continuously reorganized" which is considered increasingly important as labor markets are becoming more segmented as part of the transformation into knowledge-based economies (Lundmark and Power 2008, 209).

However, it has been argued, and found empirically, that labor mobility can also result in negative rather than positive outcomes (e.g. Lundmark and Power 2008; Boschma, Eriksson, and Lindgren 2009). Tomlinson and Miles (1999) found several downsides of external mobility compared to internal movement of personnel. More specifically, the scholars empirically demonstrated that employees learn more when moving internally within a firm rather than externally between firms, and thus, external labor mobility can hinder individual learning. In addition, frequent mobility is argued to significantly reduce commitment to work. Power and Lundmark (2008) summarize the possible downsides of excessive labor mobility: it may bring extra expenditures and risks for younger firms, which find it more difficult to attract and retain highly skilled labor; create disincentives for investment in training and skills upgrading; strengthen competition for

workers and undermine inter-firm trust; drain valuable workers from less competitive firms thus further weaken them. Labor mobility also entails the risks of spreading vital information to competitors. In fact, labor mobility can be a threat to innovation activity of firms, as they might find it difficult to appropriate returns from R&D investments (Simonen 2007). Furthermore, even though labor mobility brings advantages for individuals, such as widened career opportunities, new learning horizons, typically increased income, it also carries economic, familial and social costs to name a few (Lundmark and Power 2008).

Thus, there seem to be an argument that excessive labor mobility has negative impacts on firms and the economy, but that "some degree of labor market flexibility is desirable" (Tomlinson and Miles 1999). The bottom line is that labor mobility is often a trade-off between so called labor pooling (getting the benefits of bringing new skills, competencies and contacts into the firm) and labor poaching (paying the price of losing skilled employees or even competitive advantages, necessity to pay higher wages to attract and retain employees) (Combes and Duranton 2001).

When it comes to empirical evidence of the topic, there exist several studies that support the positive role played by the mobility of local human capital in knowledge diffusion and promoting innovation. Song, Almeida, and Wu (2003) proved that learning-by-hiring is a mechanism for the acquisition of externally developed knowledge. Franco and Filsson (2006) proved that spin-outs are certainly a way of transmitting knowledge between firms. Maliranta, Mohnen, and Rouvinen (2009, 1181), confirmed that "inter-firm labor mobility is indeed found to be a channel of knowledge spillovers". The majority of studies emphasize the importance of skilled labor in innovation. "The contents and the quality of the knowledge base (of a firm) is directly dependent on people constituting it" (Zellner and Fornahl 2002, 192). For instance, Zucker, Darby and Brewer (1998) introduced the concept of star scientists as carriers of intellectual capital as opposed to ordinary human capital. They claim that it is only intellectual capital that can contribute to firm performance and earn monopoly rent. Other experts in the area, such as Dahl (2002), Rosenkopf and Almeida (2003), Angel (1991), Breschi and Lissoni (2005) Power and Lundmark (2004), Eriksson (2009) to name a few, also empirically supported the idea that inter-firm mobility of employees facilitates inter-firm knowledge flows and have positive effects on innovation.

However, there are also studies that did not reveal any positive relationship between labor mobility and innovation. For instance, similar studies by Simonen and McCann (2007, 2008, 2010) and Felsenstein (2010) provided consistent results that labor inflows do not result in significant performance benefits for recipient firms.

Overall, despite increasing recent attention to the role of labor mobility in innovation, there still exists a lot of blind spots and controversy in both theoretical and empirical findings on the topic, which indicates the necessity to explore it further.

2.5 KIBS' impact on innovation through labor mobility

Noticing that labor mobility patterns in KIBS sector differ from the rest of the economy, scholars have implied that studying labor mobility patterns in KIBS may have additional value to researchers and practitioners due to the fact that the fast growing KIBS sector may provide a snapshot of the future labor mobility structures in the society of knowledge-based economy (Stambøl 2005).

As discussed above, labor mobility in an alternative mechanism of knowledge diffusion between firms and, therefore, a driver of innovation. It is also important to remember that through mobility of their employees KIBS can indirectly contribute with knowledge to firms that are not necessarily their clients. There are reasons and evidence to believe that KIBS employees might have a special role in the economy due to the inherent characteristics of KIBS firms as well as labor mobility patterns in this sector different from the rest of the economy.

First, firms in the KIBS sector are known to rely on their knowledge base and consequently on highly specialized and professional employees that constitute it (Tomlinson and Miles 1999). Bryson, Daniels, and Warf (2004, 87) pointed out that "the core competence of professional service firms is the expertise, experience and reputation of their staff, the asset base is knowledge and the competitive advantage is reputation". In addition, KIBS staff often gains expertise across industries and organizational areas. Consequently, "KIBS employees are assumed to have an important role as knowledge diffusers in the economy due to the fact that the sector is characterized by modern education, intra and interregional as well as international networking, dynamism and flexibility" (Stambøl 2005, 15). Importance of the quality of the labor force for KIBS is emphasized by the fact that KIBS firms compete on the basis of their ability to

recruit and retain highly skilled workers (Audretsch and Keilbach 2005). Thus, Mamede (2006, 4) empirically showed on a sample of KIBS firms that "increasing or decreasing the percentage of highly educated employees in the workforce has a significant and durable impact on the employing firm's performance" and survival. Similar observation was made by Tomlinson and Miles (1999, 161): "departure of personnel was thought to be a major source of threat of losing competitive knowledge" for KIBS firms. As mentioned above, previous research has showed that it is the mobility of highly skilled employees and "stars" that brings the highest returns to the recipient firm (Zucker, Darby, and Brewer 1998; Zellner and Fornahl 2002; Breschi and Malerba 2001) and that the most skilled employees are usually the most geographically mobile (Faggian and McCann 2009), which points out to the particular value of KIBS employees in the process of knowledge diffusion between firms and industries.

Second, according to recent findings labor mobility to/from KIBS sector is much higher than in any other industry (Stambøl 2005). Among others Stambøl (2005) confirmed that this pattern has been observed on Norwegian labor market over time. This result is theoretically expected due to the nature of the consultancy work, which involves a high degree of client-firm interactions. KIBS employees have a close network with their clients in an industry as well as the comprehensive knowledge about client's activities, which increases the potential job-to-job mobility between the KIBS-sectors and other sectors of the economy, and thus generate a flow of knowledge between these sectors. In addition, Aslesen, Isaksen, and Stambol (2008) in their extensive study of labor mobility patterns in Norway in general and in the KIBS sector in particular, found a net brain-drain from KIBS sector to several other sectors in the economy, i.e. the outflow of better educated employees and the inflow of less educated ones, which was interpreted as an indication of a knowledge contribution of the KIBS sector to other.

Therefore, theoretical reasoning and empirical evidence about the role of labor mobility on innovation in general and particular importance of KIBS employees leads us to expect the following:

Hypothesis 2: The gross inflow of KIBS employees is positively related to the recipient firm's ability to generate innovations.

2.6 Discussion and comparison of inter-firm cooperation and labor mobility

Above we have elaborated on the importance of innovation in today's high paced and competitive world, and explained how knowledge is crucial to innovation in the knowledge-based economy. We further emphasized that tacit knowledge, rather than codified, is especially vital for innovation, claimed that tacit knowledge diffusion is mediated by face-to-face interaction, and distinguished several channels through which tacit knowledge can be transferred between firms. We stated our decision to focus on two mechanisms, namely inter-firm cooperation and labor mobility. We further discussed KIBS, and elaborated on their special role in the knowledge-based economy as knowledge and innovation agents through client cooperation and labor mobility. We now clarify the purpose and goals of our research.

Our primary goal is to separate the importance of two distinct knowledge transfer mechanisms, inter-firm cooperation and labor mobility, through which KIBS can influence innovation in other firms through. An enquiry about the differentiation and relative importance of these mechanisms on innovation has only recently appeared in the literature. According to Simonen (2007, 139) "no previous studies have been able to identify and distinguish between these two knowledge transfer effects". And as far as we know, such studies are non-existent in the context of KIBS. This indicates a knowledge gap in the literature and certainly places us in a position to be one of the first to contribute to its coverage.

As Simonen and McCann (2008, 2010) point out it has been acknowledged in the literature before that inter-firm interaction and human capital mobility mechanisms are qualitatively different. While inter-firm cooperation and interaction involve frequent short-term transactions of relatively small portion of the total knowledge and information possessed by parties involved in a transaction; inter-firm mobility involves less frequent transactions in which the whole knowledge capital of the individual is transferred for a significant period to a recipient entity. Moreover, according to some, these mechanisms also imply different relationship between geography and innovation, which will be discussed below. For these reasons Simonen (2007) emphasized the importance to treat these mechanisms differently and study their effect on innovation separately. The fact that this has rarely been attempted to do before may in part be explained by Krugman's (1991, 51) warning that it is very difficult to empirically investigate

knowledge spillovers due to the fact that "knowledge flows are invisible, they leave no paper trail by which they may be measured and tracked." Another reason is the lack of appropriate data especially on labor mobility flows. While the former problem has been tackled with the use of various proxies, the latter has been resolved only recently with the availability of extensive labor databases in Scandinavia[4] allowing to track labor flows and patterns over time and space, thus enabling a number of studies that were impossible to conduct before (Lundmark and Power 2008).

We located several studies that "aimed to identify, isolate and measure these different innovation mechanisms" (Simonen and McCann 2010, 298). Simonen and McCann studying innovation in Finish high technology industries found that "R&D cooperation is an essential feature of innovation, … and labor acquisition appears to be only of limited importance for innovation". Following Simonen and McCann (2008, 2010), Fedselstein (2010) ran a similar study on Israeli high-tech employment data and received consistent results i.e. that labor mobility had a small effect on innovation. He concluded that "while knowledge spillovers are notoriously difficult to trace, it would seem that knowledge externalities are a prime source of regional productivity gains and probably more so than labour market processes of human capital migration and mobility" (Felsenstein 2010, 14).

In contrast, Zellner and Fornahl (2002, 190) analyzed how several types of scientific knowledge are associated with three knowledge acquisition channels ("the recruitment of people; the external informal networks of employees; and formal cooperation of the firm with other institutional agents"). Generalizing their findings they claim that "virtually all forms of knowledge can potentially be transferred" through recruitment. "On the other hand, the instances where informal contacts and networks may be drawn on are more limited" (Zellner and Fornahl 2002, 194). Their findings indicate that labor mobility may be more important for innovation than cooperation.

Few scholars have studied these aspects in relation to KIBS, but the two following studies are interesting exceptions. In the first study Aslesen, Isaksen, and Stambøl (2008) qualitatively investigated the roles KIBS play in innovation processes

[4] This also explains why the majority of quantitative studies on innovation were conducted on Scandinavian data.

through consultancy projects and through mobility of workers between industries and geographical areas. The authors base their positions on the discrepancy between theoretical statements on the importance of the KIBS sector for innovation in client firms and empirical findings on this question. They point out that recent quantitative innovation studies did not confirm the alleged importance of KIBS as innovation agents (Aslesen, Isaksen, and Stambol 2008, 141). Using surveys and in depth interviews they confirmed that KIBS' role as innovation agents seems to be overestimated. Further, Aslesen, Isaksen, and Stambøl (2008) and Stambøl (2005) investigate labor mobility patterns in Norway in general and in KIBS sector in particular. Having found significantly higher labor flows from and to KIBS sector than the rest of the economy, as well as an indication of knowledge outflows from KIBS to other sectors referred to as "brain drain", the scholars suggest that labor mobility from KIBS sector may be an alternative type of knowledge spillovers relevant for innovation in client firms, which was disregarded before and thus requires further attention.

The second study by Tomlinson and Miles (1999) suggests an interesting implication of the results of their attempt to disentangle the importance of two knowledge diffusion channels, namely labor mobility and development of networks and collaborations. Acknowledging that external labor mobility may indeed promote innovation and therefore is desirable to a certain extent, the authors point to the negative effects of labor mobility and claims that "the diffusion of knowledge and learning can be promoted by employees of different firms and organizations working together rather than shifting jobs" (Tomlinson and Miles 1999, 152) and that innovation and production networks are "perhaps the best way to promote diffusion of tacit and embodied knowledge" (Tomlinson and Miles 1999, 158). Finally, they imply that "knowledge intensive business services (KIBS) can have a vital role to play in facilitating knowledge transfers as an alternative to external mobility" (Tomlinson and Miles 1999, 152). The arguments made by Tomlinson and Miles are illustrative evidence of the dynamic dialog on-going in Academia on the importance of the two different types of knowledge transfer mechanisms and the role of KIBS in these innovation processes.

Due to the lack of clear theoretical implications as well as mixed empirical findings on the issue we restrain ourselves from formulating a hypothesis about

the individual importance of KIBS-client cooperation and labor mobility from KIBS on innovation. Instead we set a goal to disentangle and investigate both these mechanisms simultaneously and report our results. Therefore, our first inquiry is:

Question 0: Investigate and compare the individual impact of KIBS-client cooperation and labor mobility of KIBS employees on innovation.

2.7 The role of technological and geographical proximity in knowledge transmission

As discussed above it is now generally accepted that inter-firm cooperation and labor mobility play important roles in knowledge diffusion and innovation. Some authors have recently pointed out that not enough attention has been paid to conditions that determine success of knowledge diffusion (Song, Almeida, and Wu 2003; Boschma, Eriksson, and Lindgren 2009). One interesting concept that has captured a prominent position in the literature recently is proximity. In general proximity is defined as "being close to something measured on a certain dimension" (Knoben and Oerlemans 2006, 71-71). However, proximity has many dimensions such as institutional: organizational; cultural; social; technological; and geographical which to some extent overlap, partly because of the lack of consistency of the definitions in the literature, and partly because the concepts are not distinct (e.g. Knoben and Oerlemans 2006; Lorentzen 2005). Recognizing this we still set out to investigate two of the areas that are interesting for our research: the importance of technological and geographical proximity (and distance) for innovation. Consequently we review the literature on technological and geographical proximity (and distance) in general and in particular in relation to inter-firm cooperation and labor mobility.

2.6.1 The importance of technological proximity

Technological proximity can be understood as common technological experience and knowledge bases (Knoben and Oerlemans 2006, 77). This is closely related to absorptive capacity as it is a well-accepted fact in innovation studies that firms need absorptive capacity to understand and apply external knowledge (Cohen and Levinthal 1990). Cohen and Levinthal (1990, 135-136) explain that some fraction of prior knowledge should be closely related to new knowledge to enable absorption, however, some part of the knowledge must be quite diverse, but related, to create the effective and innovative utilization of the new knowledge.

Thus the match between a firm's existent capabilities and new external knowledge is important. The extent of technological distance sought entails a trade-off between the motivation to learn (higher when firms are technologically distant) and the ability to learn (higher when firms are close) (Song, Almeida, and Wu 2003). Therefore, the type of knowledge sourced (i.e. similar, related or unrelated) can impact the success of knowledge acquisition.

Cooperation and technological proximity

Specifically for inter-firm cooperation the importance of technological proximity can be understood from the concept of *relative* cognitive capacity in that cooperation partners "need to be similar enough in knowledge bases to be able to recognize the opportunities that the other actor's knowledge gives, but different enough to contribute new knowledge" (Knoben and Oerlemans 2006, 78). Thus Lane and Lubatkin (1998) argue that the ability to learn from other firms depends on firms similarity in knowledge bases; organizational structures and compensation policies; and dominant logics. Wathne, Roos, and Krogh (1996, 72) found that the "greater the prior experience, richness in the channel of interaction, trust, and perceived openness, the greater the effectiveness of knowledge transfer is likely to be". However, at the same time the cooperation partners should have different knowledge as the innovativeness of a firm largely depends on the extent to which they are able to "supplement their in-house competence with information and competence from other firms" (Aslesen and Isaksen 2007, 329). In fact, one of the reasons why firms establish relationships and cooperate is to access dissimilar and complementary knowledge (Simonen 2007, 47). At the same time, Wathne, Roos, and Krogh (1996) argue that firms through cooperation come to develop a common knowledge base. Building on this we can suggest that over time the dissimilarity of knowledge may be of greater importance for innovation in an inter-firm cooperation than the original similarity of knowledge bases. We may also argue that the problems typically associated with cognitive distance in case of unrelated skills are moderate for the interaction channel compared to labor mobility, as the nature of contact is typically short-term, reversible and a full appropriation of external knowledge might not be a purpose. This may lead to a wider spread of technologically distant knowledge searched through cooperation that through labor acquisition.

Labor mobility and technological proximity

The idea of technological proximity has been incorporated into the studies of labor mobility only recently. Eriksson, Boschma and Lindgren (2008; Boschma, Eriksson, and Lindgren 2009) criticize existent literature saying that the effect of labor mobility is almost taken for granted, assuming that new employees are easily integrated into the firm and will certainly contribute to further knowledge creation and innovation. Authors claim that such view is very simplified and the effect of labor mobility can only be assessed when one account for the type of skills that flow to the firm, and the match between new and existing skills in the firm. They assess new knowledge inflows from two dimensions – firm's ability to absorb them, and value added potential. Thus, similar new skills (coming from the same sector) are easy to absorb, but add little value to the firm; unrelated skills are very difficult to absorb, which makes it nearly impossible for a firm to benefit from them; and the inflow of related skills should have the most significant impact on firm performance as it presents real learning opportunities.

Existent evidence on the issue of relatedness in labor mobility is persuasive. Boschma, Eriksson and Lindgren (2008, 2009) and Timmermans and Boschma (2011) in their studies of plant performance found strong empirical evidence that related skills had positive impact on plant performance, while both similar and unrelated skills impacted it negatively. Song, Almeida, and Wu (2003, 351), exploring the conditions under which learning-by-hiring is most likely to give results, also found that mobility is more likely to result in knowledge transfer when the firm is "exploring technologically distant knowledge, rather than for reinforcing existing firm expertise". Rosenkopf and Almeida (2003) concluded that the usefulness of mobility increased with technological distance. Results of Maliranta, Mohnen, and Rouvinen (2009, 1161) are also similar: "Somewhat surprisingly, hiring workers from others' R&D labs to one's own does not seem to be a significant spillover channel. Hiring workers previously in R&D to one's non-R&D activities, however, boosts both productivity and profitability".

From the reasoning above the implications of the relatedness of knowledge brought to the knowledge already possessed by a firm should be about the same for both the mechanisms of knowledge transfer. Not being able to investigate exactly the type of knowledge in different firms and sectors, we however can reasonably assume that firms within KIBS sector possess similar competences to

each other, but different from other sectors in the economy. In addition, we know that due to the nature of work KIBS often have expertise in other industries, and thus offer related knowledge rather than unrelated. Therefore, we hypothesize:

Hypothesis 1a: The impact of cooperation with KIBS on innovation should be stronger on firms outside the KIBS-sector than on other KIBS.

Hypothesis 2a: The impact of labor mobility from KIBS sector on innovation should be stronger on firms outside the KIBS-sector than on other KIBS.

2.6.1 The importance of geographical proximity

Geographical proximity can be understood as the geographical distance separating actors; the travel times; or the perception of proximity by actors. The levels of what is defined as close and distant do also wary between authors (Knoben and Oerlemans 2006, 73-74). Geographical proximity is the most frequently investigated dimension of proximity (Knoben and Oerlemans 2006, 74), and a large area of scientific research is dedicated to agglomeration of economic activities and the role played by geographical proximity in innovation. A classic explanation for why firms tend to cluster together is referred to as Marshallian trinity and includes access to skilled labor, inter-firm knowledge spillovers, and non-traded local inputs (Cortright 2006). Furthermore, it has been noticed that "knowledge has certain characteristics which may condition the effects of location on innovation" (Simonen 2007, 35). It has been empirically proven that knowledge diffusion is strongly bounded in space, which seems paradoxical in the era of globalization. The explanation for this is hidden in the nature of knowledge, and more specifically in the distinction between tacit and codified knowledge (Breschi and Lissoni 2001, 6-7). The codified knowledge will diffuse rather easily across firms and distances, whereas tacit knowledge is "mainly transmitted by face-to-face contacts and through frequent and repeated personal relationships", which makes geographic proximity matter (Simonen 2007, 24).

The area of research on agglomeration is far too broad for the scope of this paper. However, its implications suggest certain location patterns to be observed both in the cooperation behavior and labor mobility, which we think are interesting too look at in our study as well.

Cooperation and geographical proximity

The importance of geographical proximity to inter-firm cooperation is explained by the fact that proximity facilitates intensive face-to-face interaction and therefore knowledge transfer, and especially tacit knowledge (Knoben and Oerlemans 2006, 74). Moreover, learning in inter-firm cooperation occurs in close cooperation between actors in an innovation system and is a socially embedded process that cannot be understood without considering its cultural and institutional context (Lundvall 2010, 1). Firms located in the same geographical area are assumed to have closer characteristics and behavior and therefore share information and knowledge easier than firms that are located in different areas (Muller 2001, 61). Moreover, "the more tacit the knowledge involved, the more important is spatial proximity between the actors taking part in the exchange (Malmberg and Maskell 2002, 26).

As argued above the inter-firm cooperation between KIBS and clients is special as a large part of the KIBS-client interaction is tacit in nature, and therefore when KIBS are faced with client problems direct contact with clients to create solutions is usually necessary, and then geographical proximity is useful (Muller and Zenker 2001, 1506). Moreover, geographical proximity also enables firms to interact with a greater number of potential contacts, both formally and informally. Thus, "proximity between KIBS and SMEs constitute an incentive for interaction and implies increased interaction opportunities as well as reduced transaction costs" (Muller 2001, 61). At the same time scholars have recently presented "the notion of temporary geographical proximity" explaining that even though actors are not located in the same geographical area they can meet or temporary co-locate which can later on allow cooperation over large geographical distances, as well as arguing that close geographical proximity might only be important in certain phases in of cooperation (Knoben and Oerlemans 2006, 74).

Empirical studies have showed that the KIBS sector is rather concentrated geographically, usually in big cities (Aslesen and Isaksen 2007, 322), allegedly due to demand for their services and supply of qualified labor in these locations. Furthermore, KIBS outside large cities are found to have strong local ties (Toivonen 2004).

Thus based on theoretical and empirical arguments we expect that:

Hypothesis 1b: The majority of cooperation relations between KIBS and clients should be local.

Labor mobility and geographical proximity

Many authors suggest that labor mobility and its effects are locally bounded. One reason is that the majority of job shifts occurs within regions (Boschma, Eriksson, and Lindgren 2009). This is especially true for regions with similar or related economic activities: clusters are characterized by a level of local labour mobility that is higher than elsewhere in an economy (Power and Lundmark, 2004). It is recognized that labor mobility is the most immobile and locally bounded factor of production (Boschma, Eriksson, and Lindgren 2009), which of course means that knowledge transfer via labor mobility is mainly a local process. In addition, social capital and networks has been cited as another reason for why the effects of labor mobility are localized (Molina-Morales and Martínez-Fernández 2010). Breschi and Lissoni (2005) found that access to local knowledge networks significantly facilitates knowledge flows between firms and explain that network positions are embedded in employees and therefore hiring employees gives access to such networks. The author also noticed that these social networks are formed locally and that people often loose contact with these networks when they move outside the region.

Therefore, acknowledging the inputs of economic geographers we believe that:

Hypothesis 2b: The majority of labor flows from KIBS to other firms should be local.

2.6.3 The importance of geographical distance

Agglomeration studies have recently received considerable critical assessment for being too focused on the advantages of localization, and neglecting the fact that firms are also engaged in relations with non-local actors. In addition, it has been said that too much reliance on local knowledge may result in lock-ins, inertia and stagnating learning which over time will have detrimental results on performance (Cortright 2006). Krugman (1991) also claimed that "knowledge spillovers are so important and forceful that there is no reason to assume that geographical boundaries would limit the spatial extent of the spillovers".

Cooperation and geographical distance

As elaborated above there are well-grounded reasons to expect cooperation relations to be geographically localized. However, according to an alternative point of view, knowledge spillovers result from long-term interactions and the exchange of information is based on trustful relationships between agents, which are independent of location and do not require spatial proximity (Caniels 2000). Supporting argument was made by Patton and Kenney (2005), who analyzed the pattern of network linkages and geographical distance in Silicon Valley. They confirmed the existence of strong local networks, but also found some evidence on the potential importance of cross-regional networks between firms. Simonen (2007, 12) also mentioned that important partners may locate both within and outside of the regional borders.

More specifically, when it comes to KIBS-client cooperation it has been empirically found that "no distinctive feature related to proximity-based interactions with KIBS can be identified" and that "proximity matters more when information flows from SMEs and knowledge is developed by KIBS than when information flows from KIBS and knowledge is developed by SMEs" (Muller 2001, 129-130). Strambach (2008) also noticed that in the course of internalization KIBS become increasingly important in promoting the transfer of local knowledge to other regional and national contexts. Overall, following Strambach (2008) we agree that the only certain conclusion on the topic is that little is known on the interplay between geography and KIBS-client knowledge dynamics.

Labor mobility and geographical distance

In the discussion above we concluded that labor mobility appear to be a highly localized process. However, a counter argument suggests that labor mobility can take place over very large spatial distances, and if so, it should actually reduce the localization effects of knowledge (Simonen, 2007). Besides, even if the majority of labor flows are local, it does not mean that they are more important in their impact on innovation that non-local mobility. In fact according to the human capital migration search arguments innovation performance is related primarily to access to a wider geographical market, rather than to specifics of the local labor market (Sjaastad 1962).

Several studies appeared in the recent literature trying to shed some light on the issue. Thus, Rosenkopf and Almeida (2003) found that labor mobility was associated with inter-firm spillovers regardless of spatial proximity. Song, Almeida, and Wu (2003) concluded that geographically distant knowledge is more valuable for innovation and suggested that geographical boundaries should be extended for the sake of learning. Simonen and McCann (2008, 2010) found that mobile human capital attracted from other regions appears to be more important for innovation than local human capital. In fact they found that "local labor acquisition is never positively related to any form of innovation" (Simonen 2007, 137). These findings are similar to Timmermans and Boschma (2011, 1)conclusion that "intra-regional skilled labor mobility had a negative effect on plant performance in general", but that the effect of inter-regional labor mobility is more complicated and its direction depends on the type of skills acquired. In addition, it has been found that international labor mobility, which is an extreme case of non-local labor flows, is an important channel for knowledge spillover and positively affects local innovation (Liu et al. 2010; Song, Almeida, and Wu 2003).

As indicated above, there clearly exists a discussion about the effect of geographically distant knowledge flows through both cooperation and labor mobility. There is also an argument that cooperation and labor mobility should "imply rather different relationships between geography and innovation" (Simonen and McCann 2010, 297). Obviously this discussion is yet quite nascent and the outcomes are unclear, which is why we restrain ourselves from formulating hypotheses about the expected results. However, we do raise an issue and set a goal to investigate the question of spatial/non-spatial dichotomy in our study and report the result.

Question 1. Investigate and compare the individual impact of cooperation with local KIBS and national KIBS on innovation.

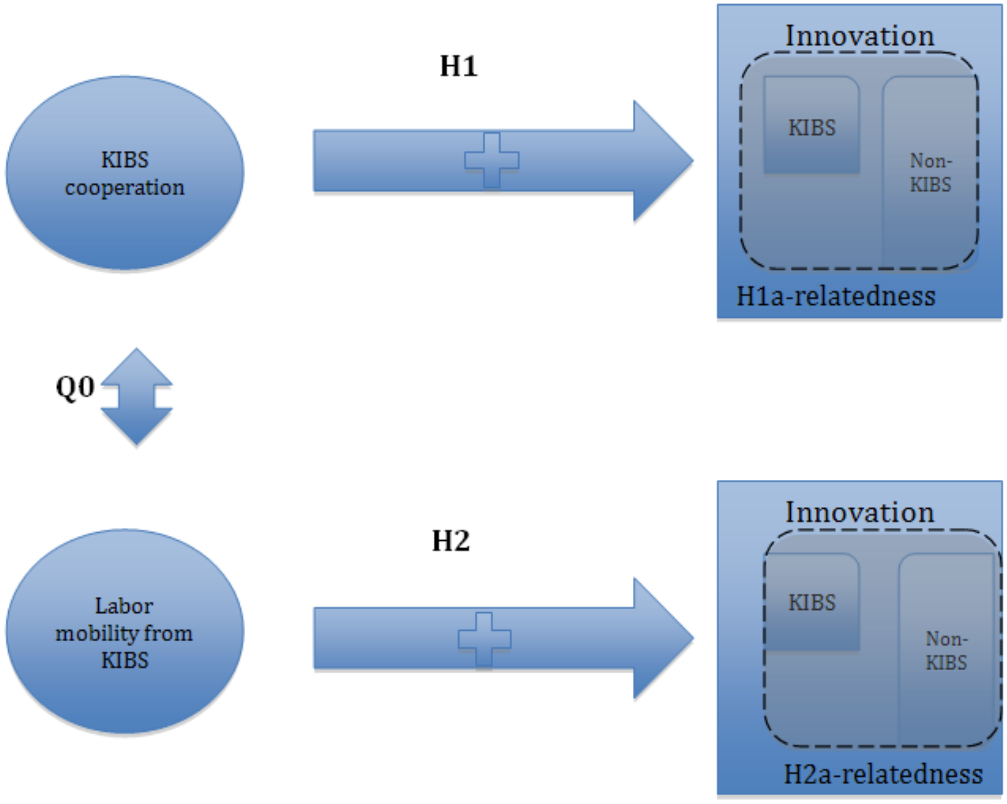
Question 2. Investigate and compare the individual impact of labor mobility from local KIBS and labor mobility from non-local KIBS on innovation.

2.8 Research model

Our research ideas formulated as testable hypotheses and exploratory questions are summarized in a research model below. Our study can be divided into two steps according to the level of disaggregation. In a first part (figure 1), we test our general hypotheses on the impact of cooperation with KIBS and labor mobility

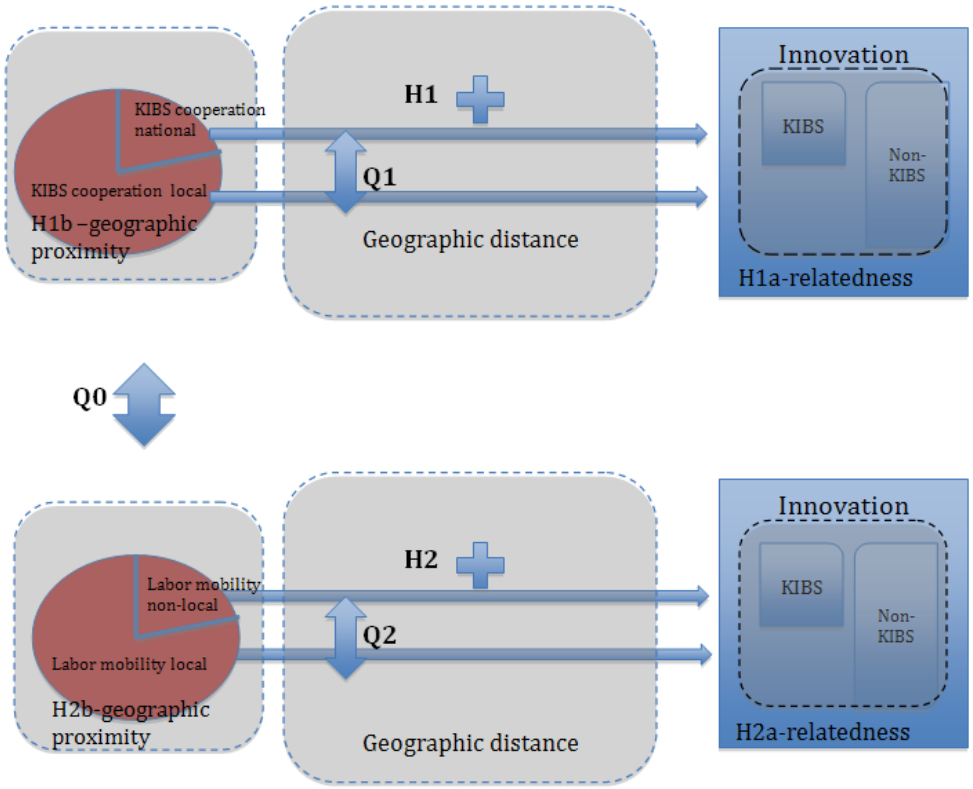
from KIBS on innovation in other firms (*Hypotheses 1 and 2*); compare the results on the individual impact of both mechanisms to get an idea about their relative importance (*Question 0*); and simultaneously investigate the role of relatedness of knowledge flows (*Hypotheses 1a and 2a).*

Figure 1: Basic set up of research



In a second part (Figure 2), we add the issues of geography to the basic research idea. We investigate both the issues of geographical proximity (*Hypotheses 1b and 2b*) and geographical distance (*Questions 1 and 2*).

Figure 2: Research set up disaggregated by geography



Acknowledging the necessity of empirical contribution to the existent literature, with no further delay we proceed to the next section presenting our research methodology.

3. Methodology

3.1 Research design

The objectives of the research determine the appropriate research design. As indicated by our research question we are interested in quantitative properties of the studied phenomena, in measuring the variables and relationships between them. Therefore, quantitative research design is the most suitable for our study.

Our study combines features of both experimental and descriptive designs. We develop a number of testable hypotheses about the causal relationships between the constructs based on theoretical arguments from the reviewed literature. At the same time, where theoretical propositions are not sufficient enough to anticipate a causal relationship, we pose several questions in order to obtain more information on particular phenomena. We portray the constructs of our interest into dependent and explanatory variables, and elaborate on appropriate measurements for them to

assure construct validity. We then build models that reflect our research ideas on the relationships between the variables. We also apply several control variables to check for a non-spurious relationship between dependent and independent variables and thus assure internal validity. We collect the relevant data from several databases described below, and make sure that the sample is representative. We then use statistical and econometric techniques to analyze the models. In addition, we perform a robustness test on a sample from another time period to check external validity of our study.

Below we discuss in turn the population and sample, data sources, construct measurement, and suggested estimation approach.

3.2 Population and Sample

A number of theoretical and practical considerations guided the construction of a sample used to test our hypotheses and explore questions.

As this study is one of the first to quantitatively analyze cooperation with KIBS and labor mobility from KIBS simultaneously we decided to take a broad view and investigate all types of innovation and to study all types of firms. The initial firm-level data used in our research comes from the innovation surveys conducted by Statistics Norway (SSB) in 2006 and 2008. The surveys apply subjective[5] approach, which is in line with the European Union Community Innovation Survey (CIS) framework. These surveys collect information about different types of innovation as well as innovation cooperation relations between firms. We adopt the sampling approach used by SSB and investigate only firms with five employees or more. We consider this reasonable, as very small firm are unlikely to have any significant cooperation with KIBS or labor mobility from KIBS. The population for the R&D and innovation survey carried out by SSB in 2008 consists of 17261 Norwegian firms, representing different industries. The sample drawn by SSB includes all firms in the population with at least 50 employees and a sample of the firms with 5-49 employees. A survey on innovation behavior was sent to this sample and 6029 firms replied which corresponds to a response rate of 96%.

[5] There are two commonly distinguished approaches of how to identify innovative output – subjective (e.g. through surveys) and objective (e.g. with patents). The biggest advantage of a subjective approach is that it provides a much broader picture about the innovation activity of firms and allows to study different types of innovation (Simonen 2007, 73).

Further, as guided by our research objectives, we split the original sample into two subsamples: KIBS and non-KIBS. The membership to the KIBS category is based on NACE codes (Appendix 1). Excluding the firms that have missing information on KIBS classification the above-mentioned sample now contains 5994 firms with in total 587 730 employees.

We have also decided to limit the sample frame to only the firms with positive turnover to include only businesses that have stabilized their activities. Furthermore, for the purposes of our study we expanded this initial database with information on labor mobility patterns and firm-specific characteristics from the Labor database and Accounting database. The linkages between the databases proved to be good. After having merged the databases, and manipulated the final sample was reduced to 5104 firms.

3.3 Data sources

To identify to what extent cooperation with KIBS and labor mobility from KIBS affect innovation in firms we use firm level data on firms' innovative behavior and firm characteristics, including recently hired human capital. We gathered the relevant data on innovation, labor and accounting data on private firms in Norway from three databases: The R&D and innovation database from SSB; the employee-employer matched database also compiled by SSB; and the Brønnøysund accounting database.

Innovation database

This database is compiled by Statistics Norway (SSB) and is based on a survey sent to Norwegian firms once every other year and asking firms to report information about their innovation activities. Some of the variables concern the specific year (e.g. 2008), while other concern the three year period (e.g. 2006-2008). The data we collect from this database are the different types of innovation; and R&D and innovation cooperation in 2006-2008 and 2004-2006; as well as R&D and innovation expenditures, turnover, and region the firm belongs to in 2008 and in 2006.

Employee-employer matched database

This database is also compiled by SSB and contains employment information on all employees working in businesses in Norway for the years 2000-2008. The information in the database is collected from the Norwegian Tax Administration

and the National Population Register, and contains unique and detailed individual geographical and socioeconomic data. This data allows us to study the mobility of labor over time at the detailed level required for our study. Access to such a database is a great advantage because "micro-econometric data on labour mobility … is very rare" (Simonen 2007, 165).[6] The data we extract from this database are labor mobility from KIBS; education level; and number of employees in the firm for the years 2005 to 2008.

Brønnøysund Accounting database

This accounting database is provided by the Brønnøysund Register Centre, to which all Norwegian firms are required by law to provide audited accounting data and other firm information. Thus this database contains all firms in Norway and the data we extract from here is ROA.

The combined and extended database at our disposal thus includes firm level data on different types of innovation; innovation cooperation with KIBS; R&D and innovation expenditure; turnover; firm region; labor mobility from KIBS; education level; number of employees in the firm; and ROA.

3.4 Measurement

This section describes dependent, independent and control variables used in the analysis and their operationalization. Appendix 2 presents a summary of the variables, their measurement.

3.4.1 Dependent variables

We study five types of innovation defined by OECD and also used in the R&D and Innovation Survey implemented by Statistics Norway. Innovation is a binary dependent variable with a value of 1 if the establishment has managed to introduce new innovations during the previous three years and equal to 0 if it has not.

Introduction of product innovation and service innovation. Statistics Norway defines product innovation as "goods or services that are either new or substantially improved with regard to characteristics, technical specifications, integrated software or other non-material components or user friendliness"

[6] In fact, availability of similar unique employee databases in Norway and other Scandinavian countries explains why a great deal of quantitative labor mobility research has been carried out in Scandinavia (Lundmark and Power 2008, 212). This puts us on the right track and makes previous findings comparable with and applicable for our study.

(StatisticsNorway 2009). The innovation must be new to the enterprise, but not necessarily new to the market and it does not matter whether the innovation has been developed by the enterprise itself or by other enterprises. However, changes of merely aesthetic nature as well as purchase of innovations that were fully developed and produced by other companies should not be included (StatistiskSentralbyrå 2008, 6).

Statistics Norway includes both goods and services into the notion of product innovation. We, however, think that product and service innovations are qualitatively different and might be affected differently by the independent variables in our study. Therefore, we decided to use them as two separate dependent variables.

Introduction of process innovation "includes new and significantly improved production technology, new and significantly improved methods of supplying services and delivering products. The outcome should be significant with respect to the level of output, quality of products (goods or services) or costs of production and distribution" (StatisticsNorway 2009). Further, innovation must be new to the enterprise, but the enterprise does not have to be the first to introduce the process. It does not matter whether the innovation has been developed by the enterprise itself or by other enterprises. Pure organizational changes must not be included (StatistiskSentralbyrå 2008, 7).

Introduction of new to market innovation occurs when a firm introduces products (goods or services), which are new to the firm itself, and also new to the market as a whole. This type of innovation can be considered as the most advanced one (Simonen 2007).

Introduction of organization innovation "is the implementation of new organizational methods in the enterprise (including information systems), the organization of work routines or processes or use of new external relations for the enterprise" (StatisticsNorway 2009). The changes must be a result of firm's strategic considerations. Mergers or acquisitions should not be included (StatistiskSentralbyrå 2008, 10).

Introduction of marketing innovation "is the implementation of a new marketing concept or new strategy that is vastly different from the enterprise's current methods and which has not been used by the enterprise previously. This requires major changes in the product's design or packaging, product placing, promotion or

pricing" (StatisticsNorway 2009). Routine or seasonal changes in marketing methods should not be included (StatistiskSentralbyrå 2008, 10).

3.4.2 Independent variables

KIBS cooperation. We employ R&D and innovation cooperation with KIBS as a proxy for knowledge flows from cooperation relations with KIBS in general. This is in line with Jensen et al. (2007) who measures learning by interacting through established close relationships. We consider it to be a reasonable proxy because, even though innovation can result from cooperation with KIBS that is not directly aimed at innovation, according to Simonen and McCann (McCann and Simonen 2005; Simonen 2007; Simonen and McCann 2010, 2008) "out of all forms of inter-firm relations, R&D and innovation cooperation requires the most intense face-to-face contact in order to be both established and maintained" (Simonen and McCann 2008, 298). Thus, R&D and innovation cooperation is a variable that reflects a close relationship between the KIBS and client with intense face-to-face interaction and a strong tacit component. This results in two implications that serve the purposes of this study. First, since tacit knowledge is primarily exchanged via interpersonal contact, R&D and innovation cooperation provides a good solution for how to capture tacit knowledge flows, which are the most important for innovation. Second, R&D and innovation cooperation allows capturing both intentional innovation outcomes resulting from service provision as well as unintentional innovation outcomes that arise in the course of KIBS interaction with their clients. As clarified by the Survey R&D and innovation, cooperation "means active participation in joined R&D or other innovation oriented activities with other establishments or non-commercial institutions. It does not necessarily mean that both partners gain immediate economic profit from cooperation. Purchase of R&D services or pure contractual work without active cooperation from both parties should not be included (StatistiskSentralbyrå 2008, 8)". Cooperation is a dummy variable indicating whether the establishment had cooperated with KIBS[7] on R&D or other innovation related issues during the previous three years. The variable takes a value of 1 if the establishment cooperated with KIBS, and 0 if it did not.

[7] Since KIBS were not defined in the Innovation and R&D survey by Statistics Norway we used the categories of "consultants" and "commercial laboratories and R&D establishments" as the closest to our definition of KIBS.

We also split the KIBS cooperation variable according to the geographical origin of KIBS in relation to clients:

KIBS cooperation_local indicates whether the establishment had cooperated with local/regional KIBS on R&D or other innovation related issues during the previous three years. The variable takes a value of 1 if the establishment cooperated with local/regional KIBS, and 0 if it did not.

KIBS_cooperation_national by analogy indicates whether the establishment had cooperated with KIBS located elsewhere in Norway on R&D or other innovation related issues during the previous three years. The variable takes a value of 1 if the establishment cooperated with national KIBS, and 0 if it did not.

Labor mobility from KIBS reflects knowledge embodied in individual employees and is measured as gross inflow of new employees to a firm from KIBS in proportion to the firm's total employment. The use of gross inflows in studies of returns to migration is recommended by several authors (e.g.Stambøl 2005; Sjaastad 1962).

The variable is split on the basis of the geographical location of KIBS, which labor flows originate from:

Labor mobility from KIBS_local is defined as gross inflow of new employees to a firm from KIBS that are localized in the same county as the firm in proportion to the firm's total employment.

Labor mobility from KIBS_non-local is measured as gross inflow of new employees to a firm from KIBS that are localized in a different county than the firm in proportion to the firm's total employment.

3.4.3 Control variables

While studying the relationship between the variables in question it is important to ensure internal validity. One of the techniques to do so is to include control variables into the model to rule out spuriousness, a situation when the observed relationship between the variables occurs due to their joint dependence on a third variable rather than an inherent connection between them. While it is important to include controls that influence both dependent and independent variables at the same time in order to rule out spuriousness, in cases of uncertainty it is advisable to use those control variables that turn out to be related to dependent variable rather than to independent as they serve an equally important role of providing an

alternative explanations for the results (Aneshensel 2002). This is what we paid attention to when selecting the appropriate control variables in our model.

Firm size. Prior research appears to be inconclusive in determining the impact of firm size on innovation, which is perhaps because firm size has both negative and positive effects on innovation (Yang, Phelps, and Steensma 2010). There are several arguments in favor of large firms, which can briefly be summarized as advantages of scale and scope economies ((Acs and Audretsch 1990) cited in (Simonen 2007)), availability of financial and other resources ((Acs 2002) cited in (Simonen 2007)) as well as higher ability to reduce risk through internal diversification and "swallow" losses in case of failed effort (Simonen 2007). Counterarguments state that large firms are very bureaucratic and less flexible to undertake risky R&D and innovation projects compared to more dynamic and entrepreneurial small firms ((Link and Bozeman 1991; Scherer 1991); cited in (Simonen 2007)). It has been concluded that there is no optimal size for innovation, and the implications vary across industries and circumstances (Simonen 2007). What is clear though is that size does seem to have something to do with innovation. In addition, firm size can influence the propensity for cooperative behavior. Conclusions here are also mixed with some studies claiming that cooperation increases with size (Fritsch and Lucas 2001), and others suggesting that small firms "are more dependent on external sources of knowledge and thereby more anxious to cooperate"(Simonen 2007, 50). We can also speculate that size influences firms' ability to acquire new labor. All these arguments make firm size an important control variable in our model. We operationalize firm size as a number of employees in a firm.

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R&D and innovation intensity. It is generally recognized in the literature that firm's own R&D has a dual role on firm's ability to innovate (e.g. Simonen 2007; Yang, Phelps, and Steensma 2010; Liu et al. 2010). First, R&D contributes directly to firm's knowledge stock and increases innovation intensity (Liu et al. 2010). Second, it improves firm's ability "to adopt and appropriate the knowledge and ideas developed by other firms, i.e. to identify, assimilate, and exploit external knowledge" (Simonen 2007, 42). It is interesting to mention that while high R&D increases firm's ability to absorb external knowledge (Cohen and Levinthal 1990), it may actually reduce firm' desire to cooperate in order not to disclose the results of their own R&D activity to others (Simonen 2007). In our study we choose to focus on broad indicators of innovation expenditures rather than pure R&D expenditures, because R&D represents only one type of innovation activities, more relevant for product innovation, while other types of innovation often require more investment in non-R&D activities. For these reasons using only R&D can lead to systematic under-estimation and bias in measuring innovation (He and Wong 2009). Therefore, we control for firm's R&D and innovation intensity measured as R&D and innovation expenditures per employee. R&D and innovation expenditures include: 1) firm's own R&D; 2) acquisition of R&D services; 3) acquisition of machinery, equipment, software and other external technology linked to innovation; 4) acquisition of external knowledge linked to innovation; 5) training directly linked to development or use of new innovations; 6) market introduction of innovations; 7) other activities necessary to develop or introduce innovations.

ROA (Net income/total assets) is employed as a measure of firm performance, which may also impact the ability and the need to innovate and to seek external knowledge. The direction of this impact is also unclear. Some authors claim that higher ROA should lead to higher innovation as innovative activity requires high costs, which can only be covered if available funds are at disposal or accessible (e.g.Nohria and Gulati 1996; Yang, Phelps, and Steensma 2010; Simonen 2007). Others point out that satisfactory performance may decrease firm's perceived need to innovate. Similar logic can be applied to the motivation of a firm to seek external knowledge through cooperation or labor mobility.

Employment density is recommended to use in innovation studies in order to "capture any local external agglomeration spillover effects, which are external to

the individual firm" (Simonen 2007, 135). Even though we do not go deep into agglomeration studies, we cannot ignore that agglomeration can have an impact on innovation, labor mobility flows, as well as cooperation. It has been confirmed that "the nation's densest locations play an important role in creating the flow of ideas that generate innovation and growth" (Carlino, Chatterjee, and Hunt 2007, 3). We define density as "the intensity of labor…relative to physical space" (Ciccone and Hall 1996, 54) and measure it using the methodology consistent with Ciccone and Hall (1996) and Carlino (2007) as a number of people employed per square meter (all space is considered equivalent) for each of the 19 counties in Norway as defined by Statistics Norway.[8]

Human capital intensity is defined as percentage of the total employment that holds Bachelor's, Master's or PhD degree. We believe that it is necessary to account for the impact of high educational level of the workforce as it may have dual impact on innovation. First, it may be positively related to innovation activities per se, and second, it has been said that "the longer you are educated the better is your ability to absorb knowledge and learn new things" (Dahl 2002, 15). It is possible that education level of employees in a firm can have impact on the need to cooperate and acquire new labor as well as can determine success in appropriation and combination of new knowledge. Moreover, this variable can also be an indirect indicator of the knowledge-intensity of the industry the firm belongs to and therefore a partial proxy for the industry effects on innovation.

3.5 Estimation

Prior to estimating the models, we lagged several explanatory and control variables[9] three years to capture firm characteristics prior to the innovation period in order to account "for the delay in converting innovation inputs into outputs, reduce concerns about reverse causality, and avoid simultaneity" (Yang, Phelps, and Steensma 2010, 380).

Due to the binary nature of the dependent variables, the analysis of the data is most appropriately undertaken with a series of logit models, which estimate the

[8] The counties are: Østfold, Akerhus, Oslo, Hedmark, Oppland, Buskerud, Vestfold, Telemark, Aust-Agder, Vest-Agder, Rogaland, Hordaland, Sogn and Fjordane, Møre and Romsdal, Sør-Trøndelag, Nord-Trøndelag, Nordland, Troms, and Finmark.
Svalbard and the Continental Shelf are excluded from analysis.

[9] All the variables that were possible to lag with the data in our disposal (Labor mobility from KIBS, Labor mobility from KIBS_local, Labor mobility from KIBS_non-local, Firm size, ROA, Employement density, and Human capital intensity).

probability of a given type of innovation occurring given the independent and control variables included. We estimate a set of six logit models, one for each dependent variable i.e. innovation type (product; service; process; new to market; organization; and marketing). We then run three different sets of estimations for three different sets of circumstances. Moreover, to be able to assess the impact on KIBS and non-KIBS separately (hypotheses on relatedness) the models are run on both these samples separately. Consequently, we estimate 36 models in total.

In the first set of estimations, we first run the six models entering only the control variables to later be able to assess the explanatory power of our independent variables. In the second set we add the explanatory variables and test our first hypotheses on the effect of KIBS cooperation and KIBS labor mobility on innovation controlling for Firm size; R&D and innovation intensity; ROA; Employment density; and Human capital intensity.

To test the second hypotheses stating that most KIBS cooperation and KIBS labor mobility should be local we study the pattern of frequencies and correlations of local and non-local occurrence. Finally, to investigate the questions raised on the effect of local and non-local KIBS cooperation and KIBS labor mobility on innovation we run a third estimation testing the effect of local and non-local KIBS cooperation and local and non-local KIBS labor mobility on innovation controlling again for Firm size; R&D and innovation intensity; ROA; Employment density; and Human capital intensity.

4. Empirical results

4.1 Descriptive statistics and correlations

Table 3 and Table 4 report the descriptive statistics for the variables used in the analysis and the correlation matrices for the samples of non-KIBS and KIBS. The results show that no correlations between the explanatory variables are high enough[10] to prevent their inclusion in the models[11]. Correlation of approximately 0,9 between LABOR MOBILITY FROM KIBS and LABOR MOBILITY FROM KIBS_LOCAL gives preliminary support for Hypothesis H2b, namely that the majority of labor flows from KIBS to other firms should be local.

[10] We consider correlation of 0,7 and upward to be high.

[11] Significantly high correlations between KIBS_cooperation and KIBS_cooperation_local as well as KIBS_cooperation and KIBS_cooperation national are of course expected, but do not constitute a problem as they will be included in different models.

Some further interesting characteristics of non-KIBS and KIBS can be found in Table 1 and Table 2 and are explained below.

Table 1 non-KIBS characteristics

Size category	Firms	% of total employees	% of total turnover	ROA	R&D intensity	Human capital intensity	% in category innovated	% in category cooperated	% new from KIBS
1-9	885	0,9 %	0,7 %	-1,2 %	138	21,1 %	26,7 %	0,6 %	1,1 %
10-19	867	2,1 %	1,7 %	3,8 %	54	21,1 %	37,4 %	4,5 %	1,5 %
20-49	1542	8,1 %	5,5 %	5,5 %	36	17,4 %	37,9 %	5,2 %	1,8 %
50-99	847	10,0 %	7,5 %	4,6 %	33	20,5 %	49,7 %	8,7 %	1,7 %
100-249	652	16,8 %	14,5 %	4,8 %	32	22,0 %	52,5 %	12,4 %	2,0 %
250-->	361	51,5 %	64,5 %	5,3 %	37	21,8 %	59,8 %	18,3 %	1,6 %
Total	5154	89,3 %	94,4 %	3,9 %	56	20,1 %	41,2 %	6,7 %	1,6 %

Table 2 KIBS characteristics

Size category	Firms	% of total employees	% of total turnover	ROA	R&D intensity	Human capital intensity	% in category innovated	% in category cooperated	% new from KIBS
1-9	213	0,2 %	0,2 %	0,4 %	225	55,3 %	40,8 %	0,5 %	7,4 %
10-19	182	0,4 %	0,1 %	4,2 %	211	61,4 %	60,4 %	8,8 %	7,9 %
20-49	207	1,1 %	0,6 %	6,1 %	150	56,9 %	59,9 %	11,6 %	6,5 %
50-99	112	1,3 %	0,8 %	7,9 %	171	54,6 %	60,7 %	10,7 %	9,6 %
100-249	76	1,9 %	1,0 %	9,0 %	57	51,0 %	48,7 %	13,2 %	10,6 %
250-->	47	5,7 %	2,9 %	9,0 %	57	45,4 %	51,1 %	21,3 %	4,9 %
Total	837	10,7 %	5,6 %	4,9 %	172	56,0 %	53,8 %	8,7 %	7,7 %

Of the initial sample, 14% of firms are KIBS and these firms employ 11% of all employees, and stand for 6% of total turnover. Consequently, 86% are non-KIBS and employ 89% of all employees and stand for 94% of total turnover. To investigate the two subsamples further we have divided them into different size categories based on number of employees to get a more comprehensive overview.

Looking more closely at the numbers we notice that the majority of KIBS are rather small, while non-KIBS are more evenly divided. Moreover, we see that the

Table 3 Descriptive statistics and correlation matrix. KIBS=0

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 Product innovation	.184	.388	1															
2 Service innovation	.065	.246	.079**	1														
3 Process innovation	.193	.395	.364**	.299**	1													
4 New to market innovation	.111	.315	.605**	.303**	.347**	1												
5 Organization innovation	.183	.387	.182**	.196**	.322**	.238**	1											
6 Marketing innovation	.183	.387	.322**	.206**	.294**	.380**	.385**	1										
7 KIBS cooperation	.067	.249	245**	.135**	.252**	.293**	.231**	.203**	1									
8 KIBS cooperation_local	.039	.194	.198**	.089**	.200**	.224**	.186**	.150**	.754**	1								
9 KIBS cooperation_national	.041	.198	.187**	.101**	.191**	.207**	.166**	.153**	.771**	.301**	1							
10 Labor mobility	.014	.050	.017	.080**	.020	.038**	.043**	.031*	.000	-.007	.004	1						
11 Labor mobility_local	.009	.046	.009	.057**	.013	.019	.028	.023	-.011	-.014	-.005	.929**	1					
12 Firm size	92.818	431.314	.034*	.152**	.071**	.083**	.089**	.054**	.110**	.070**	.124**	-.001	-.001	1				
13 ROA	.055	.252	-.021	-.036*	-.033*	-.016	-.026	-.021	-.001	.001	.003	-.051**	-.027	.005	1			
14 R&D and innovation intensity	55.651	872.483	.045**	.024	.066**	.041**	.019	.019	.040**	.036*	.038**	.094**	.083**	-.004	-.016	1		
15 Density	167.981	324.535	-.017	.107**	.010	.024	.025	.039**	-.005	.007	-.011	.108**	.101**	.097**	-.017	.002	1	
16 Human capital intensity	.194	.221	.117**	.193**	.112**	.143**	.109**	.135**	.099**	.096**	.083**	.176**	.133**	.027	-.077**	.247**	.330**	1

N=4421

**. Correlation is significant at the 0.01 level.

*. Correlation is significant at the 0.05 level.

Table 4 Descriptive statistics and correlation matrix. KIBS=1

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 Product innovation	.191	.393	1															
2 Service innovation	.226	.418	.079*	1														
3 Process innovation	.285	.452	.298**	.443**	1													
4 New to market innovation	.180	.385	.459**	.415**	.323**	1												
5 Organization innovation	.248	.432	.170**	.132**	.261**	.305**	1											
6 Marketing innovation	.193	.395	.200**	.285**	.226**	.399**	.453**	1										
7 KIBS cooperation	.087	.282	.227**	.147**	.142**	.295**	.175**	.213**	1									
8 KIBS cooperation_local	.056	.230	.238**	.092**	.110**	.277**	.136**	.183**	.789**	1								
9 KIBS cooperation_national	.051	.221	.107**	.107**	.105**	.144**	.104**	.105**	.753**	.343**	1							
10 Labor mobility	.082	.177	.035	-.017	-.015	-.027	.023	-.006	-.024	.005	-.068	1						
11 Labor mobility_local	.056	.153	.030	-.022	-.015	-.026	.030	-.018	-.024	.000	-.061	.889**	1					
12 Firm size	57.748	149.462	-.046	.030	.005	.072	.024	.003	.145**	.062	.110**	-.035	-.029	1				
13 ROA	.063	.309	-.135**	-.042	-.078*	-.076*	-.014	-.025	-.004	-.006	.002	-.031	-.012	.002	1			
14 R&D and innovation intensity	171.556	443.574	.221**	.156**	.153**	.158**	.080*	.076*	.178**	.190**	.139**	.010	.033	-.088*	-.263**	1		
15 Density	269.892	385.647	-.066	.000	-.031	-.030	-.004	.024	-.005	.024	-.043	-.013	-.011	-.003	-.029	.047	1	
16 Human capital intensity	.601	.278	.042	.129**	.082*	.116**	.067	.102**	.091*	.084*	.090*	.030	-.001	-.107**	-.019	.213**	.172**	1

N=683

**. Correlation is significant at the 0.01 level.

*. Correlation is significant at the 0.01 level.

majority (68%) of all employees are employed in large non-KIBS (>100 employees), and the same firms' share of total turnover is about 79%. Looking at ROA we observe that both small non-KIBS and KIBS appear to have significantly lower ROA than the rest of the firm categories and that ROA tends to be increasing with size. However, ROA for non-KIBS is more similar across firms than for KIBS, and non-KIBS have on average lower ROA than KIBS. R&D AND INNOVATION INTENSITY also shows similar properties for non-KIBS and KIBS, and the smallest have the highest R&D AND INNOVATION INTENSITY. Interestingly we observe that KIBS tend to have much higher R&D AND INNOVATION INTENSITY than non-KIBS in all size categories. Investigating HUMAN CAPITAL INTENSITY we also observe some interesting results: KIBS have much higher HUMAN CAPITAL INTENSITY than non-KIBS (56% compared to 20% on average). This is consistent with theoretical arguments on the importance of the knowledge base and skilled employees for KIBS. Within the firm types HUMAN CAPITAL INTENSITY is evenly distributed across size categories.

Looking more closely at our dependent variable – innovation – we see that more KIBS than non-KIBS answered that they innovated. For KIBS we also see that the smallest and largest firms report less innovation than the medium sized firms, whereas for non-KIBS innovation increases with size.

If we examine the first of our independent variables, KIBS_COOPERATION, we see that small firms cooperate very little and cooperation increases with size for both KIBS and non-KIBS, and that KIBS tend to cooperate slightly more than non-KIBS. Examining the second of our independent variables, LABOR MOBILITY FROM KIBS in relation to the firms total employment, we observe that this is quite a lot higher for KIBS than non-KIBS (8% compared to 2%). For KIBS we see that the larger medium sized firms have slightly higher LABOR MOBILITY FROM KIBS than the small and large firms, whereas for non-KIBS the LABOR MOBILITY FROM KIBS in relation to total employment is about the same for all firm sizes.

In sum, most firms are (large) non-KIBS, and these stand for the majority of the total turnover. Small firms have lower ROA; higher R&D AND INNOVATION INTENSITY; and as high HUMAN CAPITAL INTENSITY as large firms. They innovate less and cooperate very little compared to large firms. KIBS have higher

ROA; HUMAN CAPITAL INTENSITY; innovate more; and cooperate slightly more than non-KIBS.

4.2 Models and hypotheses

Table 5 presents the results for the first set of models for each innovation type, which include only control variables. These models will be used as base models to further study the incremental explanatory efficacy of independent variables (Aneshensel 2002).

Table 6 shows the results of the six main models for each innovation type which test whether innovation is related to participation in R&D and innovation cooperation with KIBS, as well as labor acquisition of KIBS employees. We report the results separately for subsamples of non-KIBS and KIBS.

First, we see that R-square has improved compared to base models with control variables only, which indicates that the independent variables do add explanatory power to the model. In order to assess the overall fit of the models we employ three approaches: the chi-square test, pseudo R-square, and percentage correctly predicted. The chi-square test supports significant differences between null models (without any explanatory variables) and the proposed models for each of the six models, which indicates that the set of independent variables is significant in improving model estimation fit. Pseudo R-square measures range from 7,5% to 16,1% for non-KIBS and from 4,4% to 15% for KIBS which is somewhat low. However, we have noticed that such R-squares are common for categorical response models as ours used in similar studies (Simonen 2007; Liu et al. 2010). The percentage of correctly predicted values for each of the independent models is over 80% in non-KIBS subsample, and over 70% in KIBS. The threshold level for an acceptable prediction performance of these types of models is 50% correctly predicted (Simonen and McCann 2010, 301). In sum, we can conclude that all the models perform well and are acceptable in terms of statistical and practical significance.

The analysis of the individual coefficients reveals that the only variable that is significant and positively related to all types of innovation for both non-KIBS and KIBS subsamples is KIBS COOPERATION. Therefore, we find strong support for *Hypothesis 1* proposing positive relationship between cooperation with KIBS and the likelihood to innovate. In addition, the coefficients for

Table 5 Logit models (2008): Innovation as a function of control variables

Dependent variable (0,1)	Model 1: The introduction of product innovation				Model 2: The introduction of service innovation				Model 3: The introduction of process innovation				Model 4: The introduction of new to market innovation				Model 5: The introduction of organization innovation				Model 6: The introduction of marketing innovation			
Explanatory variables	KIBS=0		KIBS=1		KIBS=0		KIBS=1		KIBS=0		KIBS=1		KIBS=0		KIBS=1		KIBS=0		KIBS=1		KIBS=0		KIBS=1	
Intercept/constant	-1,695***	*(0,000)*	-1,453***	*(0,000)*	-3,591***	*(0,000)*	-1,929***	*(0,000)*	-1,672***	*(0,000)*	-1,290***	**(0,000)*	-2,455***	*(0,000)*	-2,100***	*(0,000)*	-1,759***	*(0,000)*	-1,444***	**(0,000)*	-1,754***	*(0,000)*	-1,919***	*(0,000)*
Independent variables:																								
KIBS cooperation																								
Labor mobility from KIBS																								
Control variables:																								
Firm size	0,000**	*(-0,044)*	0.000	*(0,503)*	0,001***	*(0,000)*	0.001	*(0,165)*	0,000***	*(0,000)*	0.000	*(0,772)*	0,000***	*(0,001)*	0,001**	*(0,022)*	0,001***	*(0,000)*	0.001	*(0,286)*	0,000**	*(0,014)*	0.000	*(0,906)*
ROA	0.115	*(0,582)*	-0,662**	*(0,026)*	-0.258	*(0,168)*	-0.110	*(0,698)*	-0.150	*(0,361)*	-0.346	*(0,201)*	0.167	*(0,478)*	-0.352	*(0,226)*	-0.139	*(0,385)*	-0.007	*(0,980)*	-0.118	*(0,458)*	-0.155	*(0,595)*
R&D and innovation intensity	0,006***	*(0,000)*	0,001***	*(0,000)*	0,000**	*(0,03)*	0,000**	*(0,013)*	0,003***	*(0,000)*	0,000**	*(0,015)*	0,003***	*(0,000)*	0,001***	*(0,004)*	0,001***	*(0,000)*	0.000	*(0,265)*	0,001***	*(0,000)*	0.000	*(0,538)*
Employment density	0,000***	*(0,006)*	0,000*	*(0,096)*	0,000***	*(0,01)*	0.000	*(0,811)*	0.000	*(0,313)*	0.000	*(0,684)*	0.000	*(0,212)*	0.000	*(0,217)*	0.000	*(0,148)*	0.000	*(0,938)*	0.000	*(0,792)*	0.000	*(0,329)*
Human capital intensity	0.123	*(0,550)*	0.134	*(0,716)*	2,226***	*(0,000)*	1,068***	*(0,003)*	0,424**	*(0,026)*	0,584*	*(0,073)*	0,900***	*(0,000)*	1,013***	*(0,008)*	0.864***	*(0,000)*	0.540	*(0,109)*	1,060***	*(0,000)*	0,808**	*(0,030)*
Number of observations	4421		683		4421		683		4421		683		4421		683		4421		683		4421		683	
Chi-square	345,187***	*(0,000)*	33,971***	*(0,000)*	183,109***	*(0,000)*	21,995***	*(0,000)*	187,899***	*(0,000)*	16,441***	*(0,006)*	206,484***	*(0,000)*	27,484***	*(0,000)*	106,194***	*(0,000)*	5.533	*(0,354)*	106,356***	*(0,000)*	8.644	*(0,124)*
Nagelkerke R-square	0.121		0.076		0.112		0.047		0.066		0.034		0.09		0.062		0.039		0.012		0.038		0.02	
% Correctly predicted	81.9		79.2		94.1		75.7		80.3		70		88.4		79.1		81.6		73.9		80.9		79.1	

Table 6 Logit models (2008): Innovation as a function of KIBS cooperation, labor mobility and control variables (basic models)

Dependent variable (0,1)	Model 1: The introduction of product innovation				Model 2: The introduction of service innovation				Model 3: The introduction of process innovation				Model 4: The introduction of new to market innovation				Model 5: The introduction of organization innovation				Model 6: The introduction of marketing innovation			
Explanatory variables	KIBS=0		KIBS=1		KIBS=0		KIBS=1		KIBS=0		KIBS=1		KIBS=0		KIBS=1		KIBS=0		KIBS=1		KIBS=0		KIBS=1	
Intercept/constant	-1,800***	*(0,000)*	-1,544***	*(0,000)*	-3,699***	*(0,000)*	-1,940***	*(0,000)*	-1,775***	*(0,000)*	-1,279***	*(0,000)*	-2,643***	*(0,000)*	-2,170***	*(0,000)*	-1,862***	*(0,000)*	-1,501***	*(0,000)*	-1,852***	*(0,000)*	-1,964***	*(0,000)*
Independent variables:																								
KIBS cooperation	1,508***	*(0,000)*	1,442***	*(0,000)*	1,026***	*(0,000)*	0,697**	*(0,013)*	1,552***	*(0,000)*	0,604**	*(0,028)*	1,876***	*(0,000)*	1,812***	*(0,000)*	1,485***	*(0,000)*	1,077***	*(0,000)*	1,362***	*(0,000)*	1,338***	*(0,000)*
Labor mobility from KIBS	0.080	*(0,931)*	0.552	*(0,285)*	2,478***	*(0,006)*	-0.130	*(0,807)*	0.334	*(0,696)*	-0.334	*(0,512)*	1.076	*(0,246)*	-0.372	*(0,545)*	0.962	*(0,219)*	0.411	*(0,398)*	0.818	*(0,294)*	-0.043	*(0,938)*
Control variables:																								
Firm size	0.000	*(0,370)*	-0.001	*(0,186)*	0,001***	*(0,000)*	0.001	*(0,355)*	0,000**	*(0,039)*	0.000	*(0,924)*	0,000**	*(0,027)*	0.001	*(0,245)*	0,000***	*(0,002)*	0.000	*(0,682)*	0,000*	*(0,087)*	0.000	*(0,495)*
ROA	0.086	*(0,687)*	-0,740**	*(0,014)*	-0.255	*(0,172)*	-0.142	*(0,619)*	-0.180	*(0,271)*	-0.377	*(0,165)*	0.110	*(0,632)*	-0.463	*(0,119)*	-0.179	*(0,259)*	-0.042	*(0,885)*	-0.151	*(0,333)*	-0.220	*(0,462)*
R&D and innovation intensity	0,005***	*(0,000)*	0,001***	*(0,001)*	0.000	*(0,239)*	0,000**	*(0,034)*	0,002***	*(0,000)*	0,000**	*(0,037)*	0,002***	*(0,000)*	0,000**	*(0,048)*	0,001***	*(0,009)*	0.000	*(0,623)*	0,001***	*(0,008)*	0.000	*(0,884)*
Employment density	0,000**	*(0,013)*	0,000*	*(0,101)*	0,000***	*(0,007)*	0.000	*(0,827)*	0.000	*(0,546)*	0.000	*(0,695)*	0.000	*(0,417)*	0.000	*(0,218)*	0.000	*(0,299)*	0.000	*(0,990)*	0.000	*(0,949)*	0.000	*(0,290)*
Human capital intensity	0.116	*(0,584)*	0.005	*(0,990)*	2,097***	*(0,000)*	1,024***	*(0,005)*	0,396**	*(0,045)*	0,548*	*(0,096)*	0,854***	*(0,000)*	0,906**	*(0,024)*	0,794***	*(0,000)*	0.442	*(0,196)*	1,004***	*(0,000)*	0,709*	*(0,063)*
Number of observations	4421		683		4421		683		4421		683		4421		683		4421		683		4421		683	
Chi-square	467,518**	*(0,000)*	58,73***	*(0,000)*	214,946***	*(0,000)*	27,997***	*(0,000)*	323,619***	*(0,000)*	21,629**	*(0,030)*	375,926***	*(0,000)*	68,581***	*(0,000)*	231,481***	*(0,000)*	21,067***	*(0,004)*	211,713***	*(0,000)*	30,235***	*(0,000)*
Nagelkerke R-square	0.161		0.13		0.131		0.06		0.113		0.044		0.16		0.15		0.083		0.045		0.075		0.067	
% Correctly predicted	82.7		79.8		94.1		75		81.2		69.8		88.7		80.7		82.3		73.9		81.3		78.9	

KIBS COOPERATION for non-KIBS are somewhat higher than for KIBS, which give some support to our *Hypothesis 1a* on relatedness of knowledge flows suggesting that the impact of cooperation with KIBS on innovation should be stronger on firms outside the KIBS sector than on other KIBS.

In terms of labor mobility, LABOR MOBILITY FROM KIBS is significantly and positively related only to service innovation in non-KIBS firms and insignificant for all the other innovation types in both sub-samples. Therefore, we find almost no support for *Hypothesis 2* that the gross inflow of KIBS employees is positively related to the recipient firm's ability to generate new innovations. *Hypothesis 2a* on relatedness, suggesting that the impact of labor mobility from KIBS sector on innovation should be stronger on firms outside the KIBS-sector than on other KIBS, cannot be tested due to the insignificant results on labor mobility reported above.

As to the control variables we find that FIRM SIZE is significant but has no effect on all types of innovation except product innovation in non-KIBS. ROA is significant and negatively related only to product innovation in KIBS. R&D AND INNOVATION INTENSITY is significant and has small positive effect on product, process, and new to market innovation in both sub-samples; on organization and marketing innovation in non-KIBS; as well as service innovation in KIBS. EMPLOYMENT DENSITY is significant but has no effect on product innovation in both sub-samples and for service innovation in non-KIBS. Finally, HUMAN CAPITAL INTENSITY is significant and positively related to service, process, new to market, and marketing innovation in both sub-samples, and to organization innovation in non-KIBS.

Prior to investigating the importance of geographical proximity or distance for innovation, we test the hypotheses on the localization patterns observed in cooperation activities and labor mobility.

The correlation[12] of approximately 0,9 between LABOR MOBILITY FROM KIBS and LABOR MOBILITY FROM KIBS_LOCAL can be used as evidence to support the *Hypothesis 2b*, namely that the majority of labor flows from KIBS to other firms should be local. The fact that the variables are so highly correlated, i.e.

[12] Correlation between Labor mobility and Labor mobility local can be used to analyze geographical split of labor flows because Labor mobility variable is a mere sum of local and non-local labor flows.

are almost identical, disables our intention to split the Labor mobility variable geographically and investigate the effect on innovation of labor mobility from local and non-local KIBS (*Question 2*) with our data.

To reveal the geographic patterns in KIBS_COOPERATION we use frequency tables[13]. From Table 7 below we see that both non-KIBS and KIBS cooperate almost equally with local and national KIBS, which does not support *Hypothesis 1b* that the majority of cooperation relations between KIBS and clients should be local.

Table 7 Frequency KIBS cooperation

	KIBS=0		KIBS=1	
	Frequency	Percent	Frequency	Percent
KIBS_cooperation	345	6,7	73	8,7
KIBS cooperation_local	202	3,9	47	5,6
KIBS cooperation_national	211	4,1	43	5,1

Having concluded that firms are as likely to cooperate locally as nationally, we now proceed to *Question 1* and investigate the importance of cooperation with local and national KIBS on innovation. The results of a final set of estimations, which test whether innovation is related to labor acquisition of KIBS employees as well as local and national KIBS cooperation, is presented in Table 8. As before, we report the results for subsamples of non-KIBS and KIBS.

Assessing the overall fit of the models, we see that the chi-square test confirms significance of a set of explanatory variables; pseudo R-square measures range from 6,7% to 15,6% for non-KIBS and from 3,6% to 10,7% for KIBS, which as mentioned above is common for the models like ours; the percentage of correctly predicted values for all the models is over 80% for non-KIBS and over 70% for KIBS. Therefore, we conclude that these models perform well and are acceptable in terms of statistical and practical significance.

The results on labor mobility as well as on control variables are identical[14] to the results in a first set of models.

When it comes to geographical patterns of KIBS cooperation, interesting findings arise. As to KIBS COOPERATION_LOCAL we find strong support for

[13] Correlation cannot be of use here due to the fact that one firm can cooperate with both local and national KIBS, which means that KIBS_cooperation variable is not a mere sum of KIBS cooperation local and KIBS cooperation national.

[14] With the exception of firm size that now became significant and slightly positively related to new to market innovation in KIBS.

Hypothesis 1 that cooperation with KIBS is significantly and positively related to innovation in both subsamples of non-KIBS and KIBS. However, *Hypothesis 1a* on relatedness in now only partially supported: the impact of cooperation with KIBS on innovation is stronger in firms outside the KIBS sector than on other KIBS only for three types of innovation (service, process, and organization) out of six. In case of product, new to market, and marketing innovation the impact of cooperation with KIBS on innovation is actually stronger for KIBS firms. As to KIBS COOPERATION_NATIONAL we now find that cooperation with KIBS is still positively and significantly related to all types of innovation for non-KIBS firms. However, KIBS COOPERATION_NATIONAL is insignificant for all types of innovation for the sample of KIBS firms. Therefore, now *Hypothesis 1* is only partially supported. At the same time, we find strong support for *Hypothesis 1a* as cooperation with national KIBS indeed has a stronger impact on innovation in non-KIBS than in KIBS. In sum, as to *Question 1* it seems that for non-KIBS, cooperation with local and national KIBS are equally important for innovation. However, for KIBS only cooperation with other local KIBS is important for innovation.

Finally, as to *Question 0* regarding the independent roles of KIBS cooperation and labor mobility on innovation, our results indicate that while R&D and innovation cooperation with KIBS has stably positive impact on the likelihood of innovation, labor mobility of KIBS employees seems to be of limited importance for innovation.

4.3 Sensitivity analysis and robustness check

In order to assure external validity of our results we implemented the same models on the data from the 2004-2006 R&D and innovation survey by SSB complemented with the same data as before. However, the dataset used for robustness check differed slightly from the main dataset. First, there was no data available on R&D and innovation expenditures in 2006, which is why this control variable was excluded from analysis. Second, due to the lack of data we were able to lag the relevant variables only one year compared to three years we lagged them before. However, we think the dataset is sufficiently good and suitable for our purposes of testing the robustness of findings, and that these slight modifications will not significantly impact the results. We ran only the base models and tested our key *Hypotheses 1 and 2* on the independent

Table 8 Logit models (2008): Innovation as a function of geographically disaggregated KIBS cooperation, labor mobility and control variables

Dependent variable (0,1)	Model 1: The introduction of product innovation				Model 2: The introduction of service innovation				Model 3: The introduction of process innovation				Model 4: The introduction of new to market innovation				Model 5: The introduction of organization innovation				Model 6: The introduction of marketing innovation			
Explanatory variables	KIBS=0		KIBS=1		KIBS=0		KIBS=1		KIBS=0		KIBS=1		KIBS=0		KIBS=1		KIBS=0		KIBS=1		KIBS=0		KIBS=1	
Intercept/constant	-1,780***	*(0,000)*	-1,511***	*(0,000)*	-3,662***	*(0,000)*	-1,927***	*(0,000)*	-1,755***	*(0,000)*	-1,272***	*(0,000)*	-2,583***	*(0,000)*	-2,134***	*(0,000)*	-1,841***	*(0,000)*	-1,485***	*(0,000)*	-1,826***	*(0,000)*	-1,934***	*(0,000)*
Independent variables:																								
KIBS cooperation LOCAl	1,209***	*(0,000)*	1,768***	*(0,000)*	0,626**	*(0,015)*	0.383	*(0,280)*	1,272***	*(0,000)*	0.552	*(0,107)*	1,406***	*(0,000)*	2,004***	*(0,000)*	1,284***	*(0,000)*	0,935***	*(0,006)*	0,980***	*(0,000)*	1,242***	*(0,000)*
KIBS cooperation NATIONAl	1,097***	*(0,000)*	-0.042	*(0,926)*	0,606**	*(0,018)*	0.398	*(0,312)*	1,113***	*(0,000)*	0.118	*(0,762)*	1,161***	*(0,000)*	0.331	(0,439)	0,954***	*(0,000)*	0.393	*(0,313)*	0,934***	*(0,000)*	0.193	(0,647)
Labor mobility from KIBS	0.103	*(0,912)*	0.466	*(0,373)*	2,470***	*(0,006)*	-0.118	*(0,825)*	0.368	*(0,665)*	-0.352	*(0,491)*	1.084	*(0,236)*	-0.465	*(-0.456)*	1.001	*(0,198)*	0.395	*(0,416)*	0.826	*(0,287)*	-0.097	(0,864)
Control variables:																								
Size	0.000	*(0,352)*	-0.001	*(0,275)*	0,001***	*(0,000)*	0.001	*(0,258)*	0,000**	*(0,033)*	0.000	*(0,932)*	0,000**	*(0,025)*	0,001*	*(0,098)*	0,000***	*(0,001)*	0.000	*(0,486)*	0,000*	*(0,079)*	0.000	*(0,774)*
ROA	0.080	*(0,703)*	-0,742**	*(0,014)*	-0.259	*(0,163)*	-0.136	*(0,632)*	-0.184	*(0,260)*	-0.374	*(0,168)*	0.102	*(0,651)*	-0.466	*(0,117)*	-0.186	*(0,238)*	-0.041	*(0,888)*	-0.156	*(0,317)*	-0.212	*(0,475)*
R&D and innovation intensity	0,005***	*(0,000)*	0,000***	*(0,001)*	0.000	*(0,233)*	0,000**	*(0,028)*	0,002***	*(0,000)*	0,000**	*(0,034)*	0,002***	*(0,000)*	0,000**	*(0,049)*	0,000***	*(0,009)*	0.000	*(0,590)*	0,001***	*(0,007)*	0.000	*(0,964)*
Employment density	-0,000**	*(0,011)*	-0,001*	*(0,070)*	0,000***	*(0,010)*	0.000	*(0,834)*	0.000	*(0,491)*	0.000	*(0,664)*	0.000	*(0,331)*	0.000	*(0,158)*	0.000	*(0,252)*	0.000	*(0,947)*	0.000	*(0,990)*	0.000	*(0,350)*
Human capital intensity	0.095	*(0,652)*	0.019	*(0,959)*	2,095***	*(0,000)*	1,026***	*(0,005)*	0,379*	*(0,056)*	0,559*	*(0,089)*	0,824***	*(0,000)*	0,923**	*(0,021)*	0,778***	*(0,000)*	0.452	*(0,185)*	0,995***	*(0,000)*	0,731*	*(0,054)*
Number of observations	4421		683		4421		683		4421		683		4421		683		4421		683		4421		683	
Chi-square	452,151***	*(0,000)*	60,954***	*(0,000)*	204,751***	*(0,000)*	25,199***	*(0,001)*	308,719***	*(0,000)*	20,182***	*(0,010)*	330,323***	*(0,000)*	67,111***	*(0,000)*	218,431***	*(0,000)*	17,164**	*(0,028)*	187,898***	*(0,000)*	23,715***	*(0,003)*
Nagelkerke R-square	0.156		0.134		0.125		0.054		0.108		0.041		0.142		0.147		0.078		0.036		0.067		0.053	
% Correctly predicted	82		80.5		94.1		75.1		80.5		69.4		88.2		81.1		81.9		73.6		81		78.5	

Table 9 Robustness check. Logit models (2006): Innovation as a function of KIBS cooperation, labor mobility and control variables

Dependent variable (0,1)	Model 1: The introduction of product innovation				Model 2: The introduction of service innovation				Model 3: The introduction of process innovation				Model 4: The introduction of new to market innovation				Model 5: The introduction of organization innovation				Model 6: The introduction of marketing innovation			
Explanatory variables	KIBS=0		KIBS=1		KIBS=0		KIBS=1		KIBS=0		KIBS=1		KIBS=0		KIBS=1		KIBS=0		KIBS=1		KIBS=0		KIBS=1	
Intercept/constant	-1,890***	*(0,000)*	-1,945***	*(0,000)*	-3,753***	*(0,000)*	-1,720***	*(0,000)*	-1,899***	*(0,000)*	-1,648***	*(0,000)*	-2,523***	*(0,000)*	-1,587***	*(0,000)*	-2,269***	*(0,000)*	-2,1445***	*(0,000)*	-1,682***	*(0,000)*	-1,320***	*(0,000)*
Independent variables:																								
KIBS cooperation	1,902***	*(0,000)*	1,036***	*(0,000)*	0,785***	*(0,000)*	1,533***	*(0,000)*	1,846***	*(0,000)*	1,725***	*(0,000)*	1,700***	*(0,000)*	1,412***	*(0,000)*	1,477***	*(0,000)*	1,401***	*(0,000)*	1,354***	*(0,000)*	1,116***	*(0,000)*
Labor mobility from KIBS	-1.068	*(0,294)*	0.433	*(0,438)*	2,524***	*(0,010)*	0.332	*(0,543)*	-0.089	*(0,923)*	0,990*	*(0,055)*	0.888	*(0,340)*	0.574	*(0,279)*	-0.037	*(0,970)*	0.897	*(0,129)*	-0.568	*(0,507)*	0.110	(0,833)
Control variables:																								
Firm size	0.000	*(0,528)*	0.000	*(0,877)*	0,000***	*(0,000)*	0.000	*(0,970)*	0,000***	*(0,000)*	0.000	*(0,559)*	0,000*	*(0,052)*	0.000	*(0,896)*	0,002***	*(0,000)*	0,001**	*(0,038)*	0,000*	*(0,070)*	-0.001	(0,197)
ROA	-0.040	*(0,825)*	-0,706**	*(0,042)*	0.096	*(0,687)*	0.147	*(0,655)*	-0,407**	*(0,012)*	-0.533	*(0,138)*	0.267	*(0,249)*	-0,804**	*(0,027)*	0.093	*(0,654)*	-0.082	*(0,819)*	-0.128	*(0,400)*	-0,557*	(0,101)
Employment density	-0,001***	*(0,000)*	0.000	*(0,123)*	0,001***	*(0,000)*	0.000	*(0,393)*	0.000	*(0,258)*	0.000	*(0,591)*	-0,000*	*(0,104)*	0.000	*(0,291)*	0.000	*(0,984)*	0,001**	*(0,051)*	0.000	*(0,121)*	0,000**	(0,042)
Human capital intensity	1,440***	*(0,000)*	0,888***	*(0,010)*	2,770***	*(0,000)*	0.356	*(0,266)*	1,116***	*(0,000)*	0.396	*(0,219)*	1,852***	*(0,000)*	0.516	*(0,106)*	1,055***	*(0,000)*	-0.269	*(0,483)*	1,719***	*(0,000)*	0.368	(0,215)
Number of observations	4918		849		4918		849		4918		849		4918		849		4918		849		4918		849	
Chi-square	451,763***	*(0,000)*	41,842***	*(0,000)*	314,543***	*(0,000)*	54,085***	*(0,000)*	465,634***	*(0,000)*	80,194***	*(0,000)*	391,984***	*(0,000)*	61,899***	*(0,000)*	422,805***	*(0,000)*	47,549***	*(0,000)*	378,862***	*(0,000)*	42,639***	*(0,000)*
Nagelkerke R-square	0.14		0.076		0.162		0.093		0.143		0.133		0.14		0.105		0.141		0.096		0.111		0.07	
% Correctly predicted	82.1		80		93.5		76.8		81.7		77.4		86.2		76.2		84.5		85.9		76.2		70.7	

importance of KIBS cooperation and labor mobility from KIBS on innovation. The results are presented in Table 9. We observe that the set of regressions ran on the dataset for 2004-2006 yielded almost identical results as for 2006-2008, which confirms external validity of our models. KIBS COOPERATION is significantly and positively related to all types of innovation, which supports *Hypothesis 1*. As before, LABOR MOBILITY FROM KIBS is significant and positively related to service innovation in non-KIBS. In addition, it is now also significant and positively related to process innovation in KIBS sample. This suggests some, although weak, support of *Hypothesis 2*. Therefore, we still find that R&D and innovation cooperation with KIBS seem to be of greater importance to innovation than labor mobility of KIBS employees.

In addition, as indicated in the methodology section we used a set of control variables to assure internal validity of the study. We tested whether inclusion of the controls in a model impacted the individual coefficients for independent variables. None of the controls included in the main models had a significant impact on individual regression coefficients, which indicates a non-spurious relationship between independent and dependent variables. To test sensitivity of these results we have also tried several additional control variables, like firm age, turnover, gender, and percentage foreigners in a firm. None of these variables affected individual coefficients or the model, and thus were not included in the final model. As indicated by Aneshensel (2002, 111) "the set of potential controls is endless and, therefore, cannot be exhaustively tested". However, even though taking several reasonable controls into consideration does not fully eliminate the uncertainty, it increases the confidence that the non-spurious relationship between the variables in question exists.

5. Discussion

Our thesis is a response to the increasing broad interest in innovation processes in the KBE, and particularly the interest in the mechanisms by which different types of knowledge exchanges contribute to innovation. More specifically, we focus our attention on knowledge gaps in studies on the role of KIBS in knowledge-diffusion and innovation. We identify and investigate the independent roles of the two mechanisms through which KIBS are likely to influence innovation in other firms, namely KIBS-client cooperation and labor mobility of KIBS employees. In

addition, we also touch upon recent research issues on the impact of relatedness of knowledge flows as well as geography on the success of knowledge diffusion and innovation. We dare to claim that our research ideas are novel to a large extent. Very few or, according to Simonen and McCann (2010, 306), "no other authors have previously been able to simultaneously relate data on inter-firm knowledge exchanges and labor mobility to different types of innovation" and "to empirically identify and distinguish the effects of these two knowledge transfer mechanisms" (Simonen 2007, 165). Furthermore, to our awareness, quantitative studies on this topic are non-existent in the context of KIBS.

In order to investigate the research issues of our interest we suggested a number of testable propositions and exploratory questions, which makes our study both confirmatory and exploratory. We based our main hypotheses on the generally accepted ideas that knowledge, and especially tacit knowledge, is embodied in individuals and therefore can best, and possibly only, be shared either through face-to-face interaction or the movement of employees. Adding that KIBS may be of special importance in these processes due to their knowledge-intensive nature and interactive mode of service provision, we hypothesized that both cooperation with KIBS, and labor mobility of KIBS employees should be positively related to the introduction of innovation in other firms. Further, we turned to the issue of technological proximity, and claimed that it is the related knowledge, as opposed to similar or unrelated, that has the highest impact on innovative performance. This led us to hypothesize that cooperation with KIBS as well as acquisition of KIBS employees should have higher impact on innovation in firms from other industries, rather than on firms from the KIBS sector. We then went on and investigated the links between geography and innovation. Acknowledging the inputs of economic geographers on the importance of geographical proximity for knowledge diffusion, we hypothesized that the majority of cooperation with KIBS, as well as labor flows from KIBS, will be local. However, interest in the conflicting arguments on the role of geographical distance led us to explore the importance of cooperation with KIBS and labor mobility from KIBS located in same or distant regions.

We tested our propositions and explored our questions using Norwegian data on firm innovation behavior, as well as data on R&D and innovation cooperation

with KIBS and labor acquisition of KIBS employees. Below we discuss our findings and relate them to the existent literature.

Our basic *Hypotheses 1 and 2* suggested that both cooperation with KIBS and labor mobility from KIBS should be positively related to innovation in recipient firms. We found strong support for *Hypothesis 1* that cooperation with KIBS indeed increases the likelihood to introduce all types of innovation. This is in line with theoretical arguments as outlined in the literature review that KIBS are special as cooperation partners due to the access they provide to specialized knowledge and knowledge links they establish between firms, industries and regions, as well as the interactive processes they engage in with their clients in the course of service delivery.

While we found strong support for the importance of cooperation with KIBS for innovation performance, there was almost no evidence for a positive innovation role played by the mobility of KIBS employees (*Hypothesis 2*). This finding contradicts theoretical arguments on the particular importance of KIBS employees as knowledge diffusers. We believe that such a result indicates that there are obstacles for successful knowledge acquisition and that knowledge embedded in an employee and sourced through recruitment does not immediately add value to the recipient firm and requires extra effort to be appropriated and integrated. Therefore, labor mobility as such should not be considered as an implicitly positive input to innovation.

Furthermore, we argued for the importance to separately investigate the individual roles played by the two mechanisms of knowledge transfer in innovation and set an objective to report our findings on this question (*Question 0*). With our data we found preliminary evidence that cooperation with KIBS is of essential importance for innovation, while recruitment of KIBS employees seems to be of limited importance. These results are generally in line with the findings obtained by Simonen (2007) in a similar study on Finish data[15]. We also support the statement of Tomlinson and Miles (1999, 152) that "the diffusion of knowledge and learning can be promoted by employees of different firms and organizations working together rather than shifting jobs", and more importantly that "KIBS can have a vital role to play in facilitating knowledge transfers as an alternative to external

[15] Simonen and McCann found inter-firm cooperation in general to be positively related to innovation. However, looking closer at the importance of different cooperation partners they did not find consultants to be important for innovation.

mobility". Our results however contradict another study on the role of KIBS in innovation in Norway by Aslesen, Isaksen, and Stambøl (2008). The authors qualitatively found that KIBS do not seem to drive innovation in client firms through consultancy projects and suggested mobility of KIBS employees as an indirect way KIBS can influence innovation in other firms. Our results also contradict the authors' claim that the "supposed importance of KIBS does not show up explicitly in quantitative innovation studies" (Aslesen, Isaksen, and Stambol 2008, 141). One possible explanation for such discrepancies in findings may be hidden in the research design. First, the general advantage of quantitative studies like ours, compared to qualitative, is their relative objectivity. When firms are asked in qualitative surveys to indicate whether KIBS contributed to innovation, they may not be aware of the full impact cooperation with KIBS had on innovation and thus may subjectively underestimate their role. Second, we used R&D and innovation cooperation with KIBS as a proxy for cooperation in general, which allowed us to capture not only the intentional impact of KIBS on innovation through service delivery, but also unintentional impact through, for instance, knowledge spillovers that can occur during the interactive process with clients. Third, when it comes to labor mobility the implied importance of KIBS employees in knowledge transfer and innovation was in the study by Alsesen, Isaksen and Stambøl (2008) based on a study of labor structure and labor mobility patterns in the economy in general compared to KIBS sector. However, as already indicated above, acquisition of skilled KIBS employees is not equivalent to acquisition of knowledge embodied in them due to the obstacles in knowledge appropriation and integration.

In our next set of Hypotheses *(1a and 2a)* we investigated the issue of relatedness of knowledge flows and postulated that cooperation and labor mobility effects should be higher on firms from other sectors than on other firms in the KIBS sector. We found support for the anticipated outcomes for cooperation relations with KIBS as the effects on innovation are somewhat higher on other firms outside the KIBS sector. However, the impact on KIBS firms is also significantly positive, which may be explained by the fact that the KIBS sector is in fact heterogeneous and thus KIBS firms do contribute to each other with relevant knowledge.

Proceeding to the next level of disaggregation in our study we investigated the role of geography in knowledge transfer and innovation. Our set of *Hypotheses (1b and 2b)* was based on the arguments made by economic geographers on the importance of geographic proximity for knowledge transfer and innovation. We thus suggested that the majority of cooperation relations will be with local KIBS and the majority of recruited employees will come from local KIBS. We found strong support that a vast majority of labor flows comes from KIBS located in the same region. This is in line with ideas that labor is the most immobile and locally bounded factor of production (Boschma, Eriksson, and Lindgren 2009). At the same time, it was somewhat unexpected that almost all the employees recruited from KIBS came from local KIBS. We would expect a larger part of labor flows to come from external regions especially since the most skilled labor, as in KIBS, is also the most mobile (Faggian and McCann 2009). A possible interpretation of this result may support the idea that KIBS are located in close proximity to their clients (Aslesen and Isaksen 2007). It is natural to assume that KIBS employees will often be employed by a former client firm, which explains why labor mobility from KIBS primarily occurs locally.

The results on cooperation relations with KIBS were somewhat different. Our findings revealed that both KIBS and non-KIBS cooperate almost equally with KIBS located in the same region as well as in Norway elsewhere. This contradicts the common argument that cooperation should be locally bounded, and that R&D and innovation cooperation is in fact the most geographically concentrated form of inter-firm relations (Arita and McCann 2000; Simonen and McCann 2010). On the other hand, it has been mentioned in the literature that important partners may locate both within and outside of the regional boundaries (Simonen 2007). We also suggest another tentative explanation for our findings as it may be argued that the results we obtained are subject to a country bias as the idea of what local cooperation is may differ across big and small countries. Due to the fact that Norway is a rather small country few KIBS are represented both locally and nationally, which requires some firms to look for relevant cooperation partners located outside their region. If KIBS were available in a local region, which is usually the case in big countries, the results might have been different.

Interestingly, our results suggest that labor mobility is strongly geographically bound, while cooperation is not, which is strictly opposite to theoretical

assumptions by Simonen and McCann (2010, 297) that cooperation should "favor geographical location", while "human capital mobility ought to actually reduce the localization effect of knowledge".

Having obtained interesting results for our hypotheses on geographic proximity, we then turned to the opponents of the agglomeration theories and explored the *Questions 1 and 2* on the relative importance of local and non-local cooperation and labor mobility. Unfortunately, our data did not allow us to disaggregate the sample on labor mobility according to geographic origins of employees recruited. We were able however to investigate the spatial dimension of cooperation with KIBS. This attempt is rather novel and has rarely been done before due to the fact that proximity arguments dominated the research on R&D cooperation. For instance, Simonen and McCann (2007, 2010) in their study did not consider looking at spatial distribution of R&D cooperation claiming that it can be used a proxy for *local* knowledge spillovers. We however decided to investigate the issue in search for interesting findings. The results differ for the two sub-samples of non-KIBS and KIBS firms.

We found that cooperation with national and local KIBS is equally important for innovation in non-KIBS. This result corresponds to the line of thought that cooperation, especially long-term, is independent of location and does not require spatial proximity (Caniels 2000). We suggest several explanations for this: First, we can agree with Simonen (2007) that R&D and innovation cooperation requires face-to-face contact. However, we disagree that this is the same as saying that cooperation necessarily requires partners to be located in geographic proximity, even though it is undeniable that proximity would make it easier. It can be argued that teams of employees can work face-to-face even if the firms themselves are not located in the same region. This statement is also in line with the recently suggested notion of temporary geographical proximity suggesting that actors can meet or temporarily co-locate, which allows cooperation over long geographic distances. Second, our result can also be explained with country specific effects as the national geographical span in Norway may be equivalent to local boundaries in other countries. In other words, face-to-face cooperation with national KIBS may be as easy in Norway as cooperation with local KIBS in other countries. Finally, the explanation may also be hidden in the nature of knowledge sought from local and national KIBS. As argued by Eriksson (2009), the effect of

geography of knowledge flows on innovation depends on the type of knowledge acquired. Scholars claim that unrelated knowledge is more prone to contribute to innovation if it comes from the same location, while related knowledge is even more important if it originated from outside the local boundaries. Therefore, the reason for why both local and national cooperation matter may lie in the fact that firms look for different types of knowledge when cooperating with KIBS from different locations. This idea goes beyond the scope of our thesis and was not closely investigated here, but will be recommended as an interesting area to look at in future research.

At the same time, we found that for firms in the KIBS sector cooperation with local KIBS is more important than cooperation with national KIBS. We can speculate that this result supports existent findings in the literature that KIBS tend to cluster together, especially in big cities (Aslesen and Isaksen 2007). Even though KIBS choose to cooperate both locally and nationally, they find the most relevant knowledge locally.

We claim that our thesis contributes to the on-going discussion on the links between inter-firm cooperation, labor mobility and firms' innovation activity as well as the specific role of KIBS in these complex processes. We also argue that our empirical findings on the issues of relatedness and geography contribute to the nascent dialog on these topics in the literature. In the next chapters we list several theoretical as well as practical implications of our findings, acknowledge possible limitations of our paper, and suggest promising areas for future research.

6. Implications

6.1 Theoretical contribution

Our study makes a number of contributions to existing research.

To begin with, the research issues raised in our thesis - the role of different knowledge diffusion mechanisms in innovation, the role of KIBS in innovation processes, the impact of relatedness and geography on success of knowledge acquisition – represent several recent trends of thoughts among scholars, which are understudied, lack empirical support, and are full of conflicting arguments. Therefore, our attempt to summarize existing theoretical propositions and expand empirical findings on these topics is valuable by itself.

Second, we identified a specific knowledge gap in the existing literature and were in the position to contribute to its coverage with our thesis. Our study is one of the few that has managed to separate the two mechanisms of knowledge transmission, namely inter-firm cooperation and labor mobility, and empirically investigate their individual effects on different types of innovation at the same time. In addition, to our knowledge, we are the first to conduct such a study in the context of KIBS. We also moved our research to another level of disaggregation and investigated the effects of technological proximity and geography (both proximity and distance) on knowledge diffusion through both cooperation and labor mobility.

The fact that similar studies have rarely been done before is explained primarily with the lack of appropriate measurements of the constructs in question as well as the lack of relevant data. We managed to overcome these obstacles by employing a number of methodological advancements. First, differing from the majority of previous studies, we examined several uniquely detailed datasets from Norway, which contain data on innovation, cooperation relations as well as detailed patterns of labor flows and thus allowed us to isolate the distinct roles of the two different knowledge transfer mechanisms on innovation. This data was also available at a disaggregation level necessary for our research purposes. Another methodological contribution of our thesis is the use of R&D and innovation cooperation with KIBS as a proxy for knowledge flows coming from cooperation relations in general; and the use of gross inflows of KIBS employees to capture knowledge acquired through labor acquisition. Even though these measures are subject to limitations, they allow us to separate the two mechanisms of knowledge transmission, and thus represent an improvement over the majority of previous approaches.

Third, our findings also contribute to the on-going discussions on the topics raised in the paper. We found two of our results to be quite unexpected, novel and thus valuable. First, our main results reveal that, based on our data, KIBS-client cooperation is an important determinant of all types of innovation, while labor mobility from KIBS seems to be of much lesser importance. Second intriguing results concern the links between geography and cooperation. Unexpectedly, we found that firms are equally likely to cooperate with KIBS located both in their local region and in Norway otherwise. Furthermore, location of KIBS as

cooperation partners does not matter for innovation in client firms; however it does matter for other KIBS firms.

Overall, we believe that our study provides interesting empirical insights into the role of KIBS in innovation processes, broadens understanding of different knowledge transmission mechanisms and their role in innovation in general, as well as contributes with solid arguments to the discussions on relatedness of knowledge flows and geography of innovation.

6.2 Practical implications

The findings from our research also have useful implication for managers.

First, as revealed by our findings, cooperation with KIBS appears to result in significant positive performance outcomes for all types of innovation. This suggests that managers should consider working closely with KIBS if their intent is to introduce new innovations. Furthermore, we found that for clients outside the KIBS sector innovation outcomes appear to be independent of geographical location of KIBS, which means that firms should not specifically differentiate between KIBS based on location.

Second, our findings on labor mobility do not indicate that recruitment of KIBS employees leads to improved innovation performance. However, implications of this finding are not straightforward. We do not claim that recruitment should be avoided as a way to source external knowledge. However, recruitment of skilled employees should not be considered as something that implicitly adds value and therefore should not be a blind or automatic decision, but rather a result of a well though-through selection process. The fact that labor acquisition can be costly and is not easily reversible adds to the point. In addition, after the recruitment decision has been made, additional efforts should be put in order to make knowledge appropriation successful.

All in all, our findings suggests that cooperation with KIBS seemingly adds more value to innovation performance than recruitment, and therefore should be considered as a primary alternative when a firm seeks external knowledge necessary for innovation. This recommendation should however be treated with caution as it does not imply that cooperation is useful in all cases, while labor mobility is not. The final choice should be made based on careful context-specific considerations.

In addition to managerial implications, our results can have implication for policy makers. Although the detailed discussion of possible policy implications is beyond the scope of this paper, we hope our results can assist in decisions aiming to facilitate innovation at both regional and national levels. For instance, our thesis draws attention to the role of the KIBS sector as a second knowledge infrastructure and driver of innovation in other firms; to the necessity to reinforce the tendency of inter-firm and inter-regional cooperation; and to be conscious about labor market policies.

7. Limitations

This thesis certainly presents interesting results, and makes significant contributions to existent research. However, the study also has some limitations, which we acknowledge below.

First, even though the data we use is quite unique and has many strengths, it also has several limitations. One important possible limitation is the subjective self reported nature of the data in the R&D and innovation database, in particular innovation and cooperation variables. It is possible that respondents to the survey are different from year to year, have different interpretation and understanding of the terms used or may not have sufficient knowledge to answer accurately, which may contain a threat to reliability of research. In addition, the variables of our interest from this database are dichotomous, which does not reveal the extent of innovative and cooperation. However, even though the data is subjective, the explanations in the survey appear clear, the approach is based on the Eurostat Community Innovation Survey framework, and the responses are checked and cleaned by SSB before being included in the final database, which gives us confidence in sufficient construct and external validity and reasons to deem the data as highly reliable.

Another potentially limiting feature with the data is that it is collected at firm level, which means that a firm is recorded in the location of the headquarters, even though it might have activities in several locations. This presents a potential source of error for the density control variable as well as the investigation on geographical proximity. Combining this with the subjective reporting of local and non-local cooperation suggests that the results on geographical proximity should be interpreted with caution.

A second limitation concerns the suggested use of R&D and innovation cooperation with KIBS as a proxy for knowledge flows coming from cooperation in general. First, inter-firm cooperation as a channel of knowledge transmission is a complex multidimensional construct, which ideally requires several variables to be measured. Therefore, the fact that we used only one variable can be faulty. Second, clearly firms can cooperate with KIBS without the explicit purpose of innovating, and, on the other hand, cooperation originally aimed at other purposes can eventually result in innovation. This points out to possible errors in measurement and to the necessity to carefully interpret the conclusion that *all* cooperation with KIBS positively affects innovation.

A third limitation concerns the operationalization of KIBS which ideally should be consistent with existent literature and constant throughout the study. To divide our sample in KIBS and non-KIBS we used NACE codes, and as there appear to be a relative consensus on these we are confident that the samples were accurately divided. However, to operationalize cooperation with KIBS we had to construct a KIBS category from consulting firms and commercial laboratories and R&D firms, due to the fact that explicitly defined category on cooperation with KIBS does not exist in the R&D and innovation database. Thus, in our study KIBS are operationalized in two different ways, which indeed presents a limitation to our research. Nevertheless, we believe that this does not significantly affect our results as, even though the two operationalizations of KIBS are not identical, they should overlap to a large extent.

A fourth limitation is that we investigated all types of firms and all industries. Thus we found that on average cooperation with KIBS positively affects innovation, and on average labor mobility from KIBS does not appear to affect innovation. However, it is possible that the effect is higher in some industries than others, and in some firms than others, which is why we should be careful to generalize our findings to all firms.

Finally, the results may also contain a country bias: while they are valid in Norway, the same research could yield different results in other countries. We are especially skeptical as to drawing conclusions on the importance of local and non-local cooperation with KIBS due to the fact that a non-local relationship in a small country such as Norway is not the same as non-local cooperation in a larger country.

8. Future research

The results of this thesis in combination with the limitations presented above suggest some interesting areas of future research. We find promising areas of research in the general set up of our research, in geographical proximity and relatedness, as well as other related research areas.

In the general set up of our study we see some potential areas for expansions and improvements to our research. First, we investigated the influence of cooperation with KIBS and labor mobility from KIBS in all firms and industries. As mentioned above the actual role of KIBS on innovation can differ across industries due to specific industry effects. Therefore, we recommend segmenting the sample further and investigating the effect of cooperation with KIBS and labor mobility of KIBS employees in different firms and industries in order to reveal whether any industry specific effects exist. Second, the scarcity of existent measures to capture knowledge flows resulting from cooperation obviously calls for methodological advancement, which could also potentially improve our understanding of cooperation behavior.

Further, several interesting areas for future research can be suggested in relation to geography and technological proximity. First, this research area is relatively nascent and underexplored in general. Even though we contribute to the ongoing discussion with some empirical evidence, we point out to the importance to further investigate the questions raised. Second, as explained in the discussion above, some authors point out that effect of geography on innovation depends on the type of knowledge flows. Even though this idea goes beyond the scope of the current thesis, we hinted that it may contain explanation for our results on the role of local and national cooperation and think that other interesting insights can come from combined studies on geography and relatedness of knowledge flows. Third, it would also be interesting to do a similar study as ours in other countries to investigate whether our results are generalizable to other national contexts. This is especially important for our questions on the importance of geographical proximity as we suggest that one of the reasons for our results is the country bias of Norway being such a small country. In addition, on a related note we claim the importance to proper define local boundaries in order to make research results from different countries comparable to a larger extent. Furthermore, our data unfortunately did not allow us to investigate the question on the importance of

geographical origins of KIBS employees. However, this is certainly an interesting question and we strongly suggest the research on this topic on other data and in other countries where different patterns might be observed and investigated. Finally, our interest in studying geography and relatedness was largely based on the recent call to investigate the conditions that facilitate successful knowledge transmission. Other conditions, besides the two identified here, may exist and require attention.

We also think that it would be interesting to investigate other, yet related, areas of research. We have based our thesis on the proposition that KIBS are particularly important agents of knowledge and innovation in other firms due to knowledge-intensity of the sector and interactive mode of service provision. However, in order to confirm the claimed importance of KIBS sector, it is necessary to actually investigate the role of other sector in innovation through the two channels of knowledge transmission and compare them with KIBS. Furthermore, while emphasizing that KIBS-client cooperation is an exceedingly interactive and two way process, we focused our attention on how KIBS influence innovation in client firms. We think that investigating the reverse feedback process of how cooperation with clients impact innovation in KIBS firms would provide further insights into the understanding of KIBS sector.

9. Conclusion

Using unique and detailed datasets from Norway, our study is one of the first to empirically distinguish between the two mechanisms of tacit knowledge transmission through which KIBS can influence innovation in other firms, namely inter-firm cooperation and labor mobility. In addition, this study is also one of the few to investigate two conditions that determine successful knowledge transfer through both these channels – technological proximity and geography.

Our primary analysis implies that cooperation with KIBS significantly increases the propensity to innovate, while acquisition of KIBS employees seems to be of limited importance for innovation. We also found that KIBS have higher impact on innovation in firms from other industries than on other KIBS, which suggests that related knowledge contributes more to innovation performance than similar knowledge. We confirmed that labor mobility is strictly bounded in space, while cooperation pattern is evenly distributed geographically. Finally, location of KIBS

as cooperation partners does not matter for innovation in client firms; however KIBS firms gain more from their local KIBS counterparts.

Our study broadens understanding of different mechanisms of tacit knowledge transmission in general, provides valuable insights into the roles of KIBS in innovation processes, and contributes with solid arguments to the nascent discussion on the importance of technological proximity and geography for innovation.

Appendix

Appendix 1: KIBS NACE codes

NACE Code	Description
9109	Other services associated with production of crude oil and natural gas
52292	Ship brokerage
62010	Programming services
62020	IT consultancy
69100	Legal services
70220	Management consulting and other administrative consulting
71112	Architectural services
71121	Technical constructing consulting
71122	Geological investigations
71129	Other technical consulting
71200	Technical testing and analysis
72190	Other research and other development in natural sciences and technology
72200	Research and development in the social sciences and humanities
73110	Advertising agencies
73200	Market and opinion surveys
74102	Graphic and visual communication design
74300	Translation and interpretation activities
78100	Recruitment and mediation of labor
78200	Rental of labor
82910	Collection agencies and credit bureaus

Appendix 2: Variables used in the analysis

Variable	Description
Dependent variables:	
Product innovation	1 if introduced new or substantially improved products over the last three years, 0 otherwise
Service innovation	1 if introduced new or substantially improved services over the last three years, 0 otherwise
Process innovation	1 if introduced new and significantly improved production technology, methods of supplying services or delivering products over the last three years, 0 otherwise
New to market innovation	1 if introduced new or substantially improved products (goods or services), which are new to the market as a whole, over the last three years, 0 otherwise
Organization innovation	1 if introduced new or substantially improved management and organizational structures, methods, or procedures as well as use of new external relations over the last three years, 0 otherwise
Marketing innovation	1 if introduced new or substantially improved marketing concept or strategy with regards to place, price, promotion, or product/service design over the last three years, 0 otherwise
Independent variables:	
Cooperation with KIBS	1 if the firm has cooperated with KIBS on innovation or R&D issues over the last three years, 0 otherwise
Cooperation with local KIBS	1 if the firm has cooperated with local/regional KIBS on innovation or R&D issues over the last

	three years, 0 otherwise
Cooperation with national KIBS	1 if the firm has cooperated with national KIBS on innovation or R&D issues over the last three years, 0 otherwise
Labor mobility from KIBS (t-3)	Gross inflow of new employees to a firm from KIBS in proportion to the firm's total employment
Labor mobility from local KIBS (t-3)	Gross inflow of new employees to a firm from KIBS that are localized in the same county as the firm in proportion to the firm's total employment
Labor mobility from non-local KIBS (t-3)	Gross inflow of new employees to a firm from KIBS that are localized in a different county than the firm in proportion to the firm's total employment
Control variables:	
Firm size (t-3)	Total employment (full time equivalent)
R&D and innovation intensity	R&D and innovation expenditures per employee. R&D and innovation expenditures include: 1) firm's own R&D; 2) acquisition of R&D services; 3) acquisition of machinery, equipment, software and other external technology linked to innovation; 4) acquisition of external knowledge linked to innovation; 5) training directly linked to development or use of new innovations; 6) market introduction of innovations; 7) other activities necessary to develop or introduce innovations.
ROA (t-3)	Net income over total assets
Employment density (t-3)	Total number of people employed per square meter in a county
Human capital intensity (t-3)	Percentage of the total employment that holds bachelor's, master's or PhD degree

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