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Spatial agglomeration, productivity and innovation of Knowledge-Intensive Business Services (KIBS) of Italian Firms.

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CONTENTS

List of Abbreviations

KIBS – Knowledge-Intensive Business Services

T-KIBS - Technology-based Knowledge-Intensive Business Services

P-KIBS - Professional-based Knowledge-Intensive Business Services

NACE - Nomenclature of Economic Activities

ATECO - ATTività ECOnomica (classification of economic activity)

AIDA - Analisi Informatizzata delle Aziende Italiane (commercial database collected by Bureau Van Dijk)

Introduction and main findings

The purpose of this dissertation is to explore Knowledge-Intensive Business Services (KIBS) theoretically and empirically regarding innovation, agglomeration and productivity. After providing in Chapter 1 a comprehensive overview of the theoretical and empirical state of art, we investigate in Chapter 2 the existence of complementarity between three innovation knowledge sources (internal, external and cooperation) and their impact on innovation, employing different measures of innovation performance across different sectors using data on Italian KIBS, manufacturing and other services firms for the period of 2008-2017 drawn from the MET database, the widest survey administrated in a single European country. Finally, in Chapter 3, we examine the role of agglomeration economies on the productivity of KIBS using data on Italian KIBS firms over a decade from 2009 to 2018 drawn from the AIDA database, a commercial database collected by Bureau Van Dijk.

Going more in detail, in Chapter 1 the systematic review by Tranfield et al. (2003) has been implemented. The aim was to identify state of the art and find research gaps regarding the innovation, agglomeration and productivity of KIBS. The innovation is more investigated by scholars than the agglomeration and productivity of KIBS and mainly has three different directions of research such as the distinction between KIBS and different sectors, the influence of KIBS on different sectors and different determinants of innovation in KIBS. Agglomeration and productivity in KIBS are rarely investigated as the existing studies are mostly concerning the manufacturing and service sector.

In Chapter 2, we have concluded that the probability of employing external knowledge sourcing is positively related to firms' internal knowledge resources in all three sectors. Besides, knowledge relates to their size, age, investment and international activities with sector-specific patterns. Turning to the innovation performances, our results differ across sectors but confirm a positive and significant impact of in-house R&D also in companies belonging to KIBS and in-service companies, even though these activities are not often formally organized, i.e., linked to specific R&D departments (Crevani et al., 2011). The main conclusion we get is that complementing the internal knowledge base with externally sourced technology is crucial to improve KIBS innovation performance and allow to better exploit the strategic and intangible resources which are a feature of this type of firm, and which allow them to make more effective use of innovation input.

According to Zhang (2015), KIBS agglomeration is a key source of aggregate urban productivity, and it boosts urban productivity more than manufacturing and non-KIBS in cities with higher levels of economic development. Therefore, the KIBS' productivity determinants were explored in Chapter 3. There is no doubt that firm characteristics are important for the productivity of the KIBS. Nevertheless, from the empirical results it is found that in order to boost productivity, consideration of the agglomeration economy is necessary.

CHAPTER 1 - Agglomeration, productivity and innovation of the Knowledge-Intensive Business Services: theoretical background and empirical findings.

1. Introduction

The growing interest among academics in studying Knowledge-Intensive Business Services (KIBS) reflects the importance of knowledge and innovation in modern economies. There has been a major increase in the attention paid to KIBS and their roles and responsibilities in innovation systems since the mid-1990s. In comparison to the industrial sector, however, KIBS continues to be understudied by scholars.

Through a literature analysis, the goal of this research is to monitor the evolution of the key aspects on which scholars have based their analyses. Three primary concerns are discussed in particular: (1) how KIBS are defined in the literature; (2) how KIBS have been empirically studied by researchers; and (3) how KIBS analysis has progressed over time. The study divides the research topic into three important conceptual aspects as a major assumption: (i) agglomeration; (ii) innovation; and (iii) productivity.

KIBS play a crucial role as one of the drivers of structural change, broadly defined as the process of reallocation of economic activity across the three broad sectors of agriculture, manufacturing and services (Van Neuss, 2019). At certain moments, structural change becomes particularly large: the economy is taking another vector of its development and deforming industrial relations. The name for this phenomenon is the Industrial Revolution. For instance, the First Industrial Revolution (late XVIII - early XIX centuries) was caused by the transition from the agricultural economy to industrial production due to the invention of steam energy, mechanical devices and the development of metallurgy. The Second Industrial Revolution (the second half of the 19th century - the beginning of the 20th century) was the invention of electric energy, followed by in-line production and the division of labour. The Third Industrial Revolution (since 1970) - the use in the production of electronic and information systems that provided intensive automation and robotization of production processes.

Also, it is worth mentioning the Fourth Industrial Revolution, a term that was introduced as part of the German initiative (Industry 4.0) at Hannover Messe in 2011 when Professor Wolfgang Wahlster, Director and CEO of the German Research Centre for Artificial Intelligence, addressed in the opening ceremony. After several international conferences, this concept received worldwide recognition, and some countries began to define the transition to a new "digital" production as a priority area of their development. As KIBS heavily rely upon professional knowledge and is knowledge-intensive, a better understanding of how KIBS operate will be very useful.

The chapter is organized as follows. Section 2 outlines the methodology followed. Section 3 examines the concept of KIBS and scholars' theoretical and empirical understanding of it. Section 4 then focuses on the conceptual and empirical investigations into the KIBS's innovation behaviours. Section 5 discusses our findings regarding the KIBS's agglomeration and productivity; Section 6 highlights opportunities for further research and summarizes our conclusions.

2. Methodology

Systematic reviews are a relatively new phenomenon in organizational and social sciences (Tranfield et al., 2003; Rashman et al., 2009; Pittaway et al., 2004). They were first developed in medical science and are used to organize and transparently present study findings. We followed the methods indicated by Tranfield et al. (2003), who were the first to use the method in management research. The procedure is summarized in Table 1. The steps include: (a) planning the review; (b) conducting the review, and (c) reporting and dissemination.

The steps are further divided into five different stages. In stage 1, the general methodology plan was identified for stage 2 for the KIBS sector which included keywords such as (1) KIBS and innovation; (2) KIBS, agglomeration and productivity. All relevant papers were searched using 3 scientific digital libraries: Scopus, Web of Science and RePEc by applying the search string to the scientific databases and exported the results (i.e., detailed information about the candidate papers) into a spreadsheet (Fig. 1).

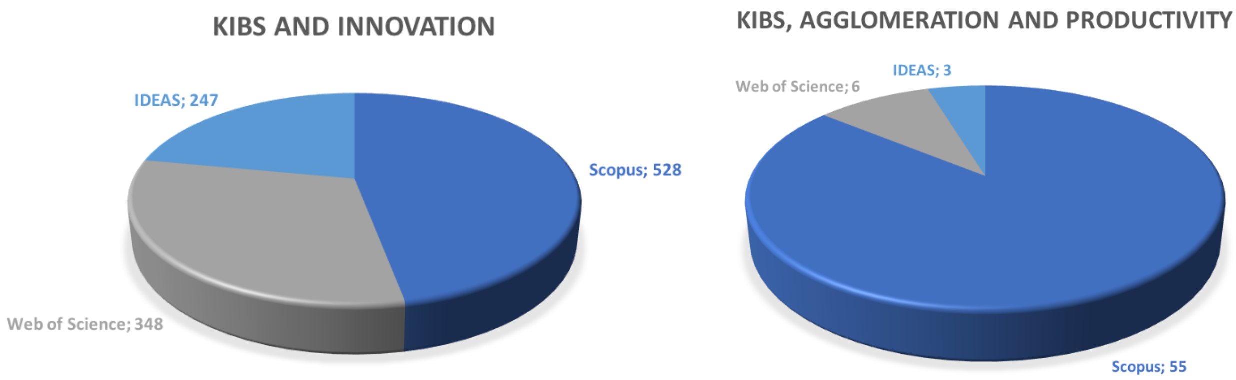

Fig. 1. The number of papers found in the databases.

Fig. 1 represents the research gap based on the number of papers found in different database search engines for KIBS and innovation with Scopus having the highest number of papers, followed by Web of Science and IDEAS. On the other hand, KIBS, agglomeration and productivity followed the same pattern as w.r.t above-mentioned search engines but culminated fewer research conducted in these areas.

Stages 3 and 4 were analyses for inclusion and exclusion, along with quality and relevance. Lastly, concluding literature review with stage 5 for interpretation and paper evaluation.

Table 1: Systematic literature review: strategy and process

Planning the review	**Conducting the review**			**Report and dissemination**
Stage 1	***Stage 2***	***Stage 3***	***Stage 4***	***Stage 5***
General methodology plan. Indendifing key words	*Search databases:* Scopus Web of Science IDEAS *Keywords used:* KIBS and innovation; KIBS, agglomeration and productivity	Inclusion and exclusion analysis	Quality and relevance analysis	Paper evaluation and interpretation

After this stage, each identified candidate paper following the selection criteria defined below were identified as potentially relevant. After that inclusion and exclusion criteria were implemented in order to determine relevancy concerning KIBS.

The selection criteria. The studies were chosen using a set of criteria for retrieving a relevant subset of articles using keywords. First, we only included publications published up to May 2021 that met the following Inclusion Criteria (IC):

IC1: The paper is available online and in English.

IC2: The paper should be about KIBS.

Furthermore, papers that met at least one of the following Exclusion Criteria (EC) were excluded:

EC1: Secondary studies such as interviews, editorials, papers by anonymous authors or conference proceedings
EC2: Duplicates
EC3: The main topic of the research is not about KIBS but some other sectors
EC4: KIBS is not mentioned in the title or abstract

Finally, after doing all the above-mentioned procedures, the found papers were studied regarding the relevancy of the topic. The papers have been divided into three categories such as relevant, partially relevant and not relevant. The relevant papers were included in the literature review evaluation and interpretation in Sections 3, 4 and 5.

KIBS and innovation are studied in a variety of fields within business and management, including general management, organizational studies and science, human resources management, and marketing, but interest also extends to the social sciences, particularly geography and industrial economics. Table 2 shows the most frequent journals where the papers were published.

Table 2. The most frequent journals from the analysed papers.

Name	***N. of papers***
Industry and innovation	6
Service Business	4
Economics of Innovation and New Technology	4
Service Indutries Journal	3
Journal of Evolutionary Economics	2
Knowledge Management Research & Practice	2
Tourism Economics	2
Regional studies	2
Sustainability	2
International Journal of Innovation Management	2
Journal of Knowledge Management	2
Technology Analysis and Strategic Management	2

3. Definition and characteristics of KIBS

In general terms, KIBS are mainly concerned with providing knowledge-intensive inputs to the business processes of other establishments, including private and public sector customers. Miles et al. (1995) identified three principal characteristics of KIBS:

1. *They rely heavily upon professional knowledge;*
2. *They either are themselves primary sources of information and knowledge or they use knowledge to produce intermediate services for their clients' production processes;*
3. *They are of competitive importance and supplied primarily to businesses.*

It is important to start by synthesizing the literature w.r.t the definition and characteristics of KIBS (see Table 3). Table 3 represents the KIBS' definition and characteristics by various authors. Interestingly, most papers do not define or provide a detailed characterization of what constitutes a 'knowledge-intensive business service firm' despite focusing on these.

Table 3. Definition and characteristics of KIBS by various authors.

Author	KIBS definition	KIBS characteristics
Miles et al. (1995)	"services that involved economic activities which are intended to result in the creation, accumulation or dissemination of knowledge"	- they rely on professional knowledge to a high extent; - they either are themselves primary sources of information/knowledge or they use knowledge to produce intermediate services for their clients' production processes; - they are of competitive importance and supplied primarily to business.
Den Hertog (2000)	-	- private companies/ organisations; - rely on knowledge or expertise related to a specific (technical) discipline or (technical) functional domain; - they supply intermediate products and services that are knowledge-based.
Toivonen (2004)	"those services provided by businesses to other businesses or to the public sector in which expertise plays an especially important role"	- they have numerous and versatile contacts with different stakeholders; - they form a node in a system of customers, cooperation partners, public institutions and R&D establishments.
Pardos, Gomex-Loscos and Rubiera-Morollon (2007)	"personalized services that offer a relatively diversified range with high-quality provision"	- they imply an important connection with information, new technologies, new management, production/sales techniques, to new markets.
Koch and Strotmann (2008)	"highly application-oriented services (in which) tacit knowledge plays an important role"	- they require specialized knowledge and cumulative learning processes
Consoli and Elche-Hortelano (2010)	"intermediary firms which specialise in knowledge screening, assessment and evaluation, and trade professional consul tancy services"	-

Source: Own, based on literature review.

KIBS sectors have been categorized into two main groups: technology-based knowledge-intensive business services (T-KIBS) and professional-based knowledge-intensive business services (P-KIBS) (Doloreux & Shearmur, 2012). T-KIBS, which includes digital and smart manufacturing technologies, bear higher innovation investments and depends to a great extent on the creation, absorption and distribution of knowledge (Wyrwich, 2019). Consequently, T-KIBS potentially play a more active role in the operational processes of manufacturing sectors and their transformation through the Fourth Industrial Revolution. P-KIBS, on the other hand, are based on professional services and support activities that rely more on expertise (Amara et al., 2016).

In general, no standard definition of KIBS has arisen, and many researchers use a pragmatic method to identify enterprises based on "standard industrial classifications." Statistically, KIBS is part of KIS. Statistics provided by Eurostat deliver a very useful distinction within the service, relating to the knowledge-content of service categories (Table 4). Based on the 2-digits level of NACE Rev. 2, Eurostat differentiates between knowledge-intensive services (KIS) and less knowledge-intensive services (LKIS). While the first group – additionally sub-divided into knowledge-intensive market services, high-tech knowledge-intensive services, knowledge-intensive financial services and other knowledge-intensive services – includes NACE sub-sectors 50 to 51, 58 to 63, 64 to 66, 69 to 75, 78, 80, and 84 to 93 (including for example water and air transport, publishing, motion picture, video and television program production, telecommunications, computer-related activities, financial and insurance activities, legal and accounting, head offices, management, architectural and engineering activities, advertising and market research, employment activities, security and investigation, public administration and defense, human health, arts, entertainment, recreation and others), LKIS – additionally divided into less knowledge-intensive market services and other less knowledge-intensive services - refer to NACE sub-sectors 45 to 47, 49, 52 to 53, 55 to 56, 68, 77, 79, 81, 82, 94 to 96, and 97 to 99 (including activities such as wholesale and retail trade, repair of motor vehicles, land transport, warehousing, rental and leasing, real estate, travel agencies, office administration, membership organizations, repair of computers and personal goods, etc.).

Table 4: Classification of KIBS activities in NACE 2

KIBS classification NACE Rev. 2	Description of section	Description of division	Comment
Section J, division 62	Information and Communication	Computer programming, consultancy and related activities	
Section J, division 63	Information and Communication	Information service activities	
Section M, division 69	Professional, scientific and technical activities		
Section M, division 70	Information and Communication	Activities of head offices; management consultancy activities	If data availability allows, restrict data to class 70.2: Management consultancy activities
Section M, division 71	Information and Communication		
Section M, division 72	Professional, scientific and technical activities	Architectural and engineering activities; technical testing and analysis	
Section M, division 73	Professional, scientific and technical activities	Advertising and market research	

4. KIBS and innovation.

Through literature review, three different paths have been identified: the distinction between KIBS and different sectors, the influence of KIBS on different sectors and different determinants of innovation in KIBS. In the section below the finding will be discussed.

4.1. Distinction between KIBS and different sectors.

The role of KIBS emerges as crucial in the current global economy innovation process, where these firms act as fundamental providers, users, and intermediaries (Lafuente et al., 2018).

Freel (2006) showed that the innovativeness of KIBS is strongly associated with highly qualified employees and intensive collaboration with local customers and suppliers, compared to manufacturing firms.

Bengtsson and Dabhilkar (2008) explored the topic of outsourcing in KIBS and manufacturing sectors in Sweden and concluded that the main motivations for outsourcing manufacturing and KIBS processes are similarly associated to cost, business orientation, and learning, and innovation-related motives are more pronounced in the services sector. The degree of outsourcing with KIBS alone does not explain the improvement in plant operational performance. One explanation is that outsourcing has mixed effects and represents a trade-off.

Ferreira et al. (2013) compared KIBS with other non-KIBS sectors (agriculture, services, transformative industry, extractive industry and construction). For organisational process innovation, the launch of already existing products in new markets, branding and new product designs, non-KIBS sectors have more greater innovation capacities, while the KIBS sector has it for attributed to product/service innovation.

KIBS are more like manufacturing than other service activities when it comes to allocating intra- and extra-mural R&D expenditures (Asikainen, 2015). The author concluded by investigating product, process and organizational innovation in 1432 KIBS, finance and manufacturing firms in Luxembourg. In addition, even though R&D spending in KIBS does influence innovation performance but those differences exist among the forms of innovation developed (Koch and Strotmann, 2008).

Audretsch and Belitski (2019) measured the impact of external collaboration by the UK's most innovative companies such as high-tech manufacturing, ICT, KIBS, creative and the rest (other industries) and the limits of such collaboration in UK companies. Interestingly, KIS companies limit collaborations by controlling the intensity of R&D rather than the percentage of scientists they hire.

According to Boring et el. (2016), age is related to innovation activity among Norwegian firms in KIBS and manufacturing: when a company grows older, its eagerness to innovate first increases and then decreases, but its ability to innovate increases and then stabilizes.

Comparing to manufacturing where a strong and positive correlation exists between R&D budgets and firm size, KIBS behave differently: small firms are most focused on R&D, which could be a sign of strong involvement in this regard, followed by large companies, but at lowers, the end is the medium-sized T-KIBS that spend only 2.5% of turnover (Bravo et al., 2020).

Cainelli et al. (2019) conducted an analysis of the innovative activities of Spanish firms over the years 2005–2010 and compared knowledge-intensive business services (KIBS) and specialized suppliers within manufacturing (SSM) in terms of three possible determinants of their innovation performance: R&D investments, cooperation with customers, and cooperation with other partners. For companies in both sectors, the association between internal R&D and interaction with customers is fundamental to their innovation effort. But interaction with other-than-customers plays an important role only for KIBS.

Castro Vergara and Marquina Feldman (2018) compared KIBS, services and creative industries with reference to the impact of broadband use (online sales, support, shopping, R&D information) on hiring new employees derived from the successful innovative behaviour. It was obtained that broadband uses are important catalysts of innovative behaviour, which implies hiring new staff, but only for services and KIBS.

4.2. Influence of KIBS on different sectors.

For many businesses, engaging with Knowledge-Intensive Business Services (KIBS) has become a key strategy. The majority of the firms require services that heavily rely on professional knowledge to solve various difficulties. The significance of KIBS plays a key role as transfer assistants in the technological renovation of local economies as KIBS's firm can be intermediate assistants between international sources and the local users who do not have the capability or the market power to access it directly (Bolsani and Scarso, 2009).

Using data of 181 KIBS firms in Singapore, He and Wong (2009) examined that not only export intensity, a strategic focus on marketing and communications, and human capital intensity are positively associated with KIBS's own innovation, but also interaction with manufacturing clients. In addition, KIBS firms are getting to be progressively influential in the industrial interface by continuously changing from being primarily knowledge carriers into influential and symbiotic partners of their clients in Taiwan (Hu, 2017).

The competitiveness and innovation of tourism companies can be enhanced by the knowledge and expertise of KIBS companies (Borodako et al., 2014; Álvarez-González and González-Morales, 2014; Borodako et al., 2015). Cao et al. (2011) explored the impact of KIBS on the innovation of Japanese manufacturing corporations and the results show: (1) KIBS contribute more to the radical innovation of a client rather than incremental innovation, (2) face-to-face is the most efficient method of service delivery, (3) the different divisions of manufacturing all need human resource training making this kind of KIBS the most popular. Besides this, production-based R&D flows acquired from KIBS companies make manufacturing companies more innovative (Ciriaci et al., 2015). As mentioned in Corrocher et al. (2014), KIBS are an important engine for the Regional Innovation System and are defining element of high-income, innovation-oriented regions. Although, KIBS are not the only option for innovation: in the regions where R&D intensity is high as in high-technology manufacturing regions, the growth of KIBS is slower. Moreover, the significant role of KIBS is confirmed for environmental innovators in Italy (De Marchi and Grandinetti, 2013).

However, Castaldi et al. (2013) found that not all KIBS firms can engage in co-innovation as it requires specific abilities and knowledge. For example, when KIBS firms only apply available solutions to deliver the clients' needs, there is no co-innovation. In fact, around 24% of KIBS do not particularly innovate as they rely upon a well-established brand reputation (Corrocher et al., 2008). Further, even if Doloreux and Shearmur (2013) showed the strategies which depend on KIBS are more successful in the terms of innovation outcomes, this does not mean that only the use of KIBS is adequate.

4.3. Different determinants of innovation in KIBS.

There are six types of innovation in knowledge-intensive business services (KIBS) in the research conducted by Amara et al. (2009) based on 1124 firms in Canada: product, process, delivery, strategic, managerial and marketing innovations. The findings of this article additionally contribute to knowledge advancement by presenting new evidence that five types of innovation are complementary (Doloreux and Shearmur, 2010). In addition, the findings of this study suggest that different explanatory variables like a variety of knowledge sources, knowledge creation (R&D), types of knowledge exchanged with clients, the strength of ties with clients and knowledge management strategies explain different types of innovation (Doloreux and Frigon, 2019). As a result, only R&D and the use of knowledge embodied in value-added production practices have a beneficial impact on the introduction of all six types of innovation. Choi and Choi (2021) indicated that R&D cooperation (vertical, competitor and institutional) have a significant effect on innovation performance derived from Korean KIBS data.

By the Wipro case study in India, Appolloni et al. (2013) concluded that it is crucial for KIBS companies to have both internal and external expertise in order to innovate.

Ab.Majid and Awang (2016) concluded that employees' entrepreneurial behaviour and the firm's collaboration with external parties drive KIBS's innovativeness by analysing 200 KIBS firms in Malaysia. One more research conducted in Malaysia by Kheng and Mahmood (2013) revealed a significant impact on the innovation of the following determinants: pro-innovation climate, social capital and leader-member exchange.

Bianchi et al. (2021) carried out different research regarding the innovation activities in KIBS firms. They have collected the data through a cross-sectional survey with 614 professionals who work in T-KIBS firms in Brazil to analyze the relationship between subjective well-being (SWB) and perceived organizational culture (POC) with the individual propensity to innovation (IPI). Since individual propensity to innovation is an important aspect of a company's competitiveness, their study offers a valuable aspect that management should consider. The trend of innovation is influenced not only by various aspects of the corporate environment and its culture but also by the SWB of its employees. Another compelling research have been conducted by Gomes et al. (2020): there is a positive impact of transformational leadership, work-life balance and organisation learning capability on service innovation. Therefore, it highlights the significance of the above-mentioned values for the promotion of the innovative behaviour.

Using a survey of 53 KIBS in a French cluster, Bosquet et al. (2016) examined the importance of internal (R&D and qualified professionals) and external (collaboration with university/external consultant and acquisition of patents, licenses, industrial design) resources on their innovation. Also, the finding confirms the importance of intermediaries such as local cluster institutions in boosting KIBS's innovation capabilities.

For four different types of innovation in German KIBS firms (product improvement, product introduction, process innovation, organizational innovation), Brunow et al. (2019) analysed the relationship between the innovation and increasing distance from the metropolis, small and large cities. The longer the distance from the metropolitan area, the greater the decrease in the probability of innovation, and even if the distance between the large city and the small city is large, the decrease in the probability of innovation is not as significant. In accordance with the research by Fernandes et al. (2013), KIBS tend to locate more in urban areas compared to rural areas within which networks are more easily reached and intensive knowledge shared. KIBS companies located in rural areas choose strategies where in urban areas the innovation activities associated with learning and networking.

There is a growing body of empirical research available on different factors or determinants for the propensity to innovate in cross-sectional comparison with services in general, and to lesser extent in the knowledge-intensive business services (KIBS). For example, Amara et al. (2016) found that the financial obstacles tend to be negatively associated with product and process innovation, while the knowledge obstacles tend to be negatively associated with delivery and managerial innovations in the Canadian KIBS companies. In the same way, lack of financing is presented as the main barrier to innovation of Spanish companies (Corchelo et al., 2019).

To show how the innovation activities in a particular technology (service modification, service innovation and process innovation) and non-technological innovations (HRM practices, marketing practices and structural changes) are affected by financial (cost of financing, access to financing and development of turnover), knowledge (access to skilled employees, information on markets, information on technology) and market (the demand of customers, intensity of competition and availability of business partners) determinants in the sample of Czech Republic KIBS firms, Bumberova and Milichovsky (2020) applied logit models and verified that different types of innovation are differentially affected by various types of determinants.

Cabigiosu and Campagnolo (2015) investigated how product and process innovation and different types of services such as customized services, standard services, standard services with minor customizations, and modular services affect each other and the performance (profitability and growth) of 319 KIBS firms: understanding of customers' specification for the innovation processes as innovation and customization are complementary; process innovation, service customization, and service standardization/modularization present complementarity effects.

Similarly, in the paper by Cabigiosu and Campagnolo (2018), the aim is to understand the effect on the growth of the following innovation types: product innovations new to the firm, product innovations new to the industry, process innovations new to the firm and process innovations new to the industry. Moreover, there is the client-supplier collaboration and service customization that plays a crucial role in the innovation and growth relationship. They found that highly inventive products (i.e., product innovations new to the industry) are more strongly connected with growth in KIBS firms and that a stronger emphasis on both client-supplier collaboration and customization diminishes this favourable effect on growth. However, the results also confirm the complex relationship between innovation and performance. Furthermore, confirmed by Corrocher et al. (2013): it was shown that the link between innovation and growth is indirect and may be influenced by other firm-level factors such as size and age. Indeed, the empirical research reveals that the interplay between firm-level variables accounts for a considerable part of the variation in firm growth.

Carmona-Lavado et al. (2013) proposed three components of intellectual capital (human, social and organizational) and the collaborative nature with clients that influence the innovativeness in Spanish T-KIBS companies. By analyzing the direct and indirect effects of human, social and organizational capital, as expected, there is a positive influence of human capital on innovation. Furthermore, results show is that social capital has a positive impact on innovation only when there is an intensive relationship with clients. Likewise, Chichkanov et al. (2021) show that human capital improves the implementation of technological innovation.

Based on a dataset of 417 Russian KIBS, Chichkanov (2020) studied the concept of client knowledge absorptive capacity (acquire, assimilate and apply) as the determinant of innovation. KIBS which acquires knowledge with help of a wider set of digital channels is more innovative. Assimilation of client knowledge measured by its codification and application of client knowledge can also contribute to not only product innovation, but also to process innovation.

Domestic establishments perform weaker than international establishments in terms of innovation-related activities and innovation outputs, but there is also a difference between KIBS with varying degrees of international activity (Doloreux and Laperriere, 2013).

Doloreux et al. (2018) evaluated internal R&D and external information in innovation based on a survey covering period of 2011-2014 in Canada. There are four innovation types in the research: service innovation, human resources innovation, management innovation and marketing innovation. Initially, the results verified the positive relationship between external information sources (clients, suppliers, consultants, commercial labs, university, technical college, public laboratory etc.) and innovation. Secondly, internal R&D and the external sourcing of information are statistically independent and cannot be considered substitutes or complements. In another research by Doloreux et al. (2018), four types of innovation such as product, process, marketing and organizational innovation were considered as independent variable where external sourcing and external partnering were dependent variables. In general, the results show a positive direct impact of innovation types on openness. While openness is a common characteristic found in literature, although, there seems to be more room in KIBS for strategically considering which activities to perform or not to perform jointly with others (Janssen et al., 2018).

By investigating 15 Italian and Polish KIBS, Zieba et al. (2017) showed that some firms adopt a passive behaviour (innovative ideas come as a kind of side effect of their daily business activities), while others an active one (namely, they actively search for new ideas); some rely more on internal resources (employees, in-house R&D, internal documents), while others on external sources (clients, suppliers, service providers, universities).

5. KIBS, Agglomeration and Productivity

The role of agglomeration economies in regional economic performance has been extensively studied. Much of the empirical analysis has focused on manufacturing (Antonelli et al., 2011). Few papers have tried to investigate whether the intensity of agglomeration economies is different for manufacturing and services due to industrial heterogeneity (Combes, 2000).

However, those papers restricted their scope to the service sector as a whole or only financial service and relied on aggregate city-industry data. None of them focused on knowledge-intensive business services (KIBS), which are mainly concerned with providing knowledge-intensive inputs to the business processes of other organizations (Muller and Doloreux, 2009). The lack of such research is surprising, given the fact that KIBS are overwhelmingly concentrated in urban areas, compared with other service industries (Jacobs et al., 2013).

Antonietti and Cainelli (2008) explored the main drivers of outsourcing of KIBS by Italian manufacturing firms and found that propensity to outsource depends directly on the firm’s size, the use of ICT, R&D and its belonging to a relatively dense local production system. The latter shows that the role of agglomeration externalities is important for interactions between local manufacturing firms and KIBS suppliers.

Antonietti and Cainelli (2016) showed that larger urban size, the amount of resident population of the area in which the firm is located, has a positive and highly significant relationship with KIBS vertical disintegration in the long and in the short run. In particular, the relationship is stronger for the province level and traditional professional KIBS.

The main result from Antonietti, Cainelli and Lupi (2013) is that KIBS companies show a strong tendency to cluster, especially w.r.t manufacturing and other service firms. Moreover, the more firms are vertically disintegrated the stronger tendency to cluster as it brings three main advantages: the local availability of specialized suppliers and customers, the higher probability of face-to-face relations and lower transport and transaction costs.

Chung and Tseng (2019) examine knowledge intensity measured by education level and found that it positively influences the productivity of KIBS. Gallego and Maroto (2015) stated that it is important to pay attention to different categories of KIBS as location factors do not seem to influence the localization strategies the same.

KIBS firms are more frequently located in more urbanized areas compared to the entire services sector. The size of the firm also plays a significant role as the KIBS productivity is higher the larger the firm (Giacinto et al, 2020).

Territorial servitization has recently been identified as territorial development based on synergetic co-location between KIBS firms and manufacturing small and medium-sized enterprises (SMEs). Gomes (2018) found that KIBS deepening, a density variable that measures the percentage of KIBS companies operating in a specific location and time is closely related to territorial servitization.

Herstad and Ebersberger (2014) concluded that KIBS located outside large urban regions with weaker external resource support are more inclined to introduce a broader range of innovations. Horvath and Rabetino (2018) suggested that the quality of the entrepreneurial ecosystem positively influences KIBS formation rates, and positively moderates the connection between manufacturing specialization and the rate of new KIBS, a process recently called 'territorial servitization'.

Using a sample of 47 Spanish regions during 2009-2013, Horvath

(2019) found a positive relationship between the number of universities in a region and the proportion of public universities on the formation rate of KIBS. Also, there is a substitution effect between the universities and industry specialization as KIBS firms expect either stronger knowledge inputs from universities or higher demand from potential industrial customers.

Johnston et al. (2015) results indicate a complex process of partner selection in terms of developing collaborative linkages between firms and universities. However, the firm size, characteristics of the university partner and location plays an important role. Firms located in areas with higher densities of KIBS employment are more likely to develop collaborative linkages with partners in proximity.

By analyzing 24 European countries, Vaillant et al. (2021) concluded the impact of KIBS businesses on manufacturing performance (GVA per worker) is conditioned by the specific nature of the locally present knowledge-intensive service provision through KIBS businesses. Regions with T-KIBS have a potential resource-based relatedness in their ‘knowledge space’ allowing their local manufacturing sectors to diversify production more easily towards Industry 4.0. Yum’s (2019) results show that to raise economic development governments should develop KIBS by considering knowledge-based environments, such as IIT (Internet Information Technology) and the specialization of KIBS, as well as human capital.

Zhang (2015) highlighted that KIBS agglomeration is an important source of aggregate urban productivity, and it provides a larger boost to urban productivity than manufacturing and non-KIBS in cities with higher levels of economic development. In addition, KIBS agglomeration can boost productivity and innovations in their client firms therefore intermediary organizations (e.g., local governments, industry/trade associations) could play significant roles to improve the accessibility of KIBS to users and reinforce the close interaction between KIBS and their clients.

Zhang (2020) noted that having access to a suitable labour force, reducing transportation and transaction costs, and increasing knowledge flows are the main channels through which agglomeration economies contribute to KIBS performance.

6. Conclusion

In advanced economies, KIBS is one of the fastest-growing sectors. They have not only developed significantly in recent years but they are anticipated to continue to do so in the future, producing highly productive and high-quality jobs.

They're also notable for their extremely high reliance on highly educated human capital; predictably, given these traits, they've received a lot of scholarly attention in the previous two decades.

In this context, the purpose of this work is to take stock of what is known about KIBS, with a focus on three points: (1) how KIBS are defined; (2) how they innovate and (3) how agglomeration economies of KIBS affect the productivity.

To begin with, there is no systematic or consensual definition of 'knowledge-intensive business services.' Rather than comparing KIBS to product-based manufacturers or other service providers, some recent research has aimed to understand the differences among them. However, there are limited research on how different types of KIBS operate.

Second, with regards to innovation, a significant increase in interest in the extent to which and how KIBS innovate. Nevertheless, most of the research have the three different directions such as the distinction between KIBS and different sectors, the influence of KIBS on different sectors and different determinants of innovation in KIBS separately, but not analysed in more whole research that will combine not only different determinants of innovation but also how they are related to each other and their impact on innovation in different sectors.

W.r.t to agglomeration and productivity in KIBS much work remains to be done as the existing studies are mostly concerning the manufacturing and service sector, but not specifically KIBS.

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CHAPTER 2 - Innovation of Italian firms in Kknowledge-Intensive Business Services, manufacturing, and other services. Internal and external knowledge.

1. Introduction

Previous analyses on firm innovation activities were mostly concerning the manufacturing sector. However, over the last 20 years, the attention has been raised to the service sector, and mainly to KIBS, which has grown in size and weight in the economic systems after the revolution of Information and Communication Technologies (Antonelli et al., 1997). The less recent literature found that R&D activities are a much weaker competitive factor in services w.r.t manufacturing (Hollenstein, 2003; Cainelli, Evangelista and Savona, 2006), and are an important innovation source only for a small number of science and technology-based service industries (Evangelista, 2000). More recently many studies on innovation in services, alone or in comparison with other sectors of activity, have reached different conclusions. Coombs and Miles (2000) argue that differences between manufacturing and services have been blurred in recent years, a statement confirmed by large ensuing evidence.

In some studies, the manufacturing industry has been compared to services in general (Álvarez et al., 2013; Sirilli and Evangelista, 1998), in other to KIBS (Cainelli, Marchi and Grandinetti, 2019; Teixeira and Santos, 2016; Asikainen 2015; Carlborg et al., 2014, Freel, 2006; Wong and He, 2005). These recent studies lay down the perspective mostly on developed countries. The interpretation is that services firms, and KIBS above all, are as innovative as firms in the manufacturing industry and appear no longer as "laggards" in terms of technology or dependent on the manufacturing industry, being the engine of the new knowledge-based economy.

The role of KIBS emerges as crucial in the current global economy innovation process, where these firms act as fundamental providers, users, and intermediaries (Lafuente et al., 2018; Cáceres and Guzmán, 2014; Gallego et al., 2013; Gallouj and Savona, 2009; Czarnitzski and Spielkamp, 2003).

Despite the increased attention received by innovation in KIBS over recent years further research is still needed to gain a synoptic view of manufacturing, other services and KIBS innovation patterns. Besides, the study of the determinants of the innovative performance of Knowledge-Intensive Business Services (KIBS) further demands exploration, particularly concerning the main external determinant of innovation.

In addition to firm's internal sources for innovation (in house R&D), this paper addresses the above-mentioned knowledge gaps by, considering two external sources: the impact on innovation of companies' outsourcing of R&D activities to different partners (Italian firms, other institutions and foreign firms), and the development of networking activities at local, domestic and international level, as innovation determinants. Innovation cannot be considered as only the result of capabilities and internal operations of companies as it increasingly depends on the interactive performance among various players due to the ever more complex environment and to the high demand for knowledge-based economy.

Most studies in the field of service innovation have found that KIBS are a leading sub-sector not only in relation to innovation, but also in the cooperative activities (Trigo and Vence, 2012) and synergy is key to succeed in the innovative process (Camacho and Rodríguez, 2005). Hence, the collaboration between companies and other partners (such as clients, suppliers, universities and research institutes) is crucial for the analysis carried out in this paper.

The empirical estimations inverstigation proposes a panel-data analysis of the innovation value chain in manufacturing, knowledge-intensive business services (KIBS) and other services. The analysis proposed in this paper had a 2-step approach. First, the modelling of the innovation process in these three sectors. Beginning with firms' attempts to assemble the bundle of different types of knowledge necessary for innovation (Roper and Arvanitis, 2012). This process entails gaining both firms 'in-house' R&D activities and external knowledge sources, such as R&D outsourcing and networking activities, complementing or substituting each other. To look at the determinant of knowledge sources and at the complementarity between sources of knowledges the approach adopted is Multivariate probit analysis (Cappellari and Jenkins, 2003), and the error correlations are presented. For the second step, the paper attempts to answer a set of questions related to the innovation production function in which the effectiveness of firms' knowledge transformation activities into new products or processes or new organization of production is influenced by firms' internal and external knowledge resources in addition to other control variables.

This research investigates the separate role of internal R&D, w.r.t six distinct sources of external R&D for innovation, i.e. outsourcing of R&D to domestic firms (such as domestic clients, suppliers and competitors), to foreign firms (such as foreign clients, suppliers and competitors) and others (universities, other science and technology organizations, exhibitions and trade fairs, industry associations), and networking of R&D with different partners (local, domestic and international), using the standard innovation production function approach (Geroski, 1990; Love and Roper, 1999). RE and IV probit was adopted for this paper.

There are a few novelties of the analysis that are worth highlighting. The main objectives of the paper are to study the existence of complementarity between three innovation knowledge sources (internal, external and cooperation) and their impact on innovation, employing different measures of innovation performance across different sectors. To the best of our knowledge, no study has yet assessed in the same analysis how different R&D sources are related to each other and how they distinctly impact different innovative performances in KIBS, service and manufacturing industries.

Only a few studies focus on different knowledge sources on more than one innovation performance measurement, and they are only based on manufacturing firms (Beneito, 2006; Schmiedeberg, 2008; Goedhuys and Veugelers, 2012; Ballot et al., 2015; Krzeminska and Eckert, 2016). Regarding the literature on KIBS, Asikainen (2015) used R&D expenditure, Cainelli et al. (2019) investment in R&D, while Teixeira and Santos (2016) examine overall external R&D acquisition and continuous intramural R&D. These studies consider the impact on overall innovation.

However, it is very difficult for a single measurement to capture all the complexity of innovation (Serrano et al. 2020; Martinez-Sanchez et al., 2009; Souitaris, 2002). Hence, a unique advantage of our analysis is the opportunity of using different types of innovation (product, process and organizational) in addition to different proxies for knowledge activities.

Another novel contribution of our paper is the focus on Italy and the time span. There are only two studies on innovation patterns focused on services in general (Sirilli and Evangelista, 1998; Evangelista and Vezzani, 2010). These two studies are based on the cross-sectional dimension of CIS data while we use a large panel dataset drawn from merging six waves of the Survey (2008, 2009, 2011, 2013, 2015, 2017). Italy is relatively backward in terms of innovation performances in KIBS and a study of the innovation chain process in this setting demands further exploration.

The main results can be summarised as follows. In the first part of the analysis the complementarity between knowledge sources appears confirmed across firms. Besides, knowledge relates to firm size, age, investment and international activities with sector specific patterns. The second part of the analysis concludes that both internal and external R&D positively influence innovative outcomes. Althought, the results highlight some differences between types of firms and not all the strategies have the same effects on innovation performances for all types of firms.

The structure of the study is as follows. The next section presents a review of the literature on the determinants of innovation in the three sectors under analysis. Section 3 describes the data and the variables used. Section 4 presents the methodologies adopted while the presentation of the results of the estimation models are shown in detail in Section 5. Finally, the last section summarizes the main conclusions and contributions of the study, considering the existing literature and indicates directions for future research. An Appendix is added at the end of the paper.

2. Literature review

The recent literature has increasingly focused on the analysis of the innovation behaviour in the service sectors (Cabigiosu and Campagnolo, 2019; Doloreux and Frigon, 2019; Lafuente et al., 2018; Zieba et al., 2017).

There is also a growing literature focused on comparisons between KIBS, manufacturing and other services (see table A.2 overview) and a wide recognition that innovative activities in KIBS are different from those in manufacturing and other service firms.[1]

Although many studies investigate the impact of the use of external knowledge sources on a manufacturing firm's innovative performance (Vivas and Barge-Gil, 2015), the existing research on internal and external innovation in KIBS is still restricted. There is a wide stream of literature on manufacturing analyzing whether innovation knowledge sources are bound together by a complementarity[2] or substitutability[3] relationship, providing mixed empirical evidence. Arguments for complementarity between internal and external knowledge sources are empirically supported in Veugelers and Cassiman (1999), Cassiman and Veugelers (2006), Hageedoorn and Wang (2012) and Catozzella and Vivarelli (2014), and in Cassiman and Veugelers (2002) for complementarity between internal R&D and cooperation. Pisano (1990) and Schmiedeberg (2008) provided empirical evidence supporting that firms tend to use only in-house R&D when they have accumulated internal experience. This also finds empirical support in Love and Roper (1999, 2001). Serrano et al. (2020) perform conditional

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1 However, Álvarez et al. (2013) have found that Chilean services sector innovates as much as manufacturing both in technological and non-technological types of innovation output.

2 The theoretical arguments supporting the complementarity between innovation knowledge sources draws upon Cohen and Levinthal (1990) theory of "absorptive capacity". The ability to open innovation processes to external flows of knowledge, known as "open innovation' paradigm', is also a critical new source of competitive advantage, according to the the Resource-Based View.

3 The choice between internal and external R&D flows, is based on the "Make or buy decision" within the Transaction Costs Economics. The external knowledge source allows firms to access to externally available specialist know-how (Veugelers and Cassiman, 1999) and to eliminate the costs and risks associated with internal development (Chen and Yuan, 2007). On the other hand, the possibility of opportunistic behavior in transactions in terms of negotiation and enforcement of contracts reduces the potential benefits of the external source (Williamson, 1985).

complementarity/substitutability tests and find evidence of conditional complementarity in product innovation performance between external and internal knowledge sources in absence of cooperation and of conditional substitute relationship between external and cooperation knowledge sources in presence of internal source.

As for the determinants of the innovative performance of service companies, as compared to manufacturing companies, there is a restricted literature regarding the role of external R&D and networking. While this scant literature is almost unanimous in recognizing the relevance of in-house/intramural Research and Development (R&D) activities for the innovative performance of companies (both in service and manufacturing) (see Carvalho et al., 2013; Pires et al., 2008), the results are more fragmentated and mixed as far as different external sources of knowledge are concerned. Despite external research has always been regarded as a key strategic source, the patterns of innovative research have mostly been explored in the manufacturing sector. There seems to be still no clear evidence to the question whether KIBS companies rely on external sourcing of new knowledge and on which external actors they tend to interact more for innovating.

Studies on manufacturing industry suggest that the use of knowledge and information from external sources increase innovation performance of companies (see Laursen and Salter, 2004). Studies focusing on services although scarcer have succeeded in finding a significant relation between innovation outcomes and the use of external sources (Gallego et al., 2013; Marin and Bermejo, 2015).

The literature highlights how service firms have a different behaviour in terms of collaborative innovation when compared to manufacturers. Some authors suggest (e.g., Tether and Tajar, 2008; Uppenberg and Strauss, 2010) that service companies rely to a larger extent on external sourcing of new knowledge industries and tend to innovate more in interaction with customers, suppliers, competitors or consulting companies. Tether (2005) also found that while manufacturers are more likely to innovate through collaborations with universities and research institutes, on the other hand, service companies are more likely to make use of collaborations with customers and suppliers.

A portion of studies have focused more specifically on KIBS. Wong and He (2005) showed that KIBS are more intensively engaged in innovation and training activities than manufacturing firms, but that they are less likely to collaborate with foreign organizations and to perform internal R&D. Freel (2006) showed that the innovativeness of KIBS is strongly associated with highly qualified employees and intensive collaboration with local customers and suppliers, compared to manufacturing firms. Pires et al. (2008) underline the ability of such companies to absorb knowledge through different forms of "knowledge-sourcing activities": R&D activities – external, internal and cooperative. Investment in external R&D for KIBS and services in innovation is also emphasized in other studies (Texeira and Santos, 2016; Asikainen, 2015). Cainelli et al. (2019) conducted an analysis of the innovative activities of Spanish firms over the years 2005–2010 and compared knowledge-intensive business services (KIBS) and specialized suppliers within manufacturing (SSM) in terms of three possible determinants of their innovation performance: R&D investments, cooperation with customers, and cooperation with other partners. For companies in both sectors, the association between internal R&D and interaction with customers is fundamental to their innovation effort. But interaction with other-than-customers plays an important role only for KIBS.

While openness is a common characteristic found in literature, although, there seems to be more room in KIBS for strategically considering which activities to perform or not to perform jointly with others (Janssen et al., 2018). The nature and scope of activities in KIBS make them more focused on external cooperation and on carrying out mainly organizational changes. This type of firm is by nature pursuing renewal, which may conduct to higher absorptive capacity also due to the expertise and know-how which they are endowed with. This might increase their capacity to utilize the positive effects of collaboration and the effort to create long-term relationships with customers, to develop inter-firm networks, internal human capital and training. It is also worth considering the major market knowledge of KIBS, their recurrent relationships with key stakeholders, and also their flexibility in providing a wide array of customised services, implementing and accommodating the new technologies as per the clients' requirements.

As for Italy, there are only two recent studies on innovation patterns focused on services in general. Sirilli et al (1998), by using firm-level data in the period 1993–1995, gathered through two innovation surveys carried out in Italy, focused on service and manufacturing sectors show more similarities than differences w.r.t some dimensions of innovation processes. Evangelista and Vezzani (2010) identified four innovations modes based on technological (product/process) and non-technological content (organizational/marketing) by principal component and cluster analyses and found similarities and differences between Italian manufacturing and service sectors based on these modes.

In the frame of this literature background, this paper analyses a substantial research gap related to two topics: first we investigate KIBs, manufacturing and other firms' participation in different knowledge sourcing activities and provide an indication of complementarities between them. Secondly, we investigate whether the companies' openness and the relative importance attributed to distinct sources of external innovation by Italian firms; other Italian organisations (such as universities, other science and technology organizations, exhibitions and trade fairs, industry associations), and foreign organisation, influence innovation outcomes similarly in these three sectors.

Collaborative innovation leads to many beneficial outcomes in terms of innovation. It lowers innovation costs and also allows firms to share the risk inherent in the innovation process (Cassiman and Veugelers 2002). However, there are also costs associated with managing the relationships with external partners (Gkypali et al. 2017; Aiello et al., 2020). The research look into the international cooperation as this activity has features associated with knowledge (e.g. use of technological synergies, access to specialized technology, greater likelihood of finding abroad highly technologically skilled partners).

3. Data

We consider firm level data on Italian firms drawn from the MET database; the widest survey administrated in a single European country. The sampling design aims at having representativeness at the size, region, and industry levels. Differently from other Italian and European datasets, the sample contains information on firms of all size classes, even very small firms with less than ten employees which play a very important role in Italy. Each wave's observations account a longitudinal data share for roughly 50% of every wave, starting from 2009 one.[4]

We will use the dataset drawn from merging six waves of the Survey (2008, 2009, 2011, 2013, 2015, 2017) to which information from the CRIBIS and ASIA ISTAT databases had been added.

For our analysis, we have used a selected sample of 33.100 observations that includes only firms appearing at least in two consecutive waves from the MET survey 2008, 2009, 2011, 2013, 2015, and 2017. In our final dataset, we have 4822 observations for KIBS firms, 18125 for manufacturing firms and 10153 for other services firms.

Table A.1 in the Appendix shows the size class and geographical distribution of the dataset.[5] Mirroring the Italian firms' population distribution, the dataset shows a firm size distribution skewed towards the smallest dimensions. Indeed, most observations (74.4%) refer to small and micro firms (<50 employees), while large enterprises with more than 249 employees account for only 6% of the panel.

In terms of geographical distribution, 44.9% of firms are in the North of Italy, 27.3% in the central regions, 20.4% in the southern regions and 7.4% in the two islands (Sicilia and Sardinia). The great majority of observations (55%) belong to the manufacturing sectors, which in turn contain higher shares of small and medium-sized enterprises than KIBS and other services which have a higher concentration of micro firms. Furthermore, manufacturing firms tend to be located more often in the North of Italy (especially in the North East), while KIBS and other ones are more frequently settled in the central regions.

Table 1 contains the definition of the variables used for the analysis, and Table 2 their descriptive statistics for KIBS, manufacturing and other services.

[4] See more details of how the dataset was setup in the paper of Brancati et al. (2018).

[5] See tab. A.2, A.3 and A.4 for the classification of these sectors.

Innovation in the MET Survey is represented by three main binary variables: product, process and organizational innovation. Over KIBS firms, 21 per cent have introduced product innovation, and 17.1 per cent introduced process innovation, while in manufacturing they were 32 per cent and 25.9 per cent respectively. As for other services firms, they are less innovative compared to KIBS and manufacturing (16 and 13 per cent). The share of organisational innovators is quite similar across the three sectors (around 43 per cent).

The firm's knowledge sourcing activities are represented by a series of binary variables that show whether they had internal R&D and whether they link to different types of partners as part of their innovation activity. Looking at R&D dummy that shows if any activities have been carried out related to R&D, we find that for KIBS it is 21.2 per cent, while for manufacturing firms 28.1 per cent and only 11.1 per cent in other services firms.

Across the dataset, the most common form of knowledge sourcing is R&D outsourcing with other Italian institutions and with other firms, whereas knowledge outsourcing to foreign entities firms is quite rare in general and especially for other services.

As for cooperation with external partners, on average manufacturing engaged in international networking more often while both KIBS and services the share of firms relying on a local network is higher than in manufacturing.

Tab. 1 and 2 around here

Figure 1 shows the trend both for R&D and for Innovation from 2009 to 2017, considering KIBS, Manufacturing and the other services. The percentage of enterprises that innovate is always greater than the percentage of firms that are involved in R&D. This is true in all the cases examined. At the same time, we observe in all the graphs the break around in 2013, when the percentage of firms that innovate and invest in R&D increases.

FIG. 1 here

4. Methodological framework

We contribute to the empirical literature on the innovative performance of companies, looking both at complementarity between knowledge inputs and at the process through which firms source and transform knowledge into innovation in the three macro sectors under analysis.

Before introducing the relevant variables that allow us to understand the determinants of innovation with a focus on KIBS, Manufacturing and other services, our attention is devoted to the main issues and tools related to knowledge inputs.

4.1. Knowledge Sources: an empirical model

We identify seven alternative routes through which firms may source the knowledge inputs for innovation reflecting both internal knowledge creation and external sources of knowledge acquisition. We have in-house R&D and six external sources measured by R&D outsourcing to Italian firms; R&D outsourcing to other Italian organizations; R&D outsourcing to foreign firms; Networking activities to local firms; Networking activities to domestic firms; Networking activities at the international level (see Table 1 for additional details).

There is a potential for complementary or substitute relationships between knowledge derived from these different sources (Cassiman and Veugelers, 2006; Love and Roper, 2004; Veugelers and Cassiman, 1999). Complementarities may arise, for example, between knowledge sources due to firms' improved ability to substitute effectively internally generated for externally sourced knowledge or vice versa. Other studies, however, have identified a substitute relationship between internal investments in knowledge creation and external knowledge sourcing.

In Schmidt (2010) firms with higher R&D intensities have a lower demand for external knowledge than firms with lower R&D intensities. The more R&D is done in-house the more knowledge is created internally, and the less external knowledge is needed. Hence, we need to check whether there are positive or negative error correlations reflecting complimentary relationships between firms' knowledge sourcing activities. We also aim to compare these relationships across the three different sectors also using some controls variables (group, size, age, sector, international activities, investment and credit access) which allow to capture some firms' characteristics such as the size and age but also the input employed in their operating activities.[6]

This paper summarizes the probability that firm *i* will engage in each of the seven knowledge sourcing activities as follows:

$$RDN_{ijt} = \beta_0 + \beta_1 \mathcal{X}_{it} + +\varepsilon_{it} \qquad (1)$$

where *RDNijt* represents the vector of Research and Development and Network variables i.e. the firm's knowledge sourcing activity *j (j = 1, . . .7)*; *X*it is the vector of explanatory variables, a set of indicators of the firms' resources such as size, age, international activities, shortage of finance; ε_{it} is an error term assumed to be independently and identically distributed with a mean of zero and a variance of σ^2.

In this first estimation of the innovation value chain model an econometric problem which arises relate first to potential simultaneity between elements of the value chain and to potential complementarities between knowledge sourcing activities.

This investigation approach explored in Cassiman and Veugelers (2006) and also followed by Roper and Arvanitis (2012) estimating a Multivariate Probit model for firms' participation in the seven knowledge sourcing activities to catch the potential correlation. Positive error correlations then provide an indication of complementarities.

4.2. Determinants of Innovation: empirical model

To keep building the innovation value chain, in the second step, we consider the process of knowledge transformation, in which knowledge

[6] See Table 1 for a complete description of all the variables considered in the analysis.

sourced by the enterprise is translated into innovation output. This is designed applying an innovation production function in which the success of firms' knowledge transformation activities is influenced by firms' knowledge resources (Love and Roper, 1999; Griliches, 1992). In terms of innovation output, following Pittaway et al. (2004) we examine both product, process and organizational innovation, and show how knowledge from different sources may have differential effects on them. There are different routes through which knowledge of different types might influence different aspects of firms' innovation activity and hence business performance.

This study checks how key innovation determinants influence innovation outcomes in KIBS and other services and manufacturing industries at three main levels: first, investigating the role of R&D; secondly, looking at companies' openness and the relative importance attributed to distinct external sources of R&D for innovation via outsourcing (firm, market and other), and thirdly, considering the external local, domestic and foreign entities, with whom companies cooperate for innovation.

We intend to compare the innovation patterns of KIBS, manufacturing and other services by resorting to two different models, panel RE probit and IV probit, for innovation proxies.

We first estimate a probit model for the innovation output, because the dependent variables are binary indicators. The baseline equation tests the effect of different drivers of innovation according to the following equation

$$Y_{it} = \beta_0 + \beta_{1a}\, R\&D_{it-1} + \beta_{2a}\, R\&DOUTfirms_{\,it-1} + \beta_{2b}\, R\&DOUTother_{\,it-1} + \beta_{2c}\, OUTforeign_{\,it-1} + \beta_{3a} Networkdomestic_{\,it-1} + \beta_{3b}\, Networklocal_{\,it-1} + \beta_{3c}\, NetworkForeign_{it-1} + \beta_4\, \mathcal{X}_{it-1} + \mu_i + \delta_t + \varepsilon_{it} \qquad (2)$$

where Y_{it} is the dependent variable described above (product, process, organizational innovation), for firm i at time t; All the $R\&D_{I,t-1}$ variables represent the vector of Research and Development variables for the alternative knowledge sources identified earlier; $\mathcal{X}_{it-1}$ is the vector of other explanatory variables: Region, Investment, Group, Size, International and Age; μ_i and δ_t denotes firm and time random/fixed effects*;* finally ε_{it} is an error term assumed to be independently and identically distributed with a mean of zero and a variance of σ^2.

Basically, with respect to the innovation production function we will test the following hypotheses:

***H1**: Internal R&D is positively and significantly associated with innovation in KIBS, manufacturing and other service sector.*

***H2:** R&D outsourcing relationship with different organizations is positively and significantly associated with innovation across KIBS, manufacturing and other service sector.*

***H3:** The degree of openness to cooperation for innovation with different types of networking (local, domestic and international) is positively and significantly associated with innovation across KIBS, manufacturing and other service sector.*

At this stage a potential issue is the endogeneity of the knowledge sourcing and network variables. Matching innovation activities with lagged regressors partially solves reverse causation but may leave residual endogeneity in case of relevant unobserved heterogeneity or high persistence of dependent and independent variables. However, we also adopt an IV estimation model. Furthermore, estimating a model instrumenting the knowledge sourcing and network variables. More in detail, the IV strategy that we perform is related to the GMM where we consider the lagged values of the knowledge sourcing variables as instruments.[7].

We use the variance inflation factor (VIF) to assess multicollinearity in our regression model. Even if the results of the pairwise correlation matrix (Table A.6 in Appendix A) show that some variables are significantly correlated between each other, the variance inflation factors (VIF) are low, and this signals the lack of multicollinearity.

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[7] The IV probit is estimated based on equation 2 but considering the lagged (at time t-2) variables as instruments.

A general result we expect is that where firms' internal knowledge resources are strong, this contributes positively to the efficiency with which firms develop new innovations. We expect that also external knowledge sourcing will be beneficial for innovation. However, our empirical comparison relates to three sectors which face different international trading environments and have different R&D and innovation patterns. Hence, we expect quite different results across sectors.

5. Estimation Results

This section is dedicated to presenting the results. The first part focuses on the knowledge sources and Multivariate Probit; and in the second part, our attention will be given to the determinants of Innovation according to the different estimations made based on XT and IV probit.

5.1. Knowledge sources

The initial link to innovation activity is firms' knowledge sourcing. Multivariate Probit models, employed for the reason clarified, for firms' knowledge sourcing are shown in Table 3 with an error correlation matrix in Table 4. Through multivariate probit model and error correlation it shows the following interesting issues: first, how do firms' knowledge sourcing activities relate to their size, age, investment, international activities and group; secondly, what pattern of complementarity or substitutability exists between the knowledge sourcing activities.

Size, measured as a log of number of employees, has, as we expect, a consistently positive relationship to knowledge sourcing in all sectors of interest, this is consistent with the literature that found a higher investment in R&D for the enterprises with a consistent number of employees (Accetturo *et al*., 2013). Similarly, investment has a positive impact in all sectors but especially in the manufacturing sector and international activities have similar effects.

More significant contrasts were observed between the impact of age on knowledge sourcing behaviours in the various sectors. In KIBS, age is showing no significant effect on almost all firms' knowledge sourcing activities but increases the probability that firms engaged in local and domestic networking. In manufacturing, similarly, no significant effect was played by age except for a positive effect on R&D outsourcing with Italian firms and a negative effect on R&D outsourcing with foreign institutions. In other services, it is negative and significant on R&D, but positively affects the R&D outsourcing with foreign institutions and local networking (Table 3).

The impact of the firms belonging to a group on knowledge sourcing for manufacturing firms does not play a big role and has no significant effect on KIBS and manufacturing. On other hand, in KIBS firms the group belonging impairs local networking, but it is positive on international networking, even if at a low significance level (Table 3). As to the other services there is, instead, a positive and significant impact on R&D, R&D outsourcing, international and domestic networking

Regarding the relationship between knowledge sourcing activities, like in Cassiman and Vergoling (2002), the results support both the idea that there are potential complementarities between internal knowledge realization (in-plant R&D) and external knowledge sourcing and that these latter are also complementary in KIBS, manufacturing and other services. As a matter of fact, complementarities between knowledge sourcing activities are numerically and statistically strong for all sectors of research interest with positive and statistically significant error correlations in all combinations (Tab. 4).

Hence, generally, we find that the probability of employing in external knowledge sourcing is positively related to firms' internal knowledge resources. The reason for that, as underlined in Roper and Arvanitis (2012), may depend on the fact that enterprises are obtaining economies of diversification as they increase their learning to manage external relationships effectively and so they have the possibility to obtain advantages from improving the variety of their external knowledge sourcing activities.

Tab. 3 and 4 around here

5.2. Determinants of innovation

The key econometric results for the innovation production function are reported in tables 5 and 6 for KIBS, manufacturing and other services in three different types of innovation: product, process and organizational. Tables 5 shows the main results of the RE probit and tab. 6 the results of the IV probit.

Our main results confirm recent studies suggesting that the introduction of different types of innovation is associated with the use of different types of external sources and collaboration relationships.

Regarding the first hypothesis (H1), and considering the total sample, the result for the R&D activity is positively and significantly associated with all types of innovation. As to the effect on each type of firm we have the same result in manufacturing and other services, while in KIBS, R&D activity is only positively significant for product innovation. In summary, considering the above results H1 is confirmed as to the manufacturing and other services, while partially approved in KIBS (Table 5). Moreover, among the other variables, it is worth emphasizing that there is a sort of complementarity with the accumulation of physical capital given that the probability to innovate increases with the firm size in all the estimations made (see also Accetturo et al. 2013 for a discussion).

As to the H2, the effect of R&D outsourcing with Italian firms is positive on product and process innovation when all sample is considered, and on product innovation in manufacturing, otherwise, the estimation does not present remarkable results.

We underline the same effects when the R&D outsourcing with other Italian organizations is considered but here the impact on the process and organizational innovation is also positive for the KIBS. As for the R&D outsourcing to foreign firms, this does not exhibit interesting values, in fact, we have that only the coefficients of organizational innovation for manufacturing and all sample are significant. So also, the H2 is partially confirmed (Table 5). As to the H3, it is also approved in part as the networking activities are more important for some sectors in specific innovation types. The local networking is significant for only organizational innovation in other sectors, while international networking is positively significant for organizational innovation in manufacturing, whereas impacting negatively process innovation in other services and for product innovation in KIBS. Domestic networking is important for process innovation in KIBS and other services.

Regarding the control variables (international activity, belonging to a group of companies, age and size of the company), in general, the results show that size and carrying out international activity like carrying out investments are positively significant and make the firm innovating more in all sectors. Futhermore, having a very weak negative influence on the age of the organizational innovation of the company and this is verified in manufacturing and in other services as in all the sample. Credit constraint harms process innovation both in manufacturing and in all the sample.

Tab. 5 around here

Table 6 shows the results of the IV strategy that is performed in order to solve the problems of endogeneity when we consider the lagged variables as instruments. This robustness check conducts to some different results to those obtained with the RE probit regressions. As to the H1 it needs to be pointed out that the effect of R&D in the KIBS sector is also positive on process innovation. Moreover, as to the H2, the R&D outsourcing with Italian firms is verified not only in the manufacturing sector but also for process innovation in KIBS and including product and organizational innovation in other services. However, differently from before, when the R&D outsourcing with other Italian organizations is considered, we observe that also the organizational innovation in KIBS improves with that.

In addition, considering the H3, we lose the significant impact of International network on Organizational Innovation in the manufacturing sector, highlighting that domestic networks positively and significantly impacts on product innovation in the manufacturing sector. In addition, the importance of the domestic networks is also increasing across KIBS, this drives the process and organizational innovation, verifying total sample and the other sectors in all the innovation types considered.

Tab. 6 around here

6. Conclusions

This paper utilizes the survey by MET company on Italian firm-level data and elucidates the innovation process in KIBS w.r.t firms belonging to manufacturing and other services. Different sectors are characterised by different technological regimes, innovation and dynamics that in our data appear to have an impact on the type of knowledge required, internal or external, and on its impact on innovation.

More in detail the main findings of the paper are the following. Regarding the firms' knowledge sourcing activity, the probability of employing external knowledge sourcing is positively related to firms' internal knowledge resources in all three sectors. Besides, knowledge relates to their size, age, investment and international activities with sector-specific patterns.

This is in line with large evidence of a positive effect on the innovative output of R&D internal investment (Love et al. 2014) and R&D cooperation between firms and other institutions (Aiello et al. 2019, 2020; Lööf and Broström 2008; Belderbos et al. 2004).

Turning to the innovation performances, our results differ across sectors but confirm a positive and significant impact of in-house R&D also in companies belonging to KIBS and in-service companies, even though these activities are not often formally organized, i.e., linked to specific R&D departments (Crevani et al., 2011). These results are in line with those found by Camacho and Rodríguez (2005) for the Spanish service companies where the most innovative sectors in services are characterized by having investments made in internal Research and Development activities.

Besides, outsourcing to external partners which is a very relevant source of innovation, and the outsourcing to other organizations is on average more valued as a source of innovation for KIBS innovators relative to outsourcing to other firms, in line with earlier empirical studies (see also Chang et al., 2012). Another feature is that networking activities are an important determinant in the innovative process but there are sector-specific patterns.

We found that participation in networking activities via international cooperation tends to have a positive effect on the organizational innovation of manufacturing companies in line with Arvanitis and Bolli (2013). Conversely, the role of interaction with foreign partners does not hold for KIBS and other services while domestic networking is highly significant across all the estimations.

Our study contributes to the empirical literature on KIBS by showing that in Italy, service (in particular KIBS) companies that have higher intramural R&D and are more open to establishing linkages with domestic sources, are much more innovative at different levels (product, process and organisational innovation). It highlights how collaborative innovation can improve performance.

The main conclusion we get is that complementing the internal knowledge base with externally sourced technology is crucial to improve KIBS innovation performance and allow to better exploit the strategic and intangible resources which are a feature of this type of firm, and which allow them to make more effective use of innovation input.

Our study has important implications and can be used in innovation management decisions both for managers and policymakers. First, it explains how the features of this type of business enable them to benefit from external knowledge. This may help to design proper policies to incentivize and make more effective use of external R&D. More specifically, the role played by the relationship with external organizations appears to be crucial, i.e. partners such as universities, research centres and other public institutions.

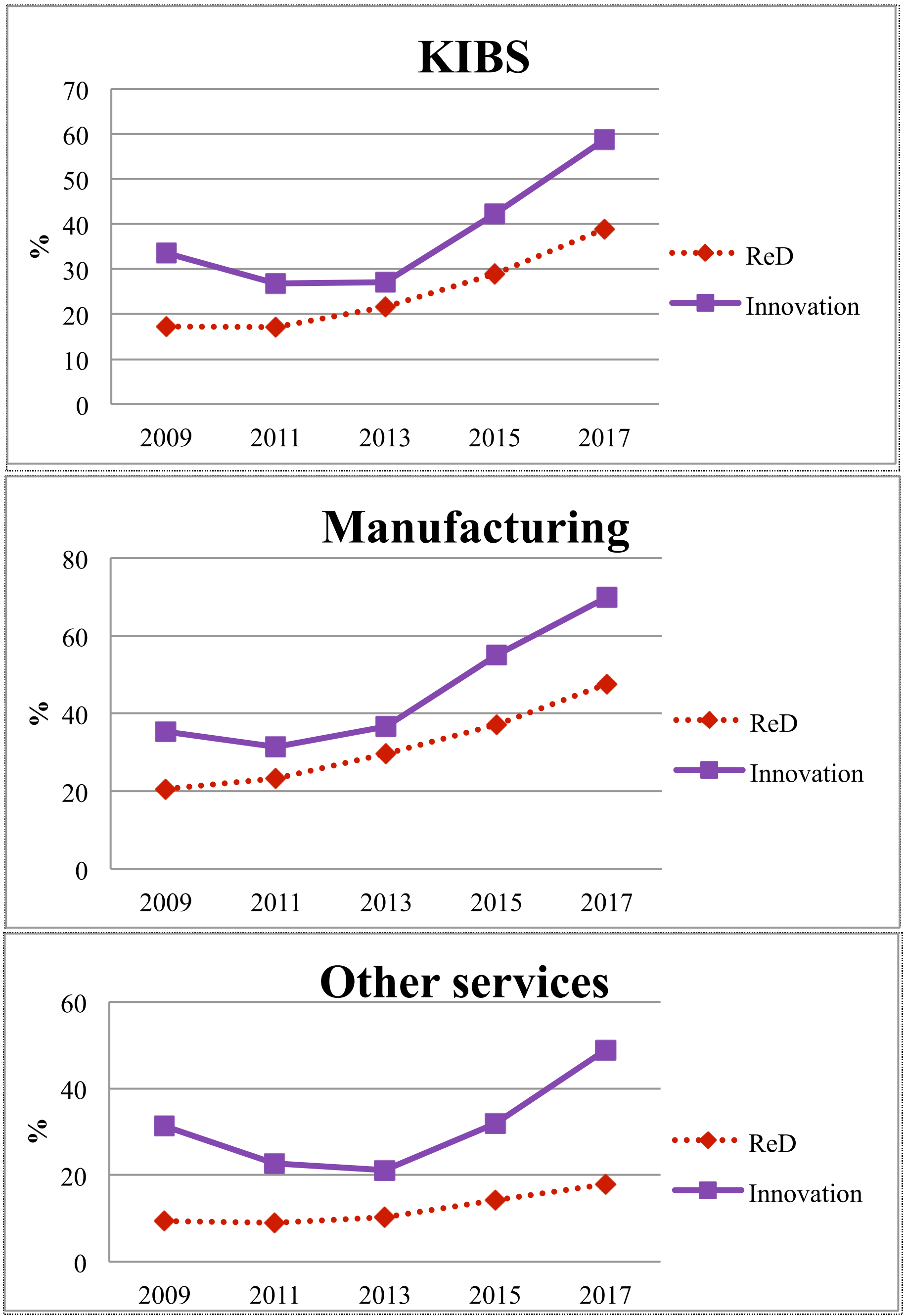
Designing incentives to reinforce such relationships for instance between firms and universities, and other channels of knowledge transmission such as association and professional networks, appear an important policy indication. Overall, our results confirm that the ongoing globalization of production and development processes has made collaboration a crucial source of competition.

Italian firms are small and open to domestic and foreign competition, and companies seeking partnerships domestically or abroad, have an important boost. Important synergies can be developed through more synergetic relationships and access, sharing and complementarity of resources, capabilities, knowledge, experience and technology transfer (Gómez and Murguía, 2010).

Additional policy-relevant results are that small firms register a lower percentage of innovation outcomes, internationalization role is confirmed for innovation, as firms need to innovate constantly to remain competitive in international markets (Bratti and Felice 2012; Castellani 2012), exporting firms have higher innovative output than non-exporters, and belonging to a group matter.

Tables and Figures

Fig. 1. Time series for innovation and R&D indicators.



Notes: Firms with innovation activities reflects firms with either product or process innovation activities. Firms with R&D are those firms with R&D based in the firm.

Table 1. Variables' definitions.

Variables		Variables
Production innovation	Prod_inn	dummy = 1 if the firm has either introduced a new product on the market, radically changed an old one or a significantly improved product
Process innovation	Proc_inn	dummy=1 if the firm has changed its production process or introduced a significantly improved production process
Organizational innovation	Org_inn	dummy=1 if the firm has changed the organisation of its activity
R&D activity (dummy)	R&D	dummy=1 if the firm carries out R&D activity
R&D outsourcing with Italian firms	R&D_out_it_firms	dummy=1 if the firm has relations for Research and Development activities with Italian firms
R&D outsourcing with other Italian institutions	R&D_out_it_other	dummy=1 if the firm has relations for Research and Development activities with other Italian organizations
R&D outsourcing with foreign institutions	R&D_out_foreign	dummy=1 if the firm has relations for Research and Development activities with foreign organizations
Network local	Net_local	dummy if the firms have significant and ongoing relationships with other companies, organizations or institutions at the local, international and domestic level
Network international	Net_internation	
Network domestic	Net_domestic	
Group (dummy)	Group	dummy=1 if the firm belongs to a group of enterprises at time t
Size	Size	ln(1 + number of employees)
Age	Age	natural logarithm of the age of the firm computed as the difference between time t and the date of its establishment
International (dummy)	International	dummy=1 if the firm participates in any international activities
Region (dummy)	Region	20 Regions of Italy
Investments (dummy)	Investments	dummy = 1 if the firm has made any type of investments

Table 2. Descriptive Statistics

	KIBS			Manufacturing			Other services		
	N	mean	sd	N	mean	sd	N	mean	sd
Prod_inn	4822	.21	.407	18125	.32	.466	10153	.163	.369
Proc_inn	4822	.171	.376	18125	.259	.438	10153	.133	.34
Org_nn	4822	.248	.432	18117	.245	.43	10152	.232	.422
R&D	3357	.212	.409	12442	.281	.449	6922	.111	.314
R&D_out_it_firms	3357	.049	.216	12450	.055	.228	6923	.022	.146
R&D_out_it_other	3357	.055	.223	12450	.063	.246	6923	.023	.148
R&D_out_foreign	3357	.013	.112	12450	.011	.103	6923	.003	.054
Net_local	1790	.321	.467	6974	.289	.453	3243	.358	.48
Net_domestic	1790	.196	.397	6974	.249	.433	3243	.199	.399
Net_internation	1790	.059	.236	6974	.119	.323	3243	.049	.216
Size	3357	2.398	1.347	12450	3.264	1.329	6923	2.914	1.481
Age	3325	2.667	.551	12292	2.941	.699	6851	2.728	.701
International	3357	.274	.446	12442	.558	.497	6922	.262	.44
Group	4822	.182	.386	18117	.209	.407	10152	.186	.389
Investment	3357	.465	.499	12442	.564	.496	6922	.487	.5
Region	4822	10.10	5.611	18125	9.064	5.377	10153	10.22	5.487

Table 3. Knowledge sourcing – Multivariate Probit models: KIBS, Manufacturing, Other services (1 – R&D, 2 - R&D_out_it_firms, 3- R&D_out_it_other, 4 – R&D_out_foreign, 5 - Net_local, 6 - Net_international, 7 - Net_domestic)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
KIBS							
Size	0.172***	0.128***	0.157***	0.114*	0.0597**	0.0127	0.0795***
	(0.0298)	(0.0369)	(0.0374)	(0.0686)	(0.0276)	(0.0442)	(0.0293)
Age	0.0536	0.0594	0.0945	0.205	0.243***	0.0205	0.164**
	(0.0754)	(0.0985)	(0.0990)	(0.234)	(0.0673)	(0.123)	(0.0752)
Investment	0.618***	0.706***	0.556***	0.429*	0.335***	0.277**	0.338***
	(0.0740)	(0.101)	(0.0992)	(0.228)	(0.0657)	(0.122)	(0.0722)
International	0.498***	0.497***	0.260**	3.464	-0.0195	1.539***	0.538***
	(0.0785)	(0.0987)	(0.101)	(54.27)	(0.0736)	(0.150)	(0.0768)
Group	0.0822	0.0918	0.0763	0.129	-0.319***	0.270*	-0.0605
	(0.104)	(0.121)	(0.125)	(0.231)	(0.101)	(0.143)	(0.103)
Credit_access	-0.0747	-0.106	-0.145*	-0.158	-0.127**	-0.230**	-0.131**
	(0.0585)	(0.0782)	(0.0812)	(0.177)	(0.0503)	(0.103)	(0.0574)
Constant	-1.506***	-2.193***	-2.362***	-5.908	-1.107***	-2.465***	-1.585***

	(0.257)	(0.338)	(0.342)	(54.28)	(0.227)	(0.427)	(0.254)
Observations	1,745	1,745	1,745	1,745	1,745	1,745	1,745
Manufacturing							
Size	0.249***	0.0886***	0.140***	0.114***	-0.0259*	0.0525***	0.0497***
	(0.0166)	(0.0204)	(0.0211)	(0.0364)	(0.0153)	(0.0196)	(0.0154)
Age	0.0107	0.0898**	-0.00529	-0.107*	0.0195	0.0523	0.0430
	(0.0296)	(0.0359)	(0.0368)	(0.0619)	(0.0265)	(0.0360)	(0.0270)
Investment	0.633***	0.519***	0.497***	0.297***	0.260***	0.279***	0.238***
	(0.0390)	(0.0518)	(0.0548)	(0.0996)	(0.0347)	(0.0483)	(0.0355)
International	0.767***	0.513***	0.603***	0.716***	-0.160***	1.447***	0.361***
	(0.0434)	(0.0585)	(0.0650)	(0.151)	(0.0363)	(0.0938)	(0.0377)
Group	0.0477	0.0374	-0.0289	0.155	0.0584	0.0855	0.0141
	(0.0482)	(0.0570)	(0.0593)	(0.0987)	(0.0465)	(0.0559)	(0.0461)
Credit_access	-0.0169	0.0217	-0.0102	-0.0180	-0.0507**	-0.142***	-0.0614**
	(0.0280)	(0.0339)	(0.0361)	(0.0648)	(0.0249)	(0.0356)	(0.0254)
Constant	-2.763***	-2.982***	-2.972***	-3.220***	-0.495***	-2.787***	-1.235***
	(0.120)	(0.148)	(0.155)	(0.285)	(0.100)	(0.163)	(0.104)
Observations	6,782	6,782	6,782	6,782	6,782	6,782	6,782
Other services							
Size	0.0885***	0.0671***	0.0621**	0.161***	0.0589***	-0.0262	0.0215
	(0.0213)	(0.0254)	(0.0298)	(0.0622)	(0.0164)	(0.0309)	(0.0182)
Age	-0.155***	0.00306	0.0109	0.467**	0.0686*	0.0506	-0.0258
	(0.0497)	(0.0666)	(0.0774)	(0.204)	(0.0369)	(0.0699)	(0.0410)
Investment	0.491***	0.608***	0.391***	0.132	0.303***	0.0901	0.383***
	(0.0676)	(0.0904)	(0.102)	(0.223)	(0.0476)	(0.0901)	(0.0535)
International	0.616***	0.395***	0.518***	0.536**	-0.206***	1.289***	0.415***
	(0.0666)	(0.0846)	(0.0973)	(0.214)	(0.0530)	(0.0994)	(0.0559)
Group	0.243***	0.201**	0.0612	-0.181	-0.0667	0.232**	0.136*
	(0.0833)	(0.102)	(0.122)	(0.309)	(0.0674)	(0.108)	(0.0722)
Credit_access	0.0340	-0.0231	-0.00959	0.122	-0.0718**	-0.127*	0.0524
	(0.0503)	(0.0649)	(0.0754)	(0.163)	(0.0361)	(0.0736)	(0.0397)
Constant	-1.699***	-2.536***	-2.634***	-5.177***	-0.707***	-2.343***	-1.269***
	(0.174)	(0.235)	(0.275)	(0.794)	(0.129)	(0.245)	(0.144)
Observations	3,122	3,122	3,122	3,122	3,122	3,122	3,122

Notes: All equations include constant terms, industry dummy variables at 2-digit level, region and time dummies.

Table 4. Complementarities between knowledge sources reflected in error correlations (1 – R&D, 2- R&D_out_it_firms, 3 – R&D_out_it_other, 4 – R&D_out_foreign, 5 – Net_local, 6 – Net_international, 7 – Net_domestic)

	(1)		(2)		(3)		(4)		(5)		(6)	
	atrho	**p**	**atrho**	**p**	**atrho**	**p**	**atrho**	**p**	**atrho**	**p**	**atrho**	**p**
KIBS												
(1)												
(2)	1.179***	(0.0954)										
(3)	1.160***	(0.0958)	1.029***	(0.0863)								
(4)	0.788***	(0.170)	0.775***	(0.153)	0.627***	(0.136)						
(5)	0.151***	(0.0419)	0.0836*	(0.0464)	0.107**	(0.0452)	0.0996*	(0.0557)				
(6)	0.0908	(0.0710)	0.136*	(0.0817)	0.0507	(0.0770)	0.225***	(0.0858)	0.273***	(0.0719)		
(7)	0.197***	(0.0451)	0.187***	(0.0510)	0.114**	(0.0487)	0.226***	(0.0662)	0.373***	(0.0450)	0.373***	(0.0450)
MANUFACTURING												
(1)												
(2)	1.055***	(0.0450)										
(3)	0.969***	(0.0435)	0.743***	(0.0352)								
(4)	0.760***	(0.0703)	0.639***	(0.0601)	0.618***	(0.0585)						
(5)	0.104***	(0.0210)	0.118***	(0.0228)	0.0918***	(0.0229)	0.0824***	(0.0273)				
(6)	0.156***	(0.0267)	0.164***	(0.0283)	0.134***	(0.0283)	0.158***	(0.0350)	0.408***	(0.0268)		
(7)	0.174***	(0.0217)	0.182***	(0.0239)	0.174***	(0.0237)	0.147***	(0.0296)	0.477***	(0.0215)	0.718***	(0.0273)
OTHER SERVICES												
(1)												
(2)	1.657***	(0.142)										
(3)	1.204***	(0.0995)	1.007***	(0.0842)								
(4)	1.063***	(0.237)	1.018***	(0.198)	1.215***	(0.238)						
(5)	0.143***	(0.0348)	0.168***	(0.0362)	0.118***	(0.0381)	0.148***	(0.0423)				
(6)	0.0798	(0.0583)	0.148**	(0.0621)	0.125*	(0.0666)	0.0959	(0.0768)	0.288***	(0.0527)		
(7)	0.103***	(0.0381)	0.161***	(0.0410)	0.113***	(0.0427)	0.112**	(0.0510)	0.390***	(0.0331)	0.406***	(0.0454)

*** p<0.01, ** p<0.05, * p<0.1

Note: Derived from Multivariate Probit models in Table 3.

Table 5. XT Probit – Impact on Innovation.

	KIBS			MANUFACTURING			OTHER			ALL SAMPLE		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
VARIABLES	Product_inn	Process_inn	Org_inn	Product_inn	Process_inn	Org_inn	Product_inn	Process_inn	Org_inn	Product_inn	Process_inn	Org_inn
LReD	0.536***	0.141	-0.0494	0.558***	0.291***	0.198***	0.702***	0.404**	0.328*	0.600***	0.300***	0.193***
	(0.188)	(0.177)	(0.179)	(0.0797)	(0.0751)	(0.0730)	(0.182)	(0.184)	(0.195)	(0.0661)	(0.0632)	(0.0622)
LReD_out_it_firms	0.342	0.327	0.0591	0.285***	0.106	0.0682	0.228	0.204	0.0137	0.267***	0.155*	0.0468
	(0.265)	(0.240)	(0.248)	(0.108)	(0.0969)	(0.0934)	(0.238)	(0.234)	(0.246)	(0.0902)	(0.0827)	(0.0814)
LReD_out_it_other	0.163	0.405*	0.680***	0.220**	0.140	-0.00376	0.113	0.231	0.104	0.197**	0.169**	0.0683
	(0.249)	(0.230)	(0.243)	(0.110)	(0.100)	(0.0973)	(0.257)	(0.254)	(0.267)	(0.0921)	(0.0851)	(0.0842)
LReD_out_foreign	0.429	0.341	0.436	-0.0714	0.175	0.340*	0.267	0.221	0.0548	0.0115	0.194	0.326*
	(0.514)	(0.456)	(0.480)	(0.216)	(0.196)	(0.188)	(0.619)	(0.597)	(0.609)	(0.186)	(0.169)	(0.167)
LNetwork_local	-0.0427	-0.0311	-0.0898	-0.0591	-0.00300	-0.0557	-0.0242	0.0889	0.127*	-0.0508	0.0153	-0.00574
	(0.112)	(0.106)	(0.102)	(0.0533)	(0.0513)	(0.0500)	(0.0754)	(0.0786)	(0.0725)	(0.0407)	(0.0397)	(0.0377)
LNetwork_international	-0.465*	-0.185	-0.306	0.00871	0.0748	0.133*	-0.0919	-0.442**	-0.115	-0.0497	-0.0315	0.0328
	(0.241)	(0.211)	(0.215)	(0.0829)	(0.0785)	(0.0767)	(0.165)	(0.185)	(0.159)	(0.0693)	(0.0665)	(0.0645)
LNetwork_domestic	0.0598	0.244*	0.137	0.0175	-0.0246	-0.0319	0.0829	0.166*	0.145	0.0490	0.0558	0.0371
	(0.138)	(0.126)	(0.124)	(0.0623)	(0.0600)	(0.0585)	(0.0905)	(0.0928)	(0.0881)	(0.0479)	(0.0466)	(0.0448)
Group	0.0836	0.106	0.131	0.0434	-0.00371	0.187***	0.165*	0.102	0.235**	0.0952*	0.0360	0.185***
	(0.153)	(0.141)	(0.137)	(0.0670)	(0.0637)	(0.0614)	(0.0982)	(0.101)	(0.0957)	(0.0516)	(0.0497)	(0.0473)
Lln_size	0.142***	0.151***	0.185***	0.110***	0.149***	0.131***	-0.00668	0.112***	0.135***	0.0758***	0.139***	0.137***
	(0.0473)	(0.0436)	(0.0414)	(0.0243)	(0.0233)	(0.0222)	(0.0258)	(0.0273)	(0.0262)	(0.0166)	(0.0163)	(0.0152)
Lln_age	-0.0329	-0.0526	-0.157	-0.0363	-0.0464	-0.0891**	-0.0504	-0.0332	-0.159***	-0.0373	-0.0455	-0.118***
	(0.121)	(0.109)	(0.105)	(0.0418)	(0.0397)	(0.0384)	(0.0600)	(0.0629)	(0.0597)	(0.0331)	(0.0318)	(0.0304)
LInternational	0.397***	0.186	0.294***	0.342***	0.113**	0.0834	0.267***	0.269***	0.318***	0.343***	0.169***	0.170***
	(0.120)	(0.113)	(0.108)	(0.0551)	(0.0532)	(0.0518)	(0.0828)	(0.0866)	(0.0810)	(0.0423)	(0.0416)	(0.0396)
LInvestment	0.270**	0.248**	0.272***	0.272***	0.464***	0.266***	0.291***	0.299***	0.204***	0.273***	0.401***	0.249***
	(0.107)	(0.100)	(0.0954)	(0.0499)	(0.0488)	(0.0473)	(0.0739)	(0.0782)	(0.0716)	(0.0386)	(0.0382)	(0.0361)
LCredit_access_lim_inv	0.00240	0.0877	0.0356	-0.0297	-0.104***	-0.0293	-0.0168	-0.0525	-0.0553	-0.0219	-0.0661**	-0.0239
	(0.0799)	(0.0744)	(0.0711)	(0.0352)	(0.0348)	(0.0334)	(0.0547)	(0.0587)	(0.0538)	(0.0278)	(0.0277)	(0.0261)
Constant	-1.769***	-1.948***	-1.255***	-1.565***	-1.440***	-1.451***	-1.462***	-1.764***	-1.215***	-1.658***	-1.762***	-1.268***
	(0.430)	(0.394)	(0.367)	(0.180)	(0.171)	(0.166)	(0.259)	(0.272)	(0.252)	(0.141)	(0.137)	(0.128)
Observations	1,593	1,593	1,593	6,102	6,102	6,102	3,015	3,015	3,015	10,710	10,710	10,710
Number of id	1,047	1,047	1,047	3,780	3,780	3,780	1,913	1,913	1,913	6,683	6,683	6,683

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: All equations include constant terms, industry dummy variables at 2-digit level, region and time dummies

Table 6. IV Probit – Impact on Innovation.

	KIBS			MANUFACTURING			OTHER			ALL SAMPLE		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
VARIABLES	Product_inn	Process_inn	Org_inn	Product_inn	Process_inn	Org_inn	Product_inn	Process_inn	Org_inn	Product_inn	Process_inn	Org_inn
LReD	0.653***	0.222**	0.0888	0.506***	0.230***	0.247***	0.549***	0.545***	0.369***	0.550***	0.289***	0.239***
	(0.0977)	(0.109)	(0.101)	(0.0446)	(0.0455)	(0.0457)	(0.102)	(0.106)	(0.101)	(0.0372)	(0.0385)	(0.0379)
LReD_out_it_firms	0.108	0.367**	0.0367	0.334***	0.203***	0.198***	0.254*	0.227	0.329**	0.276***	0.226***	0.212***
	(0.145)	(0.150)	(0.148)	(0.0656)	(0.0636)	(0.0635)	(0.152)	(0.156)	(0.152)	(0.0550)	(0.0545)	(0.0540)
LReD_out_it_other	0.0230	0.163	0.467***	0.106	0.0142	-0.0650	0.0749	0.0108	-0.181	0.0848	0.0248	-0.0122
	(0.148)	(0.156)	(0.151)	(0.0672)	(0.0659)	(0.0663)	(0.176)	(0.183)	(0.179)	(0.0573)	(0.0573)	(0.0570)
LReD_out_foreign	0.192	0.134	0.0955	-0.00381	0.239*	0.304**	-0.143	-0.0291	0.490	0.00777	0.193	0.259**
	(0.302)	(0.303)	(0.310)	(0.143)	(0.141)	(0.138)	(0.474)	(0.486)	(0.448)	(0.124)	(0.122)	(0.120)
LNetwork_local	0.0241	0.00789	-0.0363	0.0180	0.0596	0.0358	0.0489	0.154**	0.186***	0.0108	0.0574*	0.0778***
	(0.0783)	(0.0862)	(0.0775)	(0.0382)	(0.0389)	(0.0392)	(0.0599)	(0.0643)	(0.0558)	(0.0295)	(0.0307)	(0.0294)
LNetwork_international	-0.105	0.0470	-0.211	-0.0364	0.0334	0.0570	-0.0949	-0.405***	-0.108	-0.0434	-0.0221	-0.0191
	(0.159)	(0.162)	(0.158)	(0.0576)	(0.0580)	(0.0583)	(0.131)	(0.151)	(0.124)	(0.0491)	(0.0501)	(0.0493)
LNetwork_domestic	0.135	0.231**	0.175*	0.104**	0.0487	0.0423	0.119*	0.197***	0.159**	0.111***	0.0984***	0.0903***
	(0.0951)	(0.101)	(0.0940)	(0.0438)	(0.0447)	(0.0450)	(0.0720)	(0.0761)	(0.0677)	(0.0346)	(0.0358)	(0.0347)
Group	0.0273	0.137	0.00651	0.0448	0.0115	0.124***	0.120	0.0833	0.157**	0.0401	0.0178	0.115***
	(0.105)	(0.110)	(0.103)	(0.0458)	(0.0465)	(0.0463)	(0.0769)	(0.0820)	(0.0721)	(0.0362)	(0.0372)	(0.0358)
Lln_size	0.0918***	0.127***	0.151***	0.0508***	0.0979***	0.0850***	0.00528	0.100***	0.109***	0.0596***	0.117***	0.0988***
	(0.0296)	(0.0315)	(0.0289)	(0.0157)	(0.0161)	(0.0161)	(0.0195)	(0.0207)	(0.0181)	(0.0110)	(0.0114)	(0.0109)
Lln_age	0.0481	0.000121	-0.0642	0.0239	0.00684	-0.0351	0.0241	0.0191	-0.0708*	0.0531**	0.0343	-0.0581***

	(0.0764)	(0.0824)	(0.0739)	(0.0272)	(0.0278)	(0.0279)	(0.0448)	(0.0487)	(0.0419)	(0.0220)	(0.0229)	(0.0218)
LInternational	0.274***	0.163*	0.268***	0.347***	0.170***	0.130***	0.243***	0.233***	0.244***	0.381***	0.263***	0.155***
	(0.0826)	(0.0908)	(0.0812)	(0.0391)	(0.0407)	(0.0409)	(0.0642)	(0.0695)	(0.0609)	(0.0297)	(0.0313)	(0.0301)
LInvestment	0.277***	0.326***	0.273***	0.261***	0.450***	0.297***	0.282***	0.281***	0.222***	0.269***	0.399***	0.271***
	(0.0745)	(0.0819)	(0.0731)	(0.0355)	(0.0369)	(0.0370)	(0.0581)	(0.0633)	(0.0544)	(0.0279)	(0.0294)	(0.0281)
LCredit_access_lim_inv	0.00575	0.0856	0.0446	-0.0265	-0.0672**	-0.0279	-0.0231	-0.0296	-0.0269	-0.0128	-0.0319	-0.0192
	(0.0560)	(0.0604)	(0.0541)	(0.0253)	(0.0264)	(0.0263)	(0.0437)	(0.0484)	(0.0414)	(0.0203)	(0.0215)	(0.0205)
Constant	-1.423***	-1.799***	-1.079***	-1.074***	-1.254***	-1.158***	-1.395***	-1.887***	-1.223***	-1.086***	-1.391***	-1.056***
	(0.260)	(0.283)	(0.252)	(0.111)	(0.114)	(0.115)	(0.170)	(0.186)	(0.158)	(0.0945)	(0.0994)	(0.0944)
Observations	1,745	1,745	1,745	6,782	6,782	6,782	3,122	3,122	3,122	11,649	11,649	11,649

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: All equations include constant terms, industry dummy variables at 2-digit level, region and time dummies.

Appendix

Table A. 1. Size class and geographical distribution of the dataset.

	Total		KIBS		Manufacturing		Other	
	N. of obs.	**%**	**N. of obs.**	**%**	**N. of obs.**	**%**	**N. of obs.**	**%**
North_West	6 451	19,5	931	19,3	3 769	20,8	1 751	17,3
North_East	8 421	25,4	1 000	20,7	5 145	28,4	2 276	22,4
Centre	9 028	27,3	1 535	31,8	4 508	24,9	2 985	29,4
South	6 755	20,4	961	19,9	3 566	19,7	2 228	21,9
Islands	2 445	7,4	395	8,2	1 137	6,3	913	9,0
Total	**33 100**	**100**	**4 822**	**100**	**18 125**	**100**	**10 153**	**100**
Micro	11 839	35,8	2 768	57,4	4 881	26,9	4 190	41,3
Small	12 782	38,6	1 366	28,3	7 926	43,7	3 490	34,4
Medium	6 511	19,7	515	10,7	4 140	22,8	1 856	18,3
Large	1 968	6,0	173	3,6	1 178	6,5	617	6,1
Total	**33 100**	**100**	**4 822**	**100**	**18 125**	**100**	**10 153**	**100**

Table A.2. Manufacturing by ATECO 2007 classification

B05 Extraction of coal (excluded tube)

B06 Extraction of crude oil and natural gas

B08 Other extraction activities of minerals from quarries and mines

B09 Activities of extraction support services

C10 Food industries

C11 Beverage industry

C12 Tobacco industry

C13 Textile industries

C14 Packaging of clothing items; package of articles in leather and fur

C15 Manufacture of leather and similar items

C16 Wood industry and wood and cork products (excluding furniture)

C17	Manufacture of paper and paper products
C18	Printing and reproduction of recorded media
C19	Manufacture of coke and products deriving from the oil refining
C20	Manufacture of chemicals
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
C22	Manufacture of rubber items and plastic materials
C23	Manufacture of other processing products of non-metallifying minerals
C24	Metallurgy
C25	Manufacture of metal products (excluding machinery and equipment)
C26	Manufacture of computers and electronic and optical products
C27	Manufacture of electrical equipment and non-electrical household appliances
C28	Manufacture of machinery and equipment n.c.a.
C29	Manufacture of motor vehicles, trailers and semi-trailers
C30	Manufacture of other means of transport
C31	Manufacture of furniture
C32	Other manufacturing industries
C33	Repair, maintenance and installation of machines and equipment

Table A.3. KIBS by ATECO 2007 classification

J62	Software production, computer consulting and related activities
J63	Information activities and other information services
M69	Legal activities and accounting
M70	Business management and advisory management activities
M71	Activities of architectural and engineering studies; tests and technical analysis
M72	Scientific research and development
M73	Advertising and market research
M74	Other professional, scientific and technical activities

Table A.4. Other services by ATECO 2007 classification

D35	Supply of electricity, gas, steam and air conditioning
E36	Collection, treatment and supply of water
E37	Management of sewage networks
E38	Waste collection, treatment and disposal activities; recovery of materials
E39	Restoration activities and other waste management services
F41	Building construction
F42	Civil engineering
F43	Specialized construction works
G45	Wholesale and retail trade and repair of motor vehicles and motorcycles
G46	Wholesale trade (excluding motor vehicles and motorcycles)
G47	Retail trade (excluding motor vehicles and motorcycles)
H49	Land transport and transport by conduct
H50	Sea transport and for waterways
H51	Airplane transport
H52	Storage and transport support activities
H53	Postal services and courier activities
I55	Accommodation
I56	Catering services activities
J58	Publishing activities
J59	Activities of film production, video, tv programs, musical and sound recordings
J60	Programming and transmission activities
J61	Telecommunications
K64	Financial service activities (excluding insurance and pension funds)
K65	Insurance and pension funds (excluding mandatory social insurance)
K66	Auxiliary activities of financial services and insurance activities
L68	Real estate activities
N77	Rental and operating leasing activities
N78	Research, selection, personnel supply activities
N79	Activities of travel agency services, reservation services and related activities
N80	Security and investigation services

N81	Service activities for buildings and landscape
N82	Support activities for office functions and other business support services
O84	Public administration and defense; compulsory social insurance
P85	Instruction
Q86	Health care
Q87	Residential social assistance services
Q88	Non-residential social assistance
R90	Creative, artistic and entertainment activities
R91	Activities of libraries, archives, museums and other cultural activities
R92	Activities concerning lotteries, bets, playing houses
R93	Sports, entertainment and entertainment activities
S94	Activities of associative organizations
S95	Repair of computers and goods for personal and household use
S96	Other service activities for the person

Table A.5. Literature review (cont.. next page).

Authors	Sectors	Data and methodology	Results
Services			
Gallego, Gutiérrez and Taborda (2015)	Services vs. manufacturing	Colombian Innovation Survey on 7765 firms; the CDM approach using panel data	Being a large firm and having an R&D division increases the probability for innovation in both manufacturing and services sector.
Álvarez, Bravo-Ortega, and Zahler (2013)	Services vs. manufacturing	Chilean Innovation Survey on 4332 firms; the CDM approach using cross-sectional data	Consistent with recent results on developed countries, they conclude that services firms are as innovative as firms in the manufacturing industry.
Arvanitis and Bolli (2013)	Services vs. manufacturing	Swiss Innovation Survey and CIS3 data (Belgium, Germany, Norway, Portugal) on 4302 firms; Probit, tobit and IV approach using panel data	There is no effect of national cooperation on innovation performance, however, international cooperation is positively correlated with innovation. There are no visible differences between services and manufacturing sectors.
Trigo and Vence (2012)	Services	The Techonological Innovation Panel data on 2148 Spanish firms; Latent Class Analysis (LCA) using panel data	Firms that are intensive in techno-scientific interactions mainly innovate in product and, to a certain degree in organisational aspects. Intensive in client interactions, on the other hand, seem to be more process innovators than any other profile. Finally, firms with low intensity in interactions are basically organisational innovators.
Evangelista and Vezzani (2010)	Services vs. manufacturing	Survey data (CIS) on 2893 firms based in Italy; Probit, OLS and cluster analysis using cross-sectional data	The economic impact of the organizational mode is higher and more significant in the manufacturing than in services while – and this is perhaps more important – pure product or process oriented innovation strategies exert has positive and significant influence on economic performances only in the manufacturing sector.
Cainelli, Evangelista and Savona (2006)	Services	CIS II and SEA data on 735 firms based in Italy; Logit model using panel data	Investment in ICTs (both hardware and software) plays a dominant role in explaining the virtuous circle between innovation and economic achievement in the service sector. R&D activities, on the other hand, are confirmed as being a much weaker competitive factor in services.
Camacho and Rodriguez (2005)	Services	Spanish CIS3 data; Factor and cluster analysis	The groups of services called 'high and medium innovative' (research and development, software and other computer activities, telecommunications, financial intermediation and other business services) are characterised by higher levels of internal R&D.
Tether (2005)	Services vs. manufacturing	"Innobarometer 2002" Survey data on 3,014 European firms; Logit model using cross-sectional data	The answer for the question if services innovate differently from manufacturing is bothe yes and no. yes: Manufacturers are more likely to source advanced technologies through in-house R&D and through collaborations with universities and research institutes, whereas services, and particularly those with an organisational orientation to their innovation activities, are more likely to source new technologies through collaborations with customers and suppliers, or through the acquisition of external intellectual property. No: in the sense that there is no distinctively different, or unique, "services pattern of innovation"
Hollenstein (2003)	Services vs. manufacturing	Swiss Innovation Survey data on 880 firms; Cluster analysis using cross-sectional data	The results are in line with the proposition of lower R&D in services, as compared to manufacturing.However, the differences are minor.
Evangelista (2000)	Services	ISTAT Innovation Survey data on 6005 firmsin Italy; Factor analysis using panel data	R&D activities represent an important innovation source only for a small number of science and technology-based service industries
Sirilli and Evangelista (1998)	Services vs. manufacturing	Survey data on 42089 firms based in Itlay; Descriptive and exploratory statistical methods using panel data	Technological information is drawn mainly from in-house production departments as well as from outside suppliers of equipment, clients and customers. Again this is a pattern which is close to the one found in the manufacturing sector.

Authors	Sectors	Data and methodology	Results
KIBS			
Doloreux and Frigon (2019)	KIBS	Oslo Manual Survey data on 392 firms based in Canada; Logical regression model using cross-sectional data	The different forms of innovation require different strategies regarding ICT usage, R&D, human capital and sources of information in technological and non-technological innovation.
Cabigiosu and Campagnolo (2018)	KIBS	Survey and AIDA data on 98 firms based in Italy; OLS and GLM models using cross-sectional data	In KIBS firms, the positive relationship between innovation and growth that is stronger for product innovations that are new to the industry. Collaborations with clients and service customisation are the main aspects of the firms.
Janssen, Castaldi and Alexiev (2018)	KIBS	Survey data on 125 firms in the Netherlands; Series of hierarchical linear regression models using cross-sectional data	While openness is a common characteristic, there seems to be room for strategically considering which colloboration activities to perform or not to perform jointly with clients and partners.
Zieba, Bolisani, Paiola and Scarso (2017)	KIBS	Multiple case-study analysis on 7 Italian and 8 Polish companies; a multiple case-study analysis.	Companies providing standard services seem to be more oriented to internal knowledge sources while those supplying highly customized services to use external sources.
KIBS vs. other sectors			
Cainelli, Marchi and Grandinetti (2019)	KIBS vs. SSM manufacturing	Survey data (CIS) on 4290 firms based in Spain; Random-effects (RE) probit model and a panel data Heckman model using panel data	The impact of R&D is comparable in the two sectors, whereas cooperation with customers is more important for SSM than for KIBS.
Lafuente, Vaillant, Leiva, 2018	KIBS vs. traditional industires	Survey data on 74 firms based in Costa Rica; fuzzy set qualitative comparative analysis using cross-sectional data	The results give partial support that product innovation is greater in knowledge-intensive (KIBS) firms than in the firms in more traditional (manufacturing, retail, construction, and consumer services) industries.
Teixeira and Santos (2016)	KIBS vs. services vs. manufacturing	Survey data (CIS) on 4128 firms based in Portugal; Logit model using panel data	Companies in the service sector in general, and in KIBS in particular, that effectively invest in external and (continuous) internal R&D activities and use scientific sources of information for their activities are more innovative than manufacturing sector. Cooperation for innovation with foreign entities are strongly and positively associated in all sectors: KIBS, services and manufacturing.
Asikainen (2015)	KIBS vs. finance vs. manufacturing	Survey data (CIS) on 1432 firms based in Luxemburg; Descriptive and exploratory statistical methods using cross-sectional data	KIBS rely more on extra-mural R&D, in the overall allocation of R&D more similar to manufacturing than to service.
Pires, Sarkar and Calvalho (2008)	KIBS vs. services vs. manufacturing	Portuguese CIS-3 data on 23440 firms; Logit model using panel data	The best performing service sectors (KIBS and financial services) are as innovative as the best performing manufacturing sectors (high-technology manufacturing) Iintramural R&D and extramural R&D have a more positive impact on the propensity to innovate comparing in services comparing to manufacturing.
Freel (2006)	KIBS vs . manufacturing	Survey data on 1161 firms based in Nothern Britain; modified ''knowledge production function'' (KPF) using cross-sectional data	There is confirmation of the importance of customer and supplier cooperation to innovation in KIBS. In contrast, for manufactuirng sector level of R&D expenditure is importnat as it indentifies the most from the less innovative firms.
Wong and He (2005)	KIBS vs . manufacturing	Survey data on 5654 firms based in Singapore; Descriptive and exploratory statistical methods using cross-sectional data	KIBS firms are less likely to have overseas partners for innovation collaboration than manufacturing firms.

Table A.6. Pairwise correlations (1 – R&D, 2 – R&D_out_it_firms, 3 - R&D_out_it_other, 4 – R&D_out_foreign, 5 - Net_local, 6 - Net_internation, 7 - Net_domestic)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1)	1.000						
(2)	0.446	1.000					
(3)	0.490	0.353	1.000				
(4)	0.190	0.193	0.207	1.000			
(5)	0.053	0.075	0.063	0.034	1.000		
(6)	0.196	0.148	0.154	0.123	0.148	1.000	
(7)	0.187	0.155	0.155	0.088	0.265	0.407	1.000

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CHAPTER 3 - Agglomeration and productivity in Knowledge-Intensive Business Services. Firm-level analysis.

1. Introduction

Most studies regarding agglomeration and productivity are focused on the service sector as a whole and the manufacturing sector. Few papers have paid attention to knowledge-intensive business services (KIBS), which are mainly focused on providing knowledge-intensive inputs to the business processes of other organizations. The role of agglomeration economies in regional economic performance has been extensively studied. Much of the empirical analysis has focused on manufacturing (Antonelli et al., 2011). Few papers have tried to investigate whether the intensity of agglomeration economies is different for manufacturing and services due to industrial heterogeneity (Combes, 2000).

However, those papers restricted their scope to the service sector as a whole or only financial service and relied on aggregate city-industry data. None of them focused on knowledge-intensive business services (KIBS), which are mainly concerned with providing knowledge-intensive inputs to the business processes of other organizations (Muller and Doloreux, 2009). The lack of such research is surprising, given the fact that KIBS are overwhelmingly concentrated in urban areas, compared with other service industries (Jacobs et al., 2014). According to agglomeration economics Marshall (1890), an important reason for firms to locate near one another together is to take advantage of agglomeration economies. Cainelli et al. (2019) concluded that knowledge providers like KIBS firms are more reliant on a larger network of partners.

In this paper, we analyze the relationship between agglomeration and the productivity of KIBS. The purpose of this research is to analyze the agglomeration and productivity of knowledge-intensive business services (KIBS) in more detail located in Italy and operating in the period of 2009-2018 based on firm-level data drawn from AIDA database, a commercial database collected by Bureau Van Dijk. The different variables on province and regional level have been merged from ISTAT, OECD, Ufficio It. Brevetti e Marchi and Eurostat databases more specifically, we address the following three research questions: (1) How does agglomeration economies affect the productivity of KIBS? (2) How does the influence of agglomeration economies on KIBS productivity differ comparing Professional-KIBS and Technological-KIBS? (3) How does the agglomeration affect KIBS productivity in different regions of Italy?

The structure of the chapter is as follows. The next section presents a review of the literature on agglomeration and productivity under analysis. Section 3 describes the data and the variables used for the analysis. Section 4 presents the methodologies and research questions adopted while the presentation of the results of the estimation models are shown in detail in Section 5. Finally, the last section summarizes the main conclusions and contributions of the study, considering the existing literature and indicates directions for future research. Tables and an Appendix is added at the end of the chapter.

2. Literature review

Previous analyses on agglomeration issue were mostly concerning the manufacturing sector. However, over the recent years the attention has raised for the service sector, and mainly for KIBS, which after the revolution of Information and Communication Technologies have grown and weight in the economic systems (Antonelli, 1997). Existing studies are mostly in the context of the manufacturing industry or the general economy, which includes both manufacturing and services (Graham and Kim, 2008; Melo and Graham, 2014), but not specifically KIBS.

In China KIBS agglomeration affects innovation output positively and significantly, which is consistent with the theory and empirical analysis conducted previously (Shi et al., 2014). Hu et al. (2015) found out that industrial agglomeration contributed up to 14% of the productivity growth in China's industrial sector between 2000 and 2007.

Unlike manufacturing and services, KIBS are characterized by relying heavily on highly skilled employment, intense interaction with clients, and professional knowledge (Zhang, 2020). Many KIBS firms in the municipality facilitate job switching. When professionals switch employment between KIBS, they bring their skills, which are later passed on to other workers in the company, creating new knowledge (Kekezi and Klaesson, 2020). There is another interesting research by Torres and Godinho (2019) that revealed the presence of four factors that explain T-KIBS' location: (1) access to clients, (2) land-use intensity, and (3) city reputation and (4) household income.

Antonietti and Cainelli (2008) explored the main drivers of outsourcing of KIBS by Italian manufacturing firms and found that propensity to outsource depends directly on the firm's size, the use of ICT, R&D and its belonging to a relatively dense local production system. The latter shows that the role of agglomeration externalities is important for interactions between local manufacturing firms and KIBS suppliers.

Antonietti and Cainelli (2016) showed that larger urban size, and the amount of resident population of the area in which the firm is located, has a positive and highly significant relationship with KIBS vertical disintegration in the long and the short run. In particular, the relationship is stronger for province-level and traditional professional KIBS.

The main result from Antonietti et al. (2013) is that KIBS companies show a strong tendency to cluster, especially w.r.t manufacturing and other service firms. Moreover, the more firms are vertically disintegrated the stronger the tendency to cluster as it brings three main advantages: the local availability of specialized suppliers and customers, the higher probability of face-to-face relations and lower transport and transaction costs.

Chung and Tseng (2019) looked at knowledge intensity as a function of education level and discovered that it had a beneficial impact on KIBS productivity. According to Gallego and Maroto (2015), it is critical to pay attention to different types of KIBS because geographical considerations do not appear to have the same impact on localization tactics.

In comparison to the whole services sector, KIBS enterprises are more typically found in more urbanized locations. The size of the company also matters as KIBS productivity rises as the company grows (Giacinto et al, 2020).

Territorial servitization has lately been defined as territorial development based on synergetic co-location between KIBS firms and manufacturing SMEs (SMEs). Gomes (2018) discovered that territorial servitization is closely related to KIBS deepening, a density variable that quantifies the percentage of KIBS enterprises operating in a certain location and period.

According to Herstad and Ebersberger (2014), KIBS located outside of large urban areas with less external resource support is more likely to introduce a wider range of innovations. As examined by Horvath and Rabetino (2018), the quality of the entrepreneurial ecosystem influences KIBS formation rates and moderates the relationship between manufacturing specialization and the creation of new KIBS, a process known as 'territorial servitization.'

Horvath (2019) identified a positive relationship between the number of institutions in a region and the share of public universities in the KIBS formation rate using a sample of 47 Spanish regions from 2009 to 2013. There is a substitution effect between university specialization and industry specialization, as KIBS enterprises anticipate either better knowledge inputs from universities or higher demand from potential industrial clients.

The findings of Johnston et al. (2015) reveal a complicated process of partner selection when it comes to creating collaborative links between businesses and institutions. However, the size of the company, the qualities of the university partner, and the location all have a role. Firms with larger densities of KIBS employment are more likely to form collaborative relationships with nearby partners.

Vaillant et al. (2021) concluded that the influence of KIBS businesses on manufacturing performance (GVA per worker) is conditioned by the distinctive character of the locally present knowledge-intensive service offering through KIBS enterprises by evaluating 24 European countries. T-KIBS-enabled regions have a potential resource-based relatedness in their 'knowledge space,' allowing their local manufacturing sectors to more easily diversify output towards Industry 4.0.

Yum's (2019) findings show that governments should create KIBS by considering knowledge-based environments, such as IIT (Internet Information Technology) and KIBS specialization, as well as human capital, to boost economic development. The key avenues via which agglomeration economies contribute to KIBS performance, according to Zhang (2020), include having access to a suitable labour force, reducing transportation and transaction costs, and enhancing knowledge flows. In this form, a long-standing debate still exists around the KIBS location. Hence, empirical evidence on the spatial organization for KIBS is limited due to a lack of research on the spatial patterns for analyzing successful KIBS locations (Antonietti and Cainelli, 2016). Table 1 shows the data and obtained results.

As for Italy, there are very limited research on agglomeration and productivity in the KIBS sector. Giacinto, Micucci and Tosoni (2020) by analyzing the geographic localization and the productivity of KIBS in Italy have found that better human capital endowments and stronger agglomeration economies in urban areas appear to be the main explanatory factors. Increased opportunities to benefit from productive demand-side linkages were also found to represent an important factor w.r.t urban productivity advantages in the KIBS sector. Using a large, unbalanced panel dataset of Italian manufacturing firms for the period 1999–2007, Cainelli et al. (2016) found that the role of agglomeration forces (both geographic concentration and variety) is highly dependent on firm size. They showed that the spatial concentration of the local system is significant for influencing the productivity of small firms but not medium and large firms.

Antonietti and Cainelli (2016) found additional evidence that the division of labour in the KIBS industry in the metropolitan region of Milan is higher in more densely populated areas where transport and transaction costs are lower, coordination of different specializations is higher and falling marginal revenues is less problematic, allowing workers to specialize in a smaller number of activities.

The results of previous research show that study characteristics do matter. Melo et al. (2009) found that country specific effects, industrial coverage, the specification of agglomeration economies, and accounting for both the endogeneity of labor force quality and unobserved cross-sectional heterogeneity in time-variant labor quality can give rise to large differences in the results reported in the literature.

The purpose of this research is to analyze agglomeration and the productivity of knowledge-intensive business services (KIBS) operating in the 2009-2018 based on data drawn from AIDA, a commercial database collected by Bureau Van Dijk. In addition, the different variables on province and regional level have been merged from ISTAT, OECD, Ufficio It. Brevetti e Marchi and Eurostat databases.

Our analysis shows some novelty compared with previous studies: 1) the existing studies typically rely either on firm-specific factors or agglomeration economies, while the present chapter explain the productivity of KIBS from both angles, and 2) it considers how the impact of agglomeration forces differs according to different sub-sectors of P-KIBS and T-KIBS. To the best of our knowledge, this is one of first papers that attempt to investigate empirically how agglomeration is related to the productivity in KIBS using span of 10 years (2009-2018) and using not only province level data, but also rich firm-level data. In addition, the chapter investigated the difference between two regions of Italy.

3. Data and variables

3.1. Data and sample selection

Data are drawn from AIDA, a commercial database collected by Bureau Van Dijk. This large database of Italian joint stock companies provides balance sheet information on number of employees, labor costs, output value and sector of economic activity. In this paper, we rely on an unbalanced panel of almost 147 010 observations located in Italy and operating in the 2009-2018 period. In addition, the different variables on province and regional level have been merged from ISTAT, OECD, Ufficio It. Brevetti e Marchi and Eurostat databases.

As it is known, the greatest limitation of the *AIDA* database is that it considers only joint-stock companies, thus excluding partnerships. A potential consequence of this limitation is that many micro and small-sized firms, which represent in Italy a large share of some sectors, could be ruled out. Consequently, the representativeness of micro and small-sized firms could not be good. However, this is not the case. In fact, the coverage of the *AIDA* database in terms of micro and small-sized firms is generally sufficiently high. This is the reason why firm-level datasets drawn from the *AIDA* database have been used in many empirical studies on the determinants or the effects of spatial agglomeration in Italy (e.g., Cainelli and Lupi 2010; Cainelli and Ganau 2018; Cainelli, Ganau and Jiang, 2020).

Overall, a selected sample of 2 140 577 observations in the period of 2009-2018 were drawn from AIDA. In our final dataset, we have 147 010 observations for KIBS firms, 643 539 for manufacturing firms and 1 350 038 for other services firms.

In terms of geographical distribution (see table in Appendix A.1), 63.91% of firms are in the North of Italy, 16.27% in the central regions, 14.69% in the southern regions and 5.13% in the two islands (Sicilia and Sardinia). The great majority of observations (63.69%) belong to the other services sectors. Furthermore, manufacturing firms tend to be located more often in the North-East of Italy, while KIBS and other ones are more frequently settled in the North-West regions.

However, this chapter studies only the sample for KIBS while data for manufacturing and other services will be used for further studies. In terms of geographical distribution (Table 2), 71.22% of firms are in the North of Italy, 18.43% in the central regions, 7.94% in the southern regions and 2.41% in the two islands (Sicilia and Sardinia). The observations are evenly distributed between professional and technological KIBS regarding year, size and geography. Based on the European classification of the firm's size, the data distribution mirrors the Italian firms' population distribution. The dataset shows a firm size distribution skewed towards the smallest dimensions. Indeed, most observations (89,41%) refer to small and micro firms (<50 employees), while large enterprises with more than 249 employees account for only 1.79% of the panel. Also, the table shows the statistics for the quartiles of the dataset sample. The micro firms (the first quartile of the sample) is less then and equal to 3 employees while small is between 4 and 9 employees. The third quartile is medium-sized firms with the employees between 10 and 19. In the top quartile the companies have 20 or more employees. As the dataset is skewed towards the smallest dimensions, it is important to use the quartiles in order to examine the spread of size's distribution.

3.2. Firm characteristics

AIDA compiles financial and economic data on the virtual universe of Italian limited liability enterprises. The data is organized into ten sections to make finding relevant information easier: identification number, contact information, legal and account information, account header, size and group information, industry overview, financial and ratios, stock data, directors/managers/contacts and auditors, ownership data (Grazzi et al., 2017). This dataset comprises annual values for variables such as revenue, value added, net profits, book value of physical capital, number of employees, leverage, R&D expenditure, among others. The definition of variables and summary statistics can be found in Tables 3 and 4 respectively.

3.3. Agglomeration economies

Agglomeration economies are empirically separated into two types: specialization externalities and diversity externalities, which differ in terms of whether knowledge spillovers occur from inside the business or from other industries. A location quotient (the percentage of industry employment in a city relative to the share of the entire industry in national employment) is the most popular technique to measure specialization externalities since it captures both the relative relevance and the intensity of the phenomena (Marrocu et al., 2013).

So the measure of specialization of KIBS in province is the fraction of the KIBS represents in province, relative to the share of the whole industry in national employment :

$$Specialisation = \frac{industry\ employment\ in\ province/total\ employment\ in\ province}{industry\ employment\ in\ Italy/total\ employment\ in\ Italy}$$

Concerning diversity, this research employs the inverse of a Herfindahl concentration index based on employment, as Henderson et al. (1995) did, which is constructed in such a way that the sum of the squares of employment for a particular region and a specific sector does not include the employment of that sector (Marrocu et al., 2013):

$$HHI_{ik} = \sum_{j \notin k} s_{ij}^{2} \quad (1)$$

Following Combes (2000) and Zhang (2016), the population density of the province is also included, capturing the scale effect of city size.

In addition to that, dummy variable for twenty capital provinces in Italy (Ancona, Bari, Bologna, Cagliari, Campobasso, Catanzaro, Firenze, Genova, L'Aquila, Milano, Napoli, Palermo, Perugia, Potenza, Roma, Torino, Trieste, Valle d'Aosta, Venezia) have been included.

Following Meliciani and Savona (2015) we considered the intermediate demand for KIBS (INTDEM) that is proxied by the weighted share of employment in manufacturing enterprises that are intensive clients of KIBS over total employment. Intensive clients are identified using the ISTAT symmetric Input-Output tables in 2015.

In particular, in order to compute this indicator, we use a vector whose value indicates the use of services on output for manufacturing sectors that are above average KIBS users and, for each province and year, we multiply it by the total employment in each respective manufacturing sector. Then, we divide this number by the Province's total employment in a year.

In terms of geographical distribution (Table 5), weight of agglomeration variable (capital, population density, specialisation, diversity and INTDEM) in the North-East of Italy is about 26%, about 45% in the North-West regions, about 8% in the southern regions, about 18% in the Centre and 3% in the two islands (Sicilia and Sardinia).

4. Research questions and methodology

This research contributes to the extant agglomeration economies-productivity literature by focusing on KIBS, which are increasingly widespread in today's knowledge-based economy. The aim is to obtain a deep understanding of the channels through which agglomeration economies contribute to the productivity of KIBS firms.

Miles et al. (1995) classifies KIBS into 'traditional professional services (P-KIBS)' and 'new-technology-based services (T-KIBS'. IP-KIBS are 'traditional professional services, liable to be intensive users of new technology: M69 Legal activities and accounting, Business management and advisory management activities, M71 Activities of architectural and engineering studies, M73 Advertising and market research. T-KIBS are mainly related to information and communication technologies as well as technical activities: J62 Software production, computer consulting and related activities, J63 Information activities and other information services, M72 Scientific research and development, M74 Other professional, scientific and technical activities (Table 6).

There is limited research on the sub-sectors of KIBS. Therefore, the purpose of the chapter is not only look at the different determinants of productivity, but also explore how the influence of agglomeration economies on KIBS productivity differ comparing P-KIBS and T-KIBS in two regions of Italy as North-Centre (North-East, North-West and Centre regions) and Mezzogiorno (South region and Islands).

In order to analyze the sign and magnitude of the relationship between agglomeration variables and firm productivity, a two-step approach was adopted. First, TFP at firm level was estimated implementing both the semi-parametric approach proposed by Levinsohn and Petrin (2003)[8] and Cobb-Douglas production function.

Firm-level TFP is estimated on an unbalanced panel of 147 010 KIBS firms over the period 2009-2018. In detail, the first approach is based on Olley and Pakes' (1996) contribution, Levinsohn and Petrin (2003) proposed a two-step semi-parametric approach which uses intermediate inputs as a proxy for unobserved productivity in order to solve the simultaneity problem between input and productivity. However, a major limitation of this approach concerns the collinearity between labour and intermediate inputs, which is likely to arise if both inputs are allocated simultaneously by the firm as a function of productivity and capital input (Ackerberg, Caves, & Frazer, 2015; Van Beveren, 2012).

The second approach for TFP is estimated as the residual of a Cobb-Douglas production function which can be specified as follows in logarithmic form:

$$\gamma_{it} = \beta_0 + \beta_k k_{it} + \beta_1 l_{it} + u_{it} + n_{it} \qquad (2)$$

where β_0 represents the mean efficiency level across firms and over time; γ_{it} , k_{it} , l_{it} denote value-added, capital input and labour input of firm i at time t, respectively; n_{it} is an independent and identically distributed component which represents productivity shocks not affecting the firm's decision process. Then, the estimated productivity is computed by solving equation (2) for $\omega_{it} = \beta_0 + u_{it}$ as follows (Van Beveren, 2012):

$$\widehat{\omega}_{it} = \hat{u}_{it} + \hat{\beta}_0 = \gamma_{it} - \hat{\beta}_k k_{it} - \hat{\beta}_l l_{it} \qquad (3)$$

. The LP methodology will be performed using the "levpet" Stata routine (Petrin, Poi, and Levinsohn 2003) where $\widehat{\omega}_{it}$ is a state variable-transmitted component indicating that part of the firm's productivity which is known by the firm and which affects its decision process (Olley and Pakes, 1996).

Futhermore, the following equation is our main regression model as a second step in the methodology:

$$Y_{it} = \beta_1\, Firm\_Char_{it} + \beta_2 Agglomeration_{it} + \beta_3 R\&D_{it} + a_{it} + \rho_{it} + \sigma_{it} + \varepsilon_{it} \qquad (4)$$

where Y_{it} is the TFP, for firm i at time t; Firm Char is a set of control variables related to firm characteristics; Agglomeration variables represents: capital, density, specialisation, diversity and INTDEM; all the R&D variables represents: marchi, share of graduate and R&D expenditure of GDP ; a_{it} is are province fixed effects to control for unobserved province-firm heterogeneities; ρ_{it} denotes year fixed effects; σ_{it} denotes sub-sector fixed effects; finally ε_{it} is an error term assumed to be independently and identically distributed with a mean of zero and a variance.

Estimates of agglomeration economies suffer from two main biases: unobserved heterogeneity and simultaneity. Those two problems were addressed through a fixed-effects approach first (for unobserved heterogeneity). After that, firm fixed effects were added to the simple OLS regression, which help eliminate constant omitted variable bias. The standard errors are improved for potential heteroskedasticity.

5. Empirical results

Table 7 presents the results of our regression analysis related to the productivity measure by TFP based on LP approach.

As expected and based on previous research, it was found that age, tangible and intangible assets are positively significant for the whole sample and for the T-KIBS and P-KIBS sub-samples.

The results on the size of the firms shows the positive significance as well. Giacinto et al (2020) concluded as the size of the company grows so does the productivity.

Similarly, the leverage is negatively significant for KIBS and sub-sectors. R&D expenditure per employee is significant only when whole sample of KIBS was taken into consideration.

Regarding the agglomeration variables, there are different results. For the firm situated in capital province the coefficient displays positive effect on the productivity of the KIBS firm. When population density is measured at the province level, it is significant only for KIBS as a whole and in particularly for P-KIBS. Specifically, P-KIBS, are more sensitive to transaction costs and tend to rely on the market (i.e. to buy business services) as far as the size of market expands. The coefficient for specialisation is statistically significant for the whole sample and for T-KIBS sub-sample, while diversity variables is opposite: negatively significant for the whole sample and for the P-KIBS sub-sample. Finally, INTDEM variable is positively significant for all samples.

As for R&D variables, marchi as a share of brands over the population at the province level also is positively significant for all analyzed samples. On the contrary, share of R&D expenditures in GDP has no significant effect on the productivity of KIBS. Following Yum (2019), the results show that for T-KIBS the share of graduates will boost productivity. Since one of main characteristics of KIBS sector is relience on the professional knowledge, the results confirm the importance of the human capital in KIBS and especially for T-KIBS sub-sample.

Table 8 shows the results based on the Cobb-Douglas production function and has similar results as mentioned above.

Table 9 shows the regression results for two different locations: North-Centre and Mezzogiorno. The north-south division of Italy have been selected since the agglomeration economy can be a relevant factor in explaining the gap between regions (Buzzacchi et al., 2021). The following conditions are relevant: 1) aggregation has significant and persistent imbalances between the North and South of Italy; 2) positive TFP differences support more agglomerated Northern region with positive externalities created by the concentration of companies and workers in particular local markets; 3) productivity differences in relation to Southern regions to other indicators such as GDP per capita and additional welfare measures. Only firm characteristics variables are significant for both North-Centre and Mezziogiorno regions. However, all agglomeration and R&D variable are significant for only North-Centre regions. Southern Italian firms are significantly less productive than those in the north because they compete in less consentrated local environsments and are therefore less able to produce the positive externalities seen in the agglomerated areas where Northern firms are located.

6. Conclusion

Over the last two decades, a significant amount of studies has been conducted on the existence and nature of agglomeration economy, with a particular focus on regional economic performance in general or manufacturing. However, the impact of agglomeration economies on KIBS company's economic performance has rarely been investigated. In this chapter, we fill the research gaps by examining theoretically and practically the effect of agglomeration economies in promoting the economic performance of the KIBS sector.

KIBS agglomeration is a key source of aggregate urban productivity, according to Zhang (2015), and it boosts urban productivity more than manufacturing and non-KIBS in cities with higher levels of economic development. Furthermore, because KIBS agglomeration can boost productivity and innovation in their client firms, intermediary organizations (e.g., local governments, industry/trade associations) could play a key role in improving KIBS accessibility and reinforcing the close relationship between KIBS and their clients. Therefore, understanding what determinants are important for the productivity of KIBS is crucial. To conclude, there is no doubt that firm characteristics are important for productivity. Nevertheless, from the empirical results it is found that in order to boost productivity, consideration of the agglomeration economy is necessary.

Hence, having access to a suitable labour force, reducing transportation and transaction costs through being in capital and having high population density, and increasing knowledge flows are the main channels through which agglomeration economies contribute to KIBS's productivity. As per each sub-sample, for P-KIBS and T-KIBS location in the capital is a common parameter. Other parameters affecting P-KIBS are population density, diversity and INTDEM which plays a key role in improving productivity, meanwhile, for T-KIBS, specialization and share of graduate respectively. Based on the findings of this research and for the future research work, it can be concluded that as the dataset for manufacturing and other services sectors is available, the current topic can be examined further in order to see a more detailed picture of the productivity of KIBS and how the agglomeration economies influence it differently compared to manufacturing and other services sectors.

Tables

Table 1. Literature review.

Authors	Sectors	Data	Results
Giancinto, Micucci, Tosoni (2020)	KIBS	Census data and Cerved Group Database on Italy; Regression anaysis	There is evidence of a positive and significant urban productivity premium in the KIBS sector, which is more pronounced compared with the generality of non-KIS tertiary activities and also slightly larger compared with the average premium estimated for the remaining part of knowledge-intensive services. The value of the urban productivity premium was also shown to be significantly higher for larger firms, while it was essentially unrelated to size in other KIS industries.
Zhang (2020)	KIBS	The China Securities Market and Accounting Research (CSMAR) database on China; firm fixed effects to the simple OLS regression	It shows that unlike manufacturing and traditional services, KIBS are characterized by relying heavily on highly skilled employment, intense interaction with clients, and professional knowledge. Hence, having access to a suitable labour force, reducing transportation and transaction costs, and increasing knowledge flows are the main channels through which agglomeration economies contribute to KIBS performance.
Kekezi, Klaesson (2020)	KIBS	Data for Sweden's 290 municipalities, maintained by Statistics Sweden and the Swedish Trademark Database; Pooled and RE Tobit models	Results show that the distance decay of spillovers is fast. Only local concentrations of KIBS seem to be of importance. Over longer distances, we instead observe negative consequences for trademarking, indicating possible spatial competition effects.

Romero de Ávila Serrano (2019)	KIBS	Case studies of three European city-regions (London, Paris, and Madrid) and three U.S. city-regions (New York, Los Angeles, and Chicago)	The results show that (a) there is a relationship between urban spatial structure and KIBS location; (b) KIBS locate in a polycentric form in search of urbanization economies; but (c) certain KIBS are highly concentrated in just a few subcenters, looking for localization economies; (d) proximity to the core and agglomeration economies are a factor in the location of KIBS; and (e) the European cases have more KIBS subcenters but closer to their central business districts, while the American cases have fewer and larger KIBS subcenters located farther from their central business districts.
Yum (2019)	KIBS	USA; a new cluster quotient (CQ) index and Seemingly Unrelated Regression model	The results finds that Washington, DC, plays an impor- tant role in KIBS clusters in the USA, followed by California, MD, Boulder, CO, Huntsville, AL, and Boston, MA. This study also finds that the CQ index would be a better index than the LQ index for measuring the magnitude of clusters given that LQ cannot consider the agglomeration of industries into its index. By exploring econometric models, the study finds that KIBS and the GDP posi- tively interact with each other.
Giacinto, Micucci, Tosoni (2018)	KIBS	Census data, INSP and Cerved Group Database on Italy; Descriptive statistics and regression analysis	Better human capital endowments and stronger agglomeration economies in urban areas appear to be the main explanatory factors. Increased opportunities to benefit from productive demand-side linkages were also found to represent an important factor with respect to urban productivity advantages in the KIBS sector.

Antonietti, Cainelli (2016)	KIBS	AIDA database on Italy; the pooled OLS and fixed-effects regressions	Having controlled for firm age, size and endogeneity, our estimates show that larger urban size has a positive and highly significant relation with KIBS vertical disintegration in the long and in the short run. In particular, in searching for business-related services, traditional professional KIBS benefit more from increases in urban size, than technology-related KIBS. With respect to the literature on urbanization and firms' boundaries, we found additional evidence that the division of labour in the KIBS industry is higher in more densely populated areas where transport and transaction costs are lower, coordination of different specializations is higher and falling marginal revenues is less problematic, allowing workers to specialize in a smaller number of activities. Professional KIBS, in par- ticular, are more sensitive to transaction costs and tend to rely on the market (i.e. to buy business services) as far as the size of this latter expands.
Shi, Wu, Zhao (2014)	KIBS	A balanced panel data-set was taken from 30 Chinese regions; the knowledge production function (KPF)	It is found that KIBS agglomeration affects innovation output positively and significantly, which is consistent with the theory and empirical analysis conducted previously. In comparison with developed countries, KIBS in China is still in the initial stage of development.
Jacobs, Koster, Oort (2012)	KIBS and MNEs	LISA (for North-Holland/Amsterdam) and PAR (for Utrecht) databases; the method of Duranton and Overman (2005; 2008) to estimate kernel densities for a given industry	H1: KIBS have become more concentrated in the urban region over time --- yes H2: Entries of KIBS in the urban region are spatially concentrated --- yes H3: The location of entries of KIBS depends on spatial proximity to existing KIBS --- yes H4: The number of entries of KIBS depends on spatial proximity to MNEs.

Table 2. Dataset distribution by year, size and geography.

	T_KIBS			P_KIBS			Total		
	N. of obs	**% row**	**% col.**	**N. of obs**	**% row**	**% col.**	**N. of obs**	**% row**	**% col.**
2009	5484	50.25	7,4	5430	49.75	7,45	10914	100	7,42
2010	5763	49.70	7,77	5832	50.30	8	11595	100	7,89
2011	6888	50.07	9,29	6870	49.93	9,43	13758	100	9,36
2012	7313	50.53	9,87	7161	49.47	9,83	14474	100	9,85
2013	7557	50.53	10,19	7399	49.47	10,15	14956	100	10,17
2014	7880	50.45	10,63	7740	49.55	10,62	15620	100	10,63
2015	8199	50.64	11,06	7991	49.36	10,96	16190	100	11,01
2016	8381	50.70	11,31	8148	49.30	11,18	16529	100	11,24
2017	8432	50.60	11,38	8232	49.40	11,29	16664	100	11,34
2018	8229	50.45	11,1	8081	49.55	11,09	16310	100	11,09
Total	**74126**	**50.42**	**100**	**72884**	**49.58**	**100**	**147010**	**100**	**100**
NE	20590	53.15	27,78	18151	46.85	24,9	38741	100	26,35
NW	31914	48.39	43,05	34043	51.61	46,71	65957	100	44,87
Centre	13831	51.05	18,66	13264	48.95	18,2	27095	100	18,43
South	6100	52.28	8,23	5568	47.72	7,64	11668	100	7,94
Islands	1691	47.65	2,28	1858	52.35	2,55	3549	100	2,41
Total	**74126**	**50.42**	**100**	**72884**	**49.58**	**100**	**147010**	**100**	**100**
Micro (<=9)	34751	45.62	46,88	41420	54.38	56,83	76171	100	51,81
Small (10-49)	31529	55.59	42,53	25188	44.41	34,56	56717	100	38,58
Medium (50-249)	6517	55.36	8,79	5255	44.64	7,21	11772	100	8,01
Large (>250)	1329	56.55	1,79	1021	43.45	1,4	2350	100	1,6
Total	**74126**	**50.42**	**100**	**72884**	**49.58**	**100**	**147010**	**100**	**100**
Micro (<=3)	16209	41.29	21,87	23048	58.71	31,62	39257	100	26,7
Small (4-9)	18542	50.23	25,01	18372	49.77	25,21	36914	100	25,11
Medium (10-19)	19109	55.86	25,78	15099	44.14	20,72	34208	100	23,27
Large (>20)	20266	55.32	27,34	16365	44.68	22,45	36631	100	24,92
Total	**74126**	**50.42**	**100**	**72884**	**49.58**	**100**	**147010**	**100**	**100**

Table 3. Variables' definition.

Stata's name	Definition	Source	Year
Firm-level			
id	# of observation	AIDA database	2009-2018
T	Year of observation	AIDA database	2009-2018
Name	Business name	AIDA database	2009-2018
Year	Year of establishment	AIDA database	2009-2018
Province	Province	AIDA database	2009-2018
Region	Region	AIDA database	2009-2018
Activity_desc	Activity Description (GB)	AIDA database	2009-2018
ateco07	ATECO 2007 Code	AIDA database	2009-2018
ateco02	ATECO 2002 Code	AIDA database	2009-2018
nace2	NACE Rev. 2	AIDA database	2009-2018
Assets_fix_total	Total fixed assets	AIDA database	2009-2018
Assets_fix_intang	Total intangible fixed assets	AIDA database	2009-2018
Assets_fix_tang	Total tangible assets	AIDA database	2009-2018
ReD_exp	R&D expenditure	AIDA database	2009-2018
Assets_total	Total assets	AIDA database	2009-2018
Leverage	Debts/Assets	AIDA database	2009-2018
Revenue	Revenues from sales and services	AIDA database	2009-2018
Added_value	Added value	AIDA database	2009-2018
Productivity_empl	Turnover/Cost of employees	AIDA database	2009-2018
N_employee	Number of employees	AIDA database	2009-2018
Sector_3	Dummy for KIBS, manufacturing and other services	AIDA database	2009-2018
Nace2digit	2-digits level NACE Rev. 2 classification	AIDA database	2009-2018
ln_age	Age of establishment	AIDA database	2009-2018
LabourProd	Value added/N_employee	AIDA database	2009-2018
Specialisation	Province specialisation in KIBS; (Number of employees in KIBS/ total number of employees)/(Number of employees in KIBS/total number of employees)	AIDA database	2009-2018
Location	Location for macro areas: North-West, North-East, South, Centre and Islands	AIDA database	2009-2018

Size	Size class: Micro, Small, Medium and Large	AIDA database	2009-2018
CAP	“Capoluogo di provincia” Proxy of urbanisation economies; Dummy indicator, which takes the value of 1 when the observation refers to a province which is “capoluogo di provincia”; and 0 otherwise	ISTAT database	2009-2018
METRO	“Metropolitan” Proxy of urbanisation economies; Dummy indicator, which takes the value of 1 when the observation refers to a province which is “metropolitan”; and 0 otherwise	ISTAT database	2009-2018
Province-level			
Population	Population	ISTAT database	2009-2018
MARCHI_TOT2	Proxi for innovation: share of brands overpopulation at province level; Brand/population	ISTAT database	2009-2018
PopDensity	Population density. Proxy of agglomeration Economies is the share of population over the province area; Population/ surface (in sq KM)	ISTAT database	2009-2018
GDP	Gross domestic product	Eurostat database	2009-2018
INTDEM	Intermediate demand. Proxy of demand spillovers from intersectoral linkages	ISTAT database	2012-2017
Diversity	The inverse of a Herfindahl concentration index based on employment	AIDA database	2019-2018
Region-level			
Share_graduate	reg_occ_laurea/reg_occ_tot	ISTAT database	2009-2018
shareRD_GDP	share of R&D expenditure on GDP	ISTAT database	2009-2018

Table 4. Summary statistics for KIBS

	N	Mean	Std. Dev.	min	max
Age	147010	13.774	10.967	-8	135
Size 25	147010	2.464	1.132	1	4
Leverage	147010	.11	0.818	-8.719	8.978
R&D exp per emp	61430	1.65	28.230	0	5591
Assets tang per emp	129510	96.095	1038.154	0	62888
Assets intang per ~p	129497	28.593	1125.406	0	241969.5
PopDensity	146789	734.864	746.370	19.151	2652.728
Specialization	147005	1.132	0.807	0	36.322
Diversity	147010	.154	0.174	0	1
INTDEM	94242	24.326	9.814	8.954	40.817
sharerRD GDP	146537	1.377	0.326	.396	2.208
Share graduate	147010	.205	0.034	.118	.301

Table 5. Agglomeration's weight by Regions.

	Capital		**PopDensity**		**Specialisation**		**Diversity**		**INTDEM**	
	N. of obs	**% row**	**N. of obs**	**% row**	**N. of obs**	**% row**	**N. of obs**	**% row**	**N. of obs**	**% row**
NE	38741	26,35	38741	26,39	38741	26,35	38741	26,35	24758	26,27
NW	65957	44,87	65775	44,81	65957	44,87	65957	44,87	42176	44,75
Centre	27095	18,43	27076	18,45	27095	18,43	27095	18,43	17473	18,54
South	11668	7,94	11648	7,94	11667	7,94	11668	7,94	7615	8,08
Islands	3549	2,41	3549	2,42	3545	2,41	3549	2,41	2220	2,36
Total	**147010**		**146789**		**147005**		**147010**		**94242**	

Table 6. Sub-sectors of T-KIBS and P-KIBS.

Technological KIBS (T-KIBS)	**J62**	Software production, computer consulting and related activities
	J63	Information activities and other information services
	M72	Scientific research and development
	M74	Other professional, scientific and technical activities
Professional KIBS (P-KIBS)	**M69**	Legal activities and accounting
	M70	Business management and advisory management activities
	M71	Activities of architectural and engineering studies
	M73	Advertising and market research

Table 7. Regression results using TFP by LP method.

	KIBS			T-KIBS			P-KIBS		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	logTFP	logTFP	logTFP	logTFP	logTFP	logTFP	logTFP	logTFP	logTFP
Age	0.0207***	0.0248***	0.0191***	0.0216***	0.0196***	0.0196***	0.0198***	0.0188***	0.0187***
	(0.000573)	(0.000574)	(0.000609)	(0.000793)	(0.000844)	(0.000846)	(0.000818)	(0.000871)	(0.000870)
Small	0.471***	0.465***	0.446***	0.443***	0.417***	0.414***	0.496***	0.472***	0.473***
	(0.00761)	(0.00938)	(0.00939)	(0.0104)	(0.0127)	(0.0127)	(0.0111)	(0.0138)	(0.0139)
Medium	0.533***	0.603***	0.567***	0.485***	0.520***	0.517***	0.583***	0.616***	0.618***
	(0.00879)	(0.0110)	(0.0111)	(0.0117)	(0.0145)	(0.0146)	(0.0133)	(0.0168)	(0.0168)
Large	0.606***	0.751***	0.709***	0.539***	0.643***	0.638***	0.692***	0.792***	0.795***
	(0.0104)	(0.0130)	(0.0131)	(0.0137)	(0.0170)	(0.0171)	(0.0159)	(0.0201)	(0.0202)
Leverage	-0.112***	-0.109***	-0.109***	-0.143***	-0.130***	-0.130***	-0.0897***	-0.0950***	-0.0945***
	(0.00394)	(0.00467)	(0.00466)	(0.00574)	(0.00658)	(0.00660)	(0.00545)	(0.00659)	(0.00660)
logReD_exp_per_emp	0.000552	0.00341***	0.000161	0.00175	0.00215	0.00218	-0.000714	-0.00201	-0.00190
	(0.00103)	(0.00112)	(0.00113)	(0.00139)	(0.00150)	(0.00150)	(0.00151)	(0.00169)	(0.00170)
logAssets_tang_per_emp	0.0520***	0.0512***	0.0544***	0.0591***	0.0620***	0.0627***	0.0462***	0.0477***	0.0477***
	(0.00168)	(0.00205)	(0.00205)	(0.00237)	(0.00283)	(0.00283)	(0.00239)	(0.00294)	(0.00295)
logAssets_intang_per_emp	0.0304***	0.0263***	0.0260***	0.0331***	0.0280***	0.0277***	0.0289***	0.0249***	0.0251***
	(0.00128)	(0.00150)	(0.00150)	(0.00173)	(0.00197)	(0.00197)	(0.00190)	(0.00224)	(0.00225)
Capital		0.0301	0.0690***		0.0735***	0.0745***		0.0581*	0.0679**
		(0.0199)	(0.0207)		(0.0250)	(0.0262)		(0.0310)	(0.0321)
logPopDensity		0.0246**	0.0110		0.0130	-0.00695		0.0533***	0.0342*
		(0.0106)	(0.0116)		(0.0133)	(0.0147)		(0.0165)	(0.0180)

Specialisation		0.0224***	0.0171**		0.0231***	0.0224**		0.00762	0.00730
		(0.00689)	(0.00689)		(0.00888)	(0.00894)		(0.0105)	(0.0106)
Diversity		-0.206***	-0.134***		-0.0615	-0.0654		-0.155***	-0.161***
		(0.0372)	(0.0373)		(0.0537)	(0.0541)		(0.0521)	(0.0524)
INTDEM		0.00845***	-0.00175		0.00382**	-0.00302		0.00694***	-0.000928
		(0.00131)	(0.00257)		(0.00167)	(0.00332)		(0.00205)	(0.00396)
MARCHI			1.79e-05***			1.73e-05**			1.84e-05**
			(5.29e-06)			(6.87e-06)			(8.06e-06)
shareRD_GDP			0.00248			0.0170			-0.0135
			(0.0199)			(0.0253)			(0.0308)
Share_graduate			0.514**			0.552*			0.477
			(0.242)			(0.310)			(0.375)
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Location dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	3.282***	2.990***	3.163***	3.324***	3.181***	3.288***	3.165***		
	(0.0187)	(0.0538)	(0.0881)	(0.0215)	(0.0674)	(0.112)	(0.0396)		
Observations	146,258	93,747	93,278	74,000	47,588	47,358	72,258	46,159	45,920
Number of id_new	20,518	19,031	19,028	10,178	9,518	9,518	10,340	9,513	9,510

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 8. Regression results using TFP by Cobb-Douglas production function.

	KIBS			T-KIBS			P-KIBS		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	TFP	TFP	TFP	TFP	TFP	TFP	TFP	TFP	TFP
Age	0.00855***	0.00823***	0.00797***	0.00789***	0.00722***	0.00720***	0.00882***	0.00846***	0.00835***
	(0.000261)	(0.000310)	(0.000311)	(0.000367)	(0.000430)	(0.000431)	(0.000371)	(0.000445)	(0.000446)
Small	0.513***	0.464***	0.461***	0.444***	0.386***	0.386***	0.575***	0.528***	0.527***
	(0.00756)	(0.00915)	(0.00916)	(0.0102)	(0.0124)	(0.0124)	(0.0111)	(0.0134)	(0.0135)
Medium	0.534***	0.499***	0.492***	0.473***	0.430***	0.429***	0.591***	0.547***	0.546***
	(0.00793)	(0.00961)	(0.00964)	(0.0105)	(0.0127)	(0.0127)	(0.0120)	(0.0145)	(0.0146)
Large	0.711***	0.660***	0.654***	0.673***	0.613***	0.611***	0.739***	0.684***	0.685***
	(0.00809)	(0.00992)	(0.00994)	(0.0107)	(0.0132)	(0.0132)	(0.0122)	(0.0150)	(0.0150)
Leverage	-0.206***	-0.201***	-0.201***	-0.271***	-0.259***	-0.257***	-0.159***	-0.158***	-0.158***
	(0.00339)	(0.00409)	(0.00409)	(0.00483)	(0.00569)	(0.00571)	(0.00479)	(0.00585)	(0.00586)
logReD_exp_per_emp	0.00369***	0.00233	0.000903	0.00255	-0.000683	-0.000200	0.00522***	0.00184	0.00246
	(0.00129)	(0.00152)	(0.00154)	(0.00164)	(0.00193)	(0.00194)	(0.00198)	(0.00238)	(0.00238)
logAssets_tang_per_emp	-0.0343***	-0.0342***	-0.0331***	-0.0323***	-0.0349***	-0.0346***	-0.0379***	-0.0344***	-0.0340***
	(0.00151)	(0.00181)	(0.00182)	(0.00205)	(0.00243)	(0.00244)	(0.00220)	(0.00268)	(0.00269)
logAssets_intang_per_emp	-0.00253*	-0.0131***	-0.0131***	-0.0148***	-0.0264***	-0.0264***	0.0137***	0.00404	0.00378
Capital		0.0391***	0.0306***		0.0300**	0.0210		0.0616***	0.0495***
		(0.00969)	(0.0112)		(0.0121)	(0.0140)		(0.0153)	(0.0175)
logPopDensity		0.0351***	0.0331***		0.0240***	0.0190**		0.0506***	0.0493***
		(0.00529)	(0.00602)		(0.00661)	(0.00750)		(0.00833)	(0.00949)

Specialisation		0.0108**	0.0104**		0.00369	0.00201		0.0180***	0.0197***
		(0.00429)	(0.00430)		(0.00540)	(0.00542)		(0.00678)	(0.00680)
Diversity		-0.150***	-0.127***		-0.0112	-0.0110		-0.221***	-0.204***
		(0.0259)	(0.0261)		(0.0352)	(0.0354)		(0.0380)	(0.0387)
INTDEM		0.00639***	0.00791***		0.00590***	0.00711***		0.00624***	0.00786**
		(0.000693)	(0.00212)		(0.000858)	(0.00263)		(0.00110)	(0.00338)
MARCHI			-2.15e-06			-1.31e-06			-1.90e-06
			(4.03e-06)			(5.06e-06)			(6.33e-06)
shareRD_GDP			0.0460***			0.0432***			0.0430**
			(0.0130)			(0.0161)			(0.0207)
Share_graduate			0.440**			0.477*			0.337
			(0.215)			(0.265)			(0.341)
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Location dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.598***	-0.776***	-0.957***	-0.503***	-0.651***	-0.784***	-0.790***	-1.041***	-1.184***
	(0.0127)	(0.0280)	(0.0579)	(0.0157)	(0.0362)	(0.0718)	(0.0226)	(0.0481)	(0.0937)
Observations	145,259	93,167	92,703	73,645	47,402	47,175	71,614	45,765	45,528
R-squared	0.152	0.147	0.148	0.174	0.170	0.169	0.139	0.137	0.137

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 9. Regression results by locations.

	KIBS		T- KIBS		P- KIBS	
	North_Centre	**Mezzogiorno**	**North_Centre**	**Mezzogiorno**	**North_Centre**	**Mezzogiorno**
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	logTFP	logTFP	logTFP	logTFP	logTFP	logTFP
Age	0.0188***	0.0237***		0.0236***	0.0182***	0.0247***
	(0.000635)	(0.00216)		(0.00278)	(0.000903)	(0.00325)
Small	0.457***	0.350***	0.462***	0.295***	0.485***	0.379***
	(0.00989)	(0.0298)	(0.0133)	(0.0407)	(0.0146)	(0.0435)
Medium	0.581***	0.465***	0.596***	0.364***	0.628***	0.555***
	(0.0117)	(0.0344)	(0.0152)	(0.0457)	(0.0178)	(0.0518)
Large	0.731***	0.547***	0.763***	0.378***	0.800***	0.760***
	(0.0139)	(0.0403)	(0.0176)	(0.0526)	(0.0213)	(0.0623)
Leverage	-0.112***	-0.0830***	-0.145***	-0.0836***	-0.0943***	-0.0872***
	(0.00489)	(0.0153)	(0.00701)	(0.0200)	(0.00688)	(0.0232)
logAssets_tang_per_emp	0.0540***	0.0562***	0.0698***	0.0690***	0.0482***	0.0442***
	(0.00217)	(0.00623)	(0.00300)	(0.00846)	(0.00312)	(0.00909)
logAssets_intang_per_emp	0.0242***	0.0376***	0.0255***	0.0393***	0.0235***	0.0360***
	(0.00158)	(0.00466)	(0.00209)	(0.00611)	(0.00237)	(0.00706)
Capital	0.0778***	0.0440	0.0729**	0.0647	0.0786**	0.0150
	(0.0232)	(0.0545)	(0.0297)	(0.0678)	(0.0360)	(0.0853)
logPopDensity	0.0144	0.00517	0.00306	-0.0559	0.0308	0.0710
	(0.0144)	(0.0347)	(0.0185)	(0.0437)	(0.0222)	(0.0541)

Specialisation	0.0324***	-0.00686	0.0293**	0.00779	0.0270**	-0.0345*
	(0.00862)	(0.0121)	(0.0121)	(0.0139)	(0.0125)	(0.0208)
Diversity	-0.198***	-0.0125	-0.0666	-0.0992	-0.283***	0.0926
	(0.0444)	(0.0733)	(0.0647)	(0.107)	(0.0624)	(0.103)
INTDEM	-0.00144	-0.00191	-0.000853	-0.0160	-0.00225	0.0150
	(0.00280)	(0.00807)	(0.00365)	(0.0100)	(0.00430)	(0.0129)
MARCHI	1.50e-05***	2.56e-05	8.62e-06	7.53e-05	1.91e-05**	-3.31e-05
	(5.76e-06)	(4.51e-05)	(7.55e-06)	(5.82e-05)	(8.74e-06)	(6.97e-05)
shareRD_GDP	-0.00115	0.0632	0.0156	0.161	-0.0162	0.0122
	(0.0214)	(0.0947)	(0.0275)	(0.123)	(0.0332)	(0.144)
Share_graduate	0.574**	0.277	0.690**	-1.539	0.340	2.016
	(0.260)	(1.201)	(0.334)	(1.559)	(0.405)	(1.848)
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummy	Yes	Yes	Yes	Yes	Yes	Yes
Location	Yes	Yes	Yes	Yes	Yes	Yes
Constant	3.120***		3.319***	3.912***	2.988***	2.178***
	(0.101)		(0.130)	(0.365)	(0.159)	(0.453)
Observations	83,677	9,652	42,432	4,954	41,245	4,698
Number of id	17,014	2,026	8,503	1,021	8,511	1,005

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Appendix

Table A.1. Dataset distribution by year, size and geography.

	KIBS		Manufacturing		Other services		Total	
	N. of obs	%	N. of obs	%	N. of obs	%	N. of obs	%
2009	10914	6,99	48460	31,04	96757	61,97	156131	100
2010	11595	7,09	51057	31,22	100913	61,7	163565	
2011	13758	6,92	61174	30,77	123882	62,31	198814	100
2012	14474	6,94	63329	30,36	130762	62,7	208565	100
2013	14956	6,88	65362	30,08	136987	63,04	217305	100
2014	15620	6,86	67708	29,74	144354	63,4	227682	100
2015	16190	6,86	69935	29,62	150018	63,53	236143	100
2016	16529	6,8	71659	29,47	154990	63,74	243178	100
2017	16664	6,74	72761	29,45	157634	63,8	247059	100
2018	16310	6,74	72094	29,77	153731	63,49	242135	
Total	**147010**	**6,87**	**643539**	**30,06**	**1350028**	**63,07**	**2140577**	**100**
NE	38741	6,05	244515	38,16	357585	55,8	640841	100
NW	65957	8,97	239069	32,51	430285	58,52	735311	100
Centre	27095	7,87	68708	19,95	248645	72,19	344448	100
South	11668	3,76	71512	23,04	227212	73,2	310392	100
Islands	3549	3,24	19735	18,01	86301	78,75	109585	100
Total	**147010**	**6,87**	**643539**	**30,06**	**1350028**	**63,07**	**2140577**	**100**
Micro (<=9)	76171	7,1	224587	20,92	772740	71,98	1073498	100
Small (10-49)	56717	6,64	330063	38,63	467593	54,73	854373	100
Medium (50-249)	11772	6,57	76814	42,88	90564	50,55	179150	100
Large (>250)	2350	7	12075	35,98	19131	57,01	33556	100
Total	**147010**	**6,87**	**643539**	**30,06**	**1350028**	**63,07**	**2140577**	**100**
Micro (<=3)	39257	7,48	81345	15,49	404510	77,03	525112	100
Small (4-9)	36914	6,73	143242	26,12	368230	67,15	548386	100
Medium (10-19)	35957	6,9	191268	36,71	293799	56,39	521024	100
Large (>20)	34882	6,39	227684	41,7	283489	51,92	546055	100
Total	**147010**	**6,87**	**643539**	**30,06**	**1350028**	**63,07**	**2140577**	**100**

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