ICTs, internal and external enablers of innovation: An analysis of selected KIBS sectors in different regional settings

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Abstract

Based on a representative sample of knowledge-intensive firms in Canada, this paper analyzes the organization of innovation in KIBS with respect to their use of ICTs, internal activities, knowledge sources and partnerships, and development of new services. The paper then examines whether there is any evidence that the organization of innovation varies according to the regional context in which KIBS are located, and whether innovation differs in three types of regions: large metropolitan regions, central urban regions, and small peripheral regions.

Keywords: *Innovation, ICTs, knowledge sources, KIBS, Ontario, Canada*

1. Introduction

It is fairly well established in the literature that regional characteristics, along with the characteristics of a firm and industry, influence the way firms innovate (Isaksen and Trippl, 2017; Asheim et al., 2016; Shearmur, 2015; Trippl et al., 2015; Isaksen and Onsager, 2010; Teirlinck and Spithoven, 2008). Research in the area of economic geography that has produced empirical evidence that some locations are more favourable for innovation than others. This research is based on the general assumption that innovation tends to concentrate in large urban agglomerations (Herstad, 2017) within which dynamic industrial activities with high-tech industries, high levels of R&D expenditure, and a highly educated workforce are found (Teirlinck and Spithoven, 2008). This assumption has given rise to an understanding of the geography of innovation that is mainly characterised by an 'urban bias' (Shearmur, 2017), according to which firms in urban regions are expected to be more innovative.

While there is a well-established body of empirical evidence that seems to validate the aforementioned assertion, the importance of the regional context for firms' innovation has yet to be firmly established. Most theoretical models understand innovation as occurring in large urban regions (Herstad, 2017; Shearmur, 2015), and most empirical research on regional innovation has focused mainly on the mechanisms underlying firms' innovation strategies without making an effort to determine whether innovation is approached differently in different locations.

In this paper, we study whether location in a region is reflected in different innovation patterns in selected KIBS industries. We adopt a statistical approach that enables us to systematically analyze how innovation varies across different types of regions and KIBS industries. The empirical research is based on a firm-level survey carried out in 2016 using a sample of 392 KIBS firms in Ontario (Canada).

To address this broad issue, three questions are addressed. First, we investigate the organization of innovation in KIBS with respect to their use of ICT, internal activities, knowledge sources and partnerships, and development of new services. Second, we examine whether there is any evidence that these innovation activities vary according to the regional context within which they are located, and whether innovation differs between three types of regions: large metropolitan regions, central urban regions, and peripheral and rural regions. Third, we analyze whether there are differences in innovation across KIBS subsectors in the different regions.

The paper is organized as follows. The next section provides a brief overview of the literature on innovation in KIBS and discusses the role of geography in KIBS innovation. The third section describes the data and methodology, and the fourth section presents the empirical results. The final section discusses these results and draws some theoretical and practical implications.

2. Literature review

The analytical framework includes two main theoretical constructs, innovation in KIBS and the geography of innovation. An understanding of these concepts is required before they can be combined in an analysis that seeks to explore whether innovation processes and patterns are particularly stimulated by specific types of regions.

2.1 Innovation and KIBS

Within the research on innovation, differences in innovation behaviour and approach across firms and service industries have been acknowledged. According to the knowledge-based view of the firm (Kogut and Zander, 1992) and the dynamic capabilities approach (Levinthal and Cohen, 1990; Teece et al., 1997), firms might have different abilities to generate knowledge and to benefit from knowledge spillovers. Thus, these capabilities may be the source of differences in strategy and behaviour across firms and industries. If firms have different knowledge resources and capabilities, these differences also have significant implications for their innovative performance. Another key distinction lies in the nature of the external information or knowledge that firms require to innovate. It has been argued that firms whose innovations rely on knowledge (as opposed to information) inputs will have fewer, but more targeted, interactions, whereas those that rely on information (as opposed to knowledge) will have a larger number of more opportunistic external interactions (Shearmur and Doloreux, 2015).

In the early 1990s, service research began and scholars conceptualized service innovation as the adoption, by service firms, of new technologies that altered management and communication practices (Barras, 1990; Miles, 1993). More recently, the economic and business literature has recognized that service firms are innovative not just as adopters (and adapters) of technology and management techniques, but also as developers of new service products and processes.

The research has turned to studying the main characteristics of innovation activities and strategies in the service sector, both theoretically and empirically (Agarwal and Selen, 2011; Asikainen, 2013; Corrocher et al., 2008; Doloreux and Shearmur, 2013; Freel, 2006; Prajogo et al., 2013; Rodriguez et al., 2015; Tether, 2005). Scholars have conceptualized and explored distinctive innovation patterns for services, with a primary focus on what differentiates innovation in services and manufacturing (Evangelista, 2006), and more recently, on differences across services, and in particular KIBS (Doloreux and Shearmur, 2012; Freel, 2006; Rodriguez et al., 2016; Tether et al., 2012).

The different forms of innovation in KIBS have been well documented by researchers such as Pina and Tether (2016), Rodriguez et al. (2016), Miozzo et al., (2016) Doloreux and Shearmur (2010), Amara et al. (2009), and Freel (2006). One of the main distinguishing characteristics of KIBS is that they are sources of knowledge, as

noted by Miles et al., who state that 'Knowledge-Intensive Business Services involve economic activities which are intended to result in the creation, accumulation or dissemination of knowledge' (Miles et al. 1995:18). The core competence of KIBS resides in their capability to combine, in a unique new body of knowledge, codified scientific and technical knowledge, with tacit knowledge based on extensive experience in helping 'other organizations deal with problems for which external sources of knowledge are required' (Miles, 2005:39).

There is empirical evidence to support the view that KIBS are innovators in their own rights. We can identify five characteristics of innovation in KIBS. First, KIBS do not focus solely on technological innovations, but also take into account strategies that value organizational innovations (Freel, 2006; Tether, 2005). Second, innovation is highly interactive, and the exchange of knowledge creates problem-solving processes in which KIBS transform information and knowledge into personalized solutions tailored to users' needs (Tether and Hipp, 2002). It is often said that the final service is coproduced with clients because it emerges through the interaction of service providers and service users (Muller and Doloreux, 2009). Third, the new service is less a result of R&D than of the acquisition of new technologies and/or software (Doloreux et al., 2016; Miles, 2008). Fourth, the introduction of a new service relies heavily on highly skilled workers and high-level graduates (Muller and Doloreux, 2009). Finally, service innovations remain difficult to protect (Chang and Chen, 2016).

On the basis of the empirical work on KIBS, several studies using firm-level data show that 'there is no "standard" or "unique" way KIBS innovate' (Camacho and Rodriguez, 2008). On the basis of establishment-level data from a 2007 survey, Doloreux and Shearmur (2013) show that KIBS within the same sector adopt different innovation strategies, which are found across several KIBS industries. Furthermore, innovation outcomes are not systematically associated with specific strategies. Their study therefore suggests that there are diverse ways in which KIBS firms can innovate successfully, and that this diversity does not follow sectoral boundaries. Rodriguez et al. (2015) show that there are differences in the strategies adopted by KIBS industries in Spain and recognize that the importance of external knowledge for innovation is not incompatible with the existence of firms that prefer to rely mainly on their internal capacities to innovate. Similarly, Hollenstein (2003), searching for innovation patterns in the Swiss service sector, finds that the firms that adopt the most innovative strategies are distributed across several industries. Corrocher et al. (2009) explore the existence of different innovation patterns across P-KIBS and T-KIBS in Lombardy (Italy): in keeping with the other research reviewed, they find that innovation takes various forms and reflects different strategies.

Furthermore, the sectoral heterogeneity of innovative approaches has been acknowledged in the KIBS industry, although some scholars assume that KIBS are (more or less) homogenous entities with respect to innovation. Tether (2005) and Freel (2006) are among the first scholars to explore differences in innovation strategies across KIBS, focusing on the distinction between professional and technical services. Tether et al. (2012) have recently argued that this distinction is not fine

enough, and that more detailed disaggregation is necessary, an argument we take note of in the empirical analysis below.

2.2 The geography of (KIBS) innovation

Having discussed the connection between innovation and KIBS in general, we now consider the possible geographies of this connection. More specifically, we discuss how innovation is influenced by different place-specific factors.

In studying how regional characteristics influence the innovation process, many scholars acknowledge that geography matters for innovation. One important starting point in the discussion is the fact that innovation is conceptualized as a process grounded in spatially close relations (Doloreux and Parto, 2005; Cooke et al., 2004). Geographic proximity and spatial concentration stimulate interactive learning capacities by facilitating the relations between innovating businesses and the external factors needed for innovation (Asheim et al., 2016).

A number of regional innovation approaches, including the regional innovation system, industrial district, and clusters approaches, acclaim the importance of geographical proximity for innovation. These approaches suggest a range of factors to explain why innovation differs, or should differ, across regions. Thus, large urban regions concentrate agglomeration economics, including intensive knowledge industries, a high level of R&D and number of knowledge-support organisations, and a highly educated workforce, all of which are conducive to innovation (Crescenzi and Rodriguez-Pose, 2011; Duranton and Puga, 2004). Less urbanized regions (peripheral and rural regions), in contrast, are believed to suffer from constraints such as a lack of dynamic clusters in knowledge-intensive industries and a lack of critical mass and density of relevant innovative actors and institutions (Doloreux and Dionne, 2008; Isaksen and Onsager, 2010).

If we accept that regional characteristics influence firms' innovation processes and that innovation is strongly concentrated in certain types of regions, then this has implications.

- As suggested by Isaksen and Trippl (2016), regional differences in firms' innovation performance is explained by the organizational structure of the given region. The density and variety of firms, industries, knowledge organizations, and support structures in regions should increase the innovativeness of firms located in these regions. The strong presence of these elements in regions will foster higher levels of innovation.

- However, as shown by Doloreux and Shearmur (2012), Grillitsch and Nilsson (2015), and Fitjar et Rodriguez-Pose (2015), this uneven geography may merely mean that firms in both manufacturing and service sectors located in more organizationally thin regions have fewer opportunities to innovate. In fact,

however, recent research shows that innovation opportunities are found in remote areas in general (Grillitsch and Nilsson, 2016; Dubois and Hedström, 2015) and for KIBS in particular (Doloreux and Shearmur, 2012).

The above discussion suggests that a geography of innovation exists. However, what is less clear is the extent to which some regional differences exist for specific innovation activities and the way firms undertake different activities to develop their innovative capabilities in different regional contexts. Lately, many studies carried out in the geography of innovation have criticized, each in their own way, the foundations of this theorization, questioning the founding postulate of this corpus, namely that innovation is fundamentally urban. Doloreux and Shearmur (2012) have shown that firms' innovation processes may be based on strategies different from those implemented by innovators in urban areas. Similarly, the work of Grillitsch and Nilsson (2015) shows that innovative firms in remote regions of Sweden compensate for the lack of access to knowledge spillovers by collaborating more frequently with partners at other geographical scales. Teirlinck and Spithoven (2008) reach similar conclusions by revealing that innovative firms located in less urbanized areas show a higher rate of openness. Fitjar and Rodriguez-Pose (2013) show that innovative firms compensate for the difficulty in accessing local knowledge by developing and building internal capacities. Other studies show that, although the success of innovation depends on the exchange of information and knowledge, this does not imply that a firm must be co-located with or near its partners. To this end, Carrincazeau and Coris (2011) emphasize the mobile nature of innovators who interact on a temporary basis in conferences and exhibitions to acquire new information and knowledge (Schuldt and Bathelt, 2011), exchange knowledge during temporary visits with external partners (Torre, 2008), or, in an ad hoc way, seek to establish a personal link with partners via the internet (MacPherson, 2008). In this case, the implementation of joint products and collaborative agreements do not necessarily imply the co-location or cohabitation of the partners. As Torre (2014) points out, temporary encounters and the mobility of individuals, reinforced by the use of ICTs, can lead to a different relationship to territory.

2.3 Research issues and contributions

Isaksen and Trippl (2017) argue that 'spatial patterns of learning and knowledge exchange vary substantially across different types of region and industries' (p.122), and explain this by the fact that 'regions and their innovation system vary markedly in the degree to which knowledge is generated, available, and can be shared (p.125). They further argue that 'territorial (region-specific) contexts matter, because places differ in the extent to which innovation-relevant knowledge sources are available locally' (p.140).

Given the limited number of studies that deal with the geography of KIBS innovation (Pina and Tether, 2016; Doloreux and Shearmur, 2012; Isaksen and Onsager, 2010; Todtling and al., 2006), and given that these studies have yielded mixed results, this paper will use Isaksen and Trippl's argument to structure the investigation and

interpret the findings. The objective of the present paper is to examine the empirical existence of regional patterns of innovation in selected KIBS industries in the Canadian province of Ontario. In order to do so, the study focuses on three research questions:

(1) What characterizes the organization of innovation in KIBS?

(2) How do KIBS' innovation activities vary between different types of regions?

(3) Can we identify differences in innovation across KIBS subsectors in the different types of regions investigated?

The first research question concerns the investigation of different dimensions of KIBS' innovation activities, including their use of ICTs, internal activities, knowledge sources and geographical partnerships, and development of new services. The second research questions analyzes how these innovation activities vary between three different types of regions in the province of Ontario, Canada. Although different methods exist to characterize the regional setting of a firm, we adopt a typology based on the size and centrality of a region, and with different compositions of economic and institutional activities (see Mas-Verdu et al., 2016; Isaksen and Onsager, 2010; Doloreux et al., 2008). The third research question tests whether there are sectoral-specific patterns in the different types of regions in the selected KIBS sectors, namely, Legal Services; Management, Scientific and Technical Consulting Services; and Computer System Designs and Related Services.

3. Research design

3.1 Data source

This analysis is based upon an original survey of KIBS establishments conducted in the Canadian province of Ontario between September 19, 2015 and May 4, 2016. The survey questionnaire was derived from the methodology of the OECD (2005), Statistics Canada surveys on innovation, and the literature on service innovation. The questionnaire consists of several questions on different topics regarding the firms' establishment, innovation activities and innovation forms, ICTs, knowledge sources, and innovation barriers. The survey was addressed to the director of each establishment. Given their position and responsibilities, these individuals had a good understanding of their establishment's innovation organization.

The list of establishments from which the sample is drawn comes from *Dun & Bradstreet Ontario* (2015). A total of 5,060 establishments with five or more employees in Legal Services (NAICS 5411), Management Consulting Services (SCIAN 5415) and Computer System Designs and Related Services (NAICS 5416) were identified, from which 2,000 were selected at random. A private survey company using computer-assisted telephone technology conducted a total of 392 successful telephone interviews. These subsectors do permit disaggregation into Technological-

KIBS (Computer System Designs and Related Services), P-KIBS (other business services), and Professional-KIBS (Legal Services and Management, Consulting Services).

3.2 Variables

Regions. Following Shearmur and Polèse (2007), we employ functional regions as territorial units. In the empirical analysis, we distinguish between three types of regions according to their size (population) and centrality: (1) Large urban regions (more than 500,000 inhabitants), consisting of the Greater Toronto Area Toronto region and the National Capital Region, Ottawa; (2) Central urban regions, comprising agglomerations of over 10,000 people within a one-hour driving distance of an agglomeration of at least 500,000 people); and, (3) small peripheral regions, comprising regions with fewer than 10,000 people over one hour from a central urban region (remaining regions).

ICTs, internal and external enablers of innovation. The organization of innovation in selected KIBS was studied by using three groups of variables. The first group of variables concerns the use of ICT applications that were examined based on the responses to the question 'Did your establishment use any of the following Information and Communication Technologies (ICTs) in the reference year?' In this regard, we construct an ICT-related variable according to the intensity of the use of the following seven ICT applications: (1) internet-enabled mobile devices; (2) company-wide computer networks; (3) E-commerce platforms; (4) industry-specific software; (5) Customer/supplier relationship-management software; (6) cloud computing; and (7) video-conferencing. These seven applications were aggregated into a single 'ICT' variable for the intensity and variety of usage with a range of 0 to 7.

The second group captures information on R&D activities. R&D in services is defined as 'creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of mankind, culture and society (particularly knowledge of the behaviour of economic agents and that of productive organizations), and the use of this stock of knowledge to devise new applications (whether they involve goods, services, processes, methods or organizations)' (Djellal et al., 2003, p. 427). The survey asks: 'During the three years 2014-2012, did your establishment engage in (1) in-house R&D, and (2) external R&D?' The answers are binary variables: 1 if the firm considers itself to have carried out R&D, 0 otherwise.

The third group consists of variables measuring access and openness to external knowledge. This was operationalized in two different ways. First, we measured the use of partnerships to access external knowledge. The survey asks: 'In the last three years, 2014-2012, please indicate the types of partners with whom your establishment has cooperated, and their location'. We include seven types of organizations for such cooperation: (1) clients; (2) suppliers; (3) competitors; (4) consultants; (5) universities or other higher education institutions; (6) commercial labs; and (7) government and public research institutes. The survey further specifies

four possible geographical locations of partners: within the region; Canada; the USA; and all other countries. We calculated the external partnership variable by adding 1 for every organization/location combination surveyed firms indicated. The seven types of partners were combined into a single scale with a range of 0 to 27, which refers to the firm's degree of openness to external knowledge.

Second, we measured the use of information sources. Respondents were asked: 'How important to your establishment's innovation activities was each of the following knowledge sources?' We used nine sources of information: (1) clients; (2) suppliers; (3) competitors; (4) other KIBS firms; (5) universities and other higher education institutions; (6) colleges and other technical institutes; (7) conferences, trade fairs, and exhibitions; (8) scientific journal and technical publications; and (9) industry associations. The degree of importance was graded using a four-point scale: 0=no use, 1=low, 2=moderate, and 3=high. The sources were accumulated to form a single information sourcing variable with a range of 0 to 30 and relates to the overall importance given to external sourcing of information by the firm.

Service innovation. The definition of innovation used in the article follows the OSLO manual (OCDE, 2005) and is based on prior studies on service innovation. By definition, an innovation must contain a degree of novelty that is either 'new to the firm' or 'new to the firm's market' (OCDE, 2005). In this study, we used the 'introduction of a new service product to the market' as a measure of innovation. The service innovation variable was operationalized as a dummy that takes the value of 1 if the establishment introduced any new service during the 2012-2014 period.

Control variables. We included control variables because other research has shown that other factors could be correlated with our dependent variables (Beicheikh et al., 2006). We controlled for size effect by including the logarithm of an establishment's number of employees in 2014. We included an indicator of the level of graduate skill in the establishment, as studies have shown that KIBS rely heavily on professional knowledge. Finally, we controlled for the age of the firm, as previous studies have shown that new firms operate in a highly uncertain environment and will therefore explore more new ideas and knowledge from external sources.

3.3 Model specifications

We analyze the dataset in two different ways. First, we use a battery of descriptive statistics to examine the different spatial organizations of innovation activities of selected KIBS.

We then use econometric methods to clarify the relationships, and in particular to see whether different innovation activities and the development of new services can be attributed to a specific regional profile. We opted for a multinomial regression model. Given that the sample encompasses KIBS in three different types of regions, the multinomial model was best suited to exploring how different innovative activities are associated with what type of region. The base outcome (0) is the small peripheral

regions, as it shows dissimilar patterns, as will be discussed further in the descriptive statistics. So the significance of variables for other regions should be interpreted in relation to this benchmark. The results of the multinomial models are reported in relative risk ratios (rrr). This ratio makes it possible to calculate how an increase of 1 of X multiplies the likelihood of finding a single unit in Y=n over the base outcome (0).

The general model is as follows:

$$\frac{\log\{P(Y=\mathbf{n}|X1,X2,X3,X4,X5,X6,X7,X8,X9)\{=}{\log\{P(Y=\mathbf{0}|X1,X2,X3,X4,X5,X6,X7,X8,X9)\{} \beta 01 + \beta 1\text{nUseofICTs} + \beta 2\text{nInternalRD} + \beta 3\text{nExternalRD} + \beta 4\text{nExternalpartnering} + \beta 5\text{nExternalsourcing} + \beta 6\text{nNewservice} + \beta 7\text{nSize} + \beta 8\text{nKnowledgeemployees} + \beta 9\text{Age} + \mu n$$

where
n=2

The same general model is further applied for each KIBS subsector separately to assess whether innovative activities vary between each specific sector in different regions. The test of multicollinearity (VIF) suggests no particular issues with the variables employed in the model (all variables show a VIF < 2). The McFadden R2 is reported for each model. Wald's tests for combining categories were also run for each model separately and ensured that the categorization used in this study truly reflected structural differences in the data.

4. Descriptive statistics

4.1 Regional structure and innovation activities

This section describes the regional patterns of ICT use, innovation-related activities, and innovation outcome for KIBS. The results, reported in Table 1, reveal the proportion of firms that stated that they used each type of ICT with respect to their region of operations. First, our sample shows that overall, the majority of KIBS use multiple types of ICTs in their innovation activities, regardless of their location (Table 1). The most important type of ICT used across regions is internet-enabled mobile devices, with 80.1 percent of all firms using them. A great majority of respondents also indicated using company-wide computer networks (61.7%). The type of ICT that shows the lowest usage rate is industry-specific software, at 45 percent.

The results also show that the use of different types of ICTs differs across regions. KIBS in small peripheral areas make greater use of internet-enabled mobile devices than KIBS in central urban or large urban regions, both of which show similar usage levels. The use of cloud computing technologies also differs in an important manner across types of regions. Firms in central urban settings use this technology the most (54.4%), followed by large urban regions (44%) and small peripheral regions (34.6%).

Small peripheral regions additionally have a higher proportion (73.1%) of firms using management software than firms in either central urban or large metropolitan regions. This suggests that KIBS in small peripheral regions put more emphasis on

supporting their relationships with clients with such devices. As will be discussed below, small peripheral regions also have the highest proportion of KIBS that consider their relationships with clients an important source of information and knowledge, which could explain bigger investments in ICT categories aimed at supporting communication channels between the firm and its clients.

These differences in the use of ICTs suggest that, despite slight divergences between large urban and central urban regions, these two types of regions tend to show similar usage patterns in comparison to small peripheral regions, which are more likely to use several ICTs. Their remote location can explain their more intensive use of those technologies to facilitate communication and information processing, as they have less direct access to and less frequent face-to-face interactions with the different stakeholders.

Concerning innovation-capability-building activities, the descriptive results show that, in general, KIBS rely significantly more on internal R&D (67.4%) than on external R&D (35%). Both types of R&D are, however, used more intensively by KIBS in large urban regions. This is in line with the assertion that KIBS in larger urban settings or more concentrated areas are more likely to invest in in-house R&D than firms in more remote regions, due to greater internal resources and access to a more dynamic environment for this type of activity.

Table 1. Regional structure, ICT use, innovation capabilities, and innovation

	Regional structure			
	Large urban regions	Central urban regions	Small peripheral regions	All regions
Use of ICTs				
Internet-enabled mobile devices	79.1	79.9	88.5	80.1
Company-wide computer networks	62.6	60.3	65.4	61.7
E-commerce platform	40.7	43.5	46.2	42.4
Industry-specific software	45.1	46.7	42.3	45.7
Management software	48.9	47.3	73.1	49.7
Cloud computing	47.3	54.4	34.6	49.7
Video conferencing	44.0	50.5	50.0	47.5
Innovation capabilities				
Internal R&D	70.3	64.7	65.4	67.4
External R&D	39.0	32.1	26.9	35.0
Innovative outcome				
Service new to market	40.7	39.7	38.4	40.1

Forty percent of the respondents declared that they had introduced a new service to the market during the three years covered by the survey. In line with what was suggested by Doloreux and Shearmur (2012), there are no significant differences across regions for the innovation outcomes. Firms in small peripheral regions do not show any lag behind firms in urban regions in regard to their ability to introduce new services to the market. As will be discussed in the following sections, we suggest that

it is rather the patterns of innovation-related activities that differ, while there are no noteworthy discrepancies between the types of regions in the ability to develop and introduce innovations to the market.

4.2 Regional structure and openness to knowledge

We further investigate how KIBS source their external knowledge acquisition from various sources and partners, as well as from other channels and platforms. The general results suggest that KIBS, independently of their location, rely on multiple external sources of information. Table 2 presents for each knowledge source the percentage of firms stating that the use of the source is important for their innovative activities (moderate to high usage).

Clients are judged the most important source by the greatest number of surveyed KIBS (80.1%), with a larger proportion in small peripheral regions (84.6%). Competitors and other KIBS firms are also considered important sources by a relatively high proportion of firms (50% and 53.3% respectively). This situation signals a coopetition dynamic for KIBS in Ontario (Gnyawali and Park, 2009), as sourcing knowledge and competences from rival firms seem to be an important contributor to innovation. This finding is in accordance with previous studies (Gnyawali and Park, 2009; Rital and Hurmelinna-Laukannen, 2009; Mention, 2011), which have highlighted that the mix of cooperation and competition is common in KIBS sectors. Sourcing from other KIBS and competitors are, however, deemed more important in large urban regions, followed by central urban regions. As stated earlier, metropolitan and central urban regions are considered more dynamic in terms of knowledge-intensive businesses and R&D activities. Those areas generally present more integrated networks and more frequent interactions between economic agents. Consequently, KIBS in concentrated urban areas have greater access to a broader and more diversified base of other KIBS and competitors from which to gather knowledge, so they are more likely to consider these sources as more important.

There are differences between urban and small peripheral regions in the importance of information sourcing from suppliers. On the one hand, in both large urban and central urban regions, 44 percent of respondents considered this source important, while only 30.8 percent responded in the same manner in small peripheral regions.

Universities and colleges, are not considered important sources of information: 32.2 and 22.7 percent of KIBS in urban and small peripheral regions, respectively, indicated that they are important sources. There are nevertheless differences between the regions. Colleges and technical institutes are used as a source by a larger proportion of KIBS in small peripheral regions (30.8%) than in urban regions, whereas universities are considered a source of knowledge in large urban regions more than in central urban and peripheral regions. These differences can be explained by the location of higher academic institutions in larger urban regions and more technical educational institutions in more remote regions.

The largest distinction between regions is found in the category scientific journals and technical publications. Fifty percent of firms in small peripheral regions have an important usage of this source, compared to 27.2 percent for firms in central urban regions and 30.8 percent for firms in large urban regions. Considering the fact that universities are mostly found in urban regions, it is unsurprising that KIBS in small peripheral regions access knowledge produced by research institutions via scientific journals and publications rather than through direct interactions.

Finally, knowledge sourcing via industry associations is moderate across regions (40.8%), with more importance given in central urban regions (43.5%). Conferences, trade fairs, and exhibitions are considered important by 47.5 percent of all KIBS in the sample. The greatest proportion of firms considering those important sources of knowledge are found in large urban regions.

In regard to types of information sources used in general, we found that small peripheral regions follow different patterns than KIBS in central and large urban regions. The results show that the importance of information sources is consistent with the general proximity of those channels to the KIBS respective to the region.

All in all, KIBS in large urban regions give more importance to information sourcing from universities, other KIBS, and competitors, as well as to attendance at conferences, all of which are concentrated in larger cities. KIBS in central urban regions show similar patterns, although they rely more on industry associations than their counterparts in other regions. Conversely, KIBS in small peripheral regions focus more on sourcing from clients, colleges and technical institutes, and publications. This is in accordance with their location, which is generally further from universities but closer to colleges and technical institutes, and with the greater emphasis they place on their relationships with clients.

Table 2. Sources of information (percentage of firms stating that different information source are important for innovation)

	Regional structure			
Types of sources	Large urban regions	Central urban regions	Small peripheral regions	All regions
Clients	79.7	79.9	84.6	80.1
Suppliers	44.0	44.0	30.8	43.1
Competitors	51.7	48.4	50.0	50.0
Other KIBS firms	55.5	52.2	46.2	53.3
Universities or other HEI	34.1	30.4	30.8	32.2
Colleges and other technical institutes	20.3	23.9	30.8	22.7
Conference, trade fair, exhibitions.	50.0	45.7	42.3	47.5
Scientific journals and technical pub.	30.8	27.2	50.0	30.4
Industry association	38.5	43.5	38.5	40.8

Table 3 presents six types of partnerships and their occurrence in four different geographical areas, namely regional, national, US, and other countries. The results

show that some types of partnerships are more spatially bounded than others. On the one hand, partnerships with higher-education institutions and commercial labs are predominantly found at the local level, at 66.1 and 70.7 percent, respectively. KIBS reported a limited number of partnerships with such institutions located in the US (12.1% and 6.5%, respectively), and they reported no partnerships with them at all outside of Canada and the US.

With market collaborators, including clients, suppliers, competitors, and consultants, their location is less concentrated at the local level, although the large majority of occurrences is found at both the local and national levels. A small proportion of collaborations take place with such actors located in the US, while the proportion of such collaborations with actors located in other countries is even lower. The most important type of partnerships for the US is collaboration with suppliers. This is not surprising, given the tight economic integration between the economies of Ontario, the Great Lakes, and the Northeastern United States. The highest proportion of cooperation with actors from other countries is with consultants, with 14.9 percent of the total number of occurrences.

The results suggest that geographic proximity plays an important role in the types of partnerships that KIBS develop. On the one hand, KIBS rely heavily on the local level for cooperation with research institutions, either public or commercial. However, the results are more diverse when it comes to cooperation with other private firms, whether clients, suppliers, or competitors. KIBS extend their partnerships with these firms to the national and international levels. It can be argued that KIBS use their relationships with this type of partners to acquire distant forms of knowledge in order to contribute to their innovative activities. Accordingly, we have seen in Table 2 that most KIBS, independently of their location, have identified those actors as important sources of information. Thus, KIBS may create partnerships with such partners beyond their immediate region in order to establish permanent connections with external sources of knowledge so that they may maintain or enhance their innovative capabilities.

Table 3. Location of external partners

Types of collaborators	Location of partners				
	Local	National	USA	Other countries	Total
Clients	49.3	43.4	5.0	2.3	100.0
Suppliers	47.4	25.9	18.3	8.4	100.0
Competitors	43.6	33.4	14.0	9.0	100.0
Consultants	48.4	24.6	12.1	14.9	100.0
HEI	66.1	21.8	12.1	-	100.0
Commercial labs	70.7	22.8	6.5	-	100.0

Table 4. Location of different partners in different types of regions

Location of the partners	Regional Structure			
	Large urban regions	Central urban regions	Small peripheral regions	All regions
Local	52.2	52.6	51.2	52.3
National	31.6	30.3	31.7	31.0
USA	10.4	10.6	9.6	10.4
Other Countries	5.8	6.5	7.5	6.3
Total	100.0	100.0	100.0	100.0

Lastly, we explored whether KIBS in different types of regions followed different patterns in terms of the geographic location of their partners. The results presented in Table 4 show that the type of region does not influence the geography of partnerships. Across the different types of regions, KIBS rely mostly on local and national partners. This result is interesting and somewhat contradicts recent studies that have proposed that KIBS in small peripheral regions tend to rely more strongly on partnerships in more distant geographical locations. The results here show instead that the degree of internationalization of knowledge sourcing and partnerships does not vary according to the proximity to large urban centers.

In sum, the descriptive results show different regional patterns of innovative activities and knowledge sourcing. Overall, KIBS in small peripheral regions show the greatest differences from the two other types of regions, in terms of both the types of internal activities they pursue and the types of partnerships and knowledge sourcing they maintain. The results suggest that geographic proximity plays an important role in the types of partnerships KIBS develop. KIBS have stronger linkages with organizations that are found in their region. For instance, KIBS in large urban areas are more strongly linked to universities, while KIBS in small peripheral regions develop more linkages with colleges and technical institutes. Geographic proximity for innovation-related activities in KIBS was further confirmed as important by looking at the regional distribution of partners. The majority of partnerships are found at the local level, followed by the national level. A small proportion of partnerships with actors in the US are found, while partnerships with actors located outside Canada and the US seem to be important mostly for consultants. The results therefore highlight the importance of geographic proximity for KIBS and innovation and the fact that different types of regions offer different sets of activities and partnerships for the conducting of innovative activities.

5. Econometric analysis

Table 5 presents the multinomial models to test which types of activities affected the propensity to be in central urban and large urban regions, on the one hand, and peripheral regions, on the other, and thus provide a more in-depth analysis from the insights we gathered from the descriptive statistics. Given their distinctive patterns,

revealed in the descriptive statistics, peripheral region serves as the base outcome. The first model comprises all three subsectors of KIBS (n=392). It is significant at the 5 percent level and presents a McFadden R2 of 0.05. The variable *age* is significant for the two types of regions. In both cases, the coefficient is negative (rrr=0.96; 0.97), suggesting that younger firms are more likely to be found in urban regions than in peripheral ones. *Firm* size also positively impacts the propensity to be located in a large urban region rather than a small peripheral region, while the variable has no impact for the distinction with central urban regions. The results in the general model are rather surprising, given the different patterns we identified previously in the descriptive section. We therefore pushed the analysis further by examining the subsectors of KIBS separately.

Model 2 presents the results for *Legal Services* alone. The model is significant at the 5 percent level, although no single variable stands out as being significant. This implies that the different innovation activities analalyzed reveal no significantly distinctive features in the three types of regions included in the model for this sector taken alone.

Model 3 focuses on the *Management, Scientific, and Technical Consulting Services* subsector (n=108). The general model is significant at the 1 percent level and presents a McFadden R2 of 0.20, which is within the typical range for such types of statistical tests (Sonka et al., 1989). The age of the company is significant and negative for both types of regions (rrr=0.91; 0.92), confirming the previous insights indicating that small peripheral regions are more likely to encompass older firms.

Two explanatory variables are significant. First of all, external partnerships is significant and negative (rrr=0.64; 0.60) for both central urban and large urban regions. This suggests that firms relying on external partnerships are less likely to be found in those urban regions than in rural regions. In other words, these results show that KIBS in small peripheral regions tend to focus more on external partnerships than firms in urban settings. Secondly, *internal R&D* is significant and positive for large urban regions. Firms pursuing intensive internal R&D activities are more likely to be found in large urban regions than in peripheral regions, and the rrr indicates that this likelihood is very strong (rrr=13.86). The coefficient is not significant for central urban regions. The distinctiveness of the intensity of internal R&D use is thus specific to large urban areas. Similarly to the other models, the use of ICTs, external R&D, and the external sourcing of information have no significant effects on the likelihood for a KIBS to be located in any given region. Unlike in the general model, however, the size of the firm is not a significant factor in this subsector, nor is the proportion of graduate employees.

The results for the subsector *Computer System Designs and Related Services* are found in Model 4 (n=145). The general model is not significant, although two variables are significant for large urban regions. The size of the firm and the proportion of graduate employees are both significant and positive. As in the other models, age is significant and negative (rrr=0.98), but only for large urban regions. However, given the general

unreliability of the model for this subsector, we cannot conclude that these variables have real effects on the location of firms.

Table 5. Multinomial regressions

	Model 1 (n=392)		Model 2 (n=139)		Model 3 (n=108)		Model 4 (n=145)	
Base: Small peripheral regions	Large urban regions	Central urban regions	Large urban regions	Central urban regions	Large urban regions	Central urban regions	Large urban regions	Central urban regions
Use of ICTs	0.91	0.99	0.72	1.10	1.02	1.14	1.18	0.97
Internal R&D	1.30	1.05	1.34	0.41	13.86*	9.43	0.68	1.17
External R&D	1.65	1.20	0.43	0.28	0.40	0.27	1.26	0.87
External partnering	0.93	0.95	1.01	1.04	0.64**	0.60***	1.03	1.10
External sourcing	0.99	0.97	1.01	1.10	1.13	1.15	0.98	0.86
New service (new to market)	1.08	1.07	0.17	0.20	0.43	0.46	2.00	1.60
Control variables								
Size (LnSIZE)	2.19**	1.60	1.10	1.24	4.53	2.39	2.24*	1.13
Knowledge employees (LnKEMP)	1.01	1.01	0.99	0.99	0.99	0.97	1.02*	1.02
Age	0.96***	0.97***	0.90	0.91	0.91***	0.92***	0.98*	0.99
Constant	4.04	12.88*	653.50	93.75	165.54	2009.81*	0.20	2.13
Number of observations	392		139		108		145	
Log likelihood	-333.11		-98.15		-78.05		-121.52	
LR Chi2	32.47**		31.78**		38.13***		24.42	
McFadden R2	0.05		0.14		0.20		0.09	
LR Comb (chi2)	24.18***	15.07*	12.97	9.542	27.80***	25.06***	9.03	6.25

Note: *, **, and *** indicate that the coefficient is significant at the 10%, 5% and 1% thresholds, respectively

6. Discussion and conclusions

This study makes a contribution to the academic literature by deepening the understanding of regional innovation patterns in KIBS. It provides and elaborates insights on innovation in three KIBS sectors in three different types of region. The results support the findings in the existing literature by providing a more detailed analysis of the differences in innovation activities and innovation development between different KIBS industries, and of the differences between industries in different types of regions.

The results have several implications for theory, practice, and policy. First, we find that KIBS, irrespective of their location, share many similarities in the way they innovate. Most KIBS use multiple types of ICTs and rely significantly more on internal than on external R&D. Most of them rely on multiple external sources of information and are integrated in innovation partnerships, of which clients are the most important partner. Most of these partnerships are developed with local and regional collaborators. The innovative performance of KIBS, measured in terms of new services introduced to the market, does not differ by region. This finding supports existing research on KIBS' innovation patterns (Isaksen and Onsager, 2010), but contradicts claims that different locations trigger different innovation dynamics (Asheim et al., 2011; Cooke et al., 2004), according to which firms in large urban regions are more innovative than their counterparts in more remote areas.

Second, the empirical analysis reveals that KIBS in large urban and central urban regions share many similarities with respect to innovation. The most important difference was found at the level of R&D, which was higher for KIBS in large urban regions.

Third, some noticeable differences distinguish each of the three types of regions, particularly with regard to innovation processes. Both through the descriptive and econometric results, we have shown that firms in large urban regions tend to focus more on internal resources for innovation, whereas KIBS in small peripheral regions stand out as relying more on external forms of partnerships. This is in line with recent studies that have demonstrated that firms in urban areas effectively show a higher level of internal resources for innovation (Crescenzi and Rodriguez-Pose, 2011), while KIBS in remote areas compensate for the relative lack of resources by opting for other strategies based on partnerships and openness (Grillitsch and Nilsson, 2015). This finding reaffirms that regional variations can be observed in the architecture of KIBS' innovation activities, but not in the propensity to introduce new services to the market (Doloreux and Shearmur, 2012).

The results also show that geographic proximity is an important determinant of external partnerships in every regional structure. The types of partnerships and information sources used by KIBS differ according to the region in which they operate, so this type of innovation-related activities seems to be context-specific and localized. As such, the intensity of and importance given to external relationships do

not seem to differ across regions. The differences and regional specificities are rather found in the types of partners the KIBS will collaborate with, which follow a context-specific pattern. Indeed, given that innovation in KIBS is highly interactive and involves close interaction with the market, it is unsurprising that innovation-related activities encompass an important local dimension.

In sum, the results have shown that there is no direct evidence that KIBS establishments located in major metropolitan areas are more innovative than those located elsewhere. Our study instead suggests that it is not the innovation outcome that differs depending on the regional structure, but the architecture of activities in bringing new services to the market. We believe that this is an important empirical contribution to a research field in which there is a frequent call for more scholarly work to verify how innovation and knowledge exchange unfold in different regional contexts (Isaksen and Trippl, 2017; Shearmur et al., 2016).

The study also raises another issue. Despite the general patterns we found in the descriptive statistics, the general model that included all subsectors together did not highlight any specific trends. Rather, it is by looking at the different subsectors separately that we were able to observe where the effects of the innovation activities were more pronounced. This raises questions about the view in both conceptual and empirical studies of the KIBS sector as homogeneous. The subsectors of KIBS have important dissimilarities in the types of services they offer, and the results show that they seem to follow different innovation patterns. This finding also reveals the importance of distinguishing different KIBS industries in greater detail in order to capture their specificities of innovation (Tether et al., 2012).

Based on the evidence discussed in this article, it should be stressed that more research is required to be certain that the innovation process operates as clearly for KIBS in large urban regions as it does for KIBS in small peripheral regions; nevertheless, there are lessons for policy here. The simple idea that innovation is driven by local factors that vary across different types of regions seems to be validated in this study. This result is not consistent with the arguments of prior scholars, who have speculated that differences should be observed due to the fact that firms might more effectively draw benefits from agglomeration economies. We can stress that firms embedded in a specific type of region develop firm-level capabilities that allow them to overcome regional barriers and resource deficiencies associated with their environment, and to capitalize on the resource endowments particular to their regional profile. We suggest that the resources related to regional endowment may influence the capabilities developed at the firm level, but not directly on their propensity to introduce new services to the market.

As in all research, this empirical work has limitations. The cross-sectional nature of the data and the potential endogeneity of the variables require us to be careful in interpreting any causal relation. This research highlights associations between innovation activities in KIBS and regions, and it should be seen as a first step in obtaining a better understanding of the causal processes at play. The data do not

allow us to identify how the innovation patterns change over time, nor the effects of these changes on the introduction of new services to the market. A promising approach for future research is to gather panel data in order to examine establishments' reliance on the patterns identified over time and investigate to what extent an increase or decrease in the development and use of different innovation activities and knowledge sources are associated with a higher or lower innovation performance. Such panel data would also allow for causal processes to be better apprehended.

While our sample is representative of the province of Ontario with respect to the investigated KIBS sectors and geography, it does not represent all KIBS sectors or service industries equally. We encourage future studies to extend our work by focusing on individual KIBS sectors or other service industries, as these sectors could differ in their innovation patterns. Moreover, the findings of this study are limited to a single industrial context. Of course, future research could also focus on other contexts, thereby testing for the generalizability of our findings across different locations. Nevertheless, this study makes an interesting contribution to the geography of innovation research in the KIBS sector.

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