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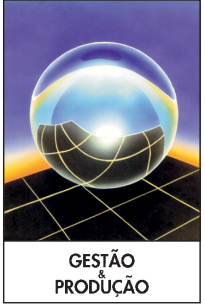

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The role of knowledge intensive business services in economic development: a bibliometric analysis from Bradford, Lotka and Zipf laws

O papel dos serviços empresariais intensivos de conhecimento no desenvolvimento econômico: uma análise bibliométrica a partir das leis de Bradford, Lotka e Zipf

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Abstract: The international scientific community considers Knowledge Intensive Business Services (KIBS) as one of the main themes related to innovation and economic development. This article presents a review based on Scopus and ISI Web of Knowledge databases, on the KIBS topic in the world, considering the period 2000-2017. The study aimed to understand the role of KIBS in regional development, and they were considered in their roles as innovations' attributes and resources, methodologies and tools for innovation management, transfer, knowledge diffusion and networks. They concentrate in the areas of business, management and economics, developing approaches to seek innovation, competitiveness and economic development.

Keywords: KIBS; Bradford; Lotka; Zipf; Innovation.

Resumo: *Os Serviços Empresariais Intensivos em Conhecimento (KIBS) são considerados pela comunidade científica internacional como um dos principais temas relacionados à inovação e ao desenvolvimento econômico. Este artigo apresenta uma revisão a partir das bases de dados Scopus e ISI Web of Knowledge no tema KIBS no mundo, considerando o período de 2000 a 2017, com o objetivo de compreender o papel dos KIBS no desenvolvimento econômico. Os KIBS foram considerados em seus papeis como características e recursos de inovações, metodologias e recursos para gerenciamento de inovação, transferência, difusão de conhecimento e redes. Eles se concentram nas áreas de negócios, gestão e economia, desenvolvendo abordagens para buscar inovação, competitividade e desenvolvimento econômico.*

Palavras-chave: *KIBS; Bradford; Lotka; Zipf; Inovação.*

1 Introduction

Over the last decade, an increasing number of contributions questioned the traditional view of service firms as unable to create innovations and businesses. This caused a wide discussion on the evolution of KIBS (Knowledge Intensive Business Services) and their approach in international literature, both from a theoretical perspective, to a lesser extent, and from an empirical view (Miles et al., 1995). KIBS have experienced a fast and acknowledged growth since the 1970s, being essential parts of knowledge

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transmission systems (Den Hertog, 2000; Muller & Zenker, 2001; Miles, 2008) and innovation (Cooke & Leydesdorff, 2006; Miles, 1999; Leiponen, 2001).

In Brazil, KIBS have recently become a research topic in studies by Almeida (2004), Jesus (2005), Freire (2006) and Kubota (2006), and their results show that they account for 39% of the service sector revenue, 27% of the salaries, 19% of the companies and 13% of the personnel employed.

Therefore, our goal was to understand the role of KIBS in economic development, in the period 2000-2017, through a bibliometric review of papers listed in Scopus and ISI Web of Knowledge databases. To carry out the analysis we used the principles and laws of Bradford, Lotka and Zipf, which showed the evolution path of this topic in the form of an observable behavior (Farias, 2009), by answering the question: "Which are KIBS concentration areas in the course of their scientific evolution?"

This article has five sections, including this introduction. The second presents the literature review on the central topic KIBS. The third section presents the methodology used to achieve the proposed goal. The fourth section shows the results of KIBS bibliometric analysis. The fifth section analyzes and discusses the results. Finally, the sixth section presents the conclusion and its managerial implications.

2 Literature review

Researchers and practitioners have recognized that services, far from being innovative latecomers or just intensive creators of technologies and news for manufacturing, are becoming increasingly important tools for innovative companies (Howells, 2004; Tether & Metcalfe, 2004).

KIBS have been growing fast since the 1970s, and are more and more acknowledged as essential constituents of service innovation systems (Cooke & Leydesdorff, 2006), and vectors of knowledge transmission (Den Hertog, 2000; Muller & Zenker, 2001; Miles, 2008). They provide a platform to study a set of integrated services for innovation, by developing knowledge for their clients and contributing to the co-production of knowledge.

In more precise terms, Den Hertog (2000) defines KIBS as organizations or private companies that frequently use professional knowledge, whether related to a specific (technical) discipline or (technical) domain, to create knowledge intermediary businesses (products or services).

Many authors consider them as a group of companies that find solutions for other companies, based on specific knowledge (Miles et al., 1995; Boden & Miles, 2000; Tomlinson, 2002; Nählinder, 2002; CRIC, 2004; Miles, 2005).

They are primarily concerned with providing knowledge intensive inputs to business processes and collaborative learning of other organizations. These include private and public sectors, in which both KIBS provider and client company learn to solve specific problems (Aslesen & Isaksen, 2007), or customer companies that use these inputs to develop new knowledge as a result of collaborative learning (Den Hertog, 2000).

KIBS provide a platform to study a set of integrated services for innovation, by developing knowledge together with their customers, in the co-production of knowledge. They are facilitators, carriers or sources of innovation that result in the creation, dissemination or accumulation of knowledge (Muller & Zenker, 2001; Wong & He, 2002; Den Hertog, 2000; Miles et al., 1995).

They are agents of dissemination and transfer of knowledge and innovation to their clients, and cannot be dissociated from the national or regional economic and social environment - macro and micro (Miles et al., 1995; Den Hertog & Bilderbeek, 1998; Hipp, 2000; André et al., 2002; Miles, 2007).

They are also classified (Miles et al., 1995) in two types: p-KIBS (professional services) and t-KIBS (technological base use), according to Table 1.

According to Nählinder (2002), there are several ways to classify KIBS, and for Wood (2002) there is no definition in the standard approach accepted for KIBS, but rather a consensus created by agencies and companies that belong to the service sector. In Europe this consensus is known as NACE (Classification of Economic Activities in the European Community), and in Brazil as CNAE (National Classification of Economic Activities).

NACE seeks to identify KIBS as a sector that comprises, among other things, Information Technology activities, research and development, and other businesses. Each category has subcategories, such as computers and related, that are deployed in subcategories (hardware consulting, software, data

Table 1. Types of KIBS.

p-Kibs	t-Kibs
Marketing	Software Development
Design	Technical Services
Advertising	Telematics
Financial Services	New Technologies
Accounting	Computer Networks
Architecture	Research & Development
Medical Services	Consulting in Information Technology
Engineering	Consulting in Research & Development
Training	-
Consulting	-

Source: Adapted from Miles et al. (1995).

processing, database activities, computer maintenance and repair), and so on (Borschiver et al., 2004).

In Brazil, the classification is done through the instrument of national standardization of the economic activities' codes and of the framing criteria used by the Tax Administration agencies.

It is the breakdown of CNAE (Receita Federal do Brasil, 2011) applied to all economic agents engaged in the manufacturing of products (goods and services), which may include private or public companies, agricultural facilities, public and private organizations, non-profit institutions and autonomous agents (individuals).

For the Federal Revenue Office, CNAE is a code that must be informed in the Legal Entity Registration Form (FCPJ), which will feed the Legal Entity National Register/CNPJ.

In the light of information presented on KIBS, we notice that no conclusion or consensus is achieved (Den Hertog, 2000; Garcia-Quevedo et al., 2013; Audretsch, 2012), and that specifically in Brazil there is a shortage of papers on this theme, to be explored by researchers in the context of innovation and economic development.

3 Methodology

The definition of the type of research requires the alignment with its objective, which is to understand the role of KIBS in economic development. According to Gil (1999, p. 42), the research is understood as the

> […] formal and systematic process of application of the scientific method. The fundamental goal of a research is to find out the answers to problems, through the use of scientific procedures.

In the view of O'Connor & Voos (1981), the use of bibliometrics contributes a lot to the fields of science and information, presenting long-term answers and benefits. Thus, the research was qualitative and exploratory.

We carried out a systematic review of the literature with the use of bibliometrics, based on the laws and principles of Bradford, Lotka and Zipf, all suitable for the analysis of articles, words and authors most quoted in scientific papers.

For Bradford, journals' degree of relevance should be estimated in each area of knowledge, fostering a supposedly higher quality core. Lotka's approach considers the most prestigious papers in a given area of knowledge. And for Zipt, the analysis should focus on the occurrence of words on the research topic, in a scientific text.

> Bradford's Law aims to find the dispersion of literature by sorting the productivity of articles on a central research topic, and dividing them in several groups or zones, with the same number in each nucleus established by the rational (n), in the nucleus and subsequent zones, varying in the proportion 1:n:n2 [...] (Brookes, 1969).

Zipf's Law establishes the relationship between frequency and a given word, creating an occurrence ranking of series 1 for the highest frequency word, and of series 2 for the second, and so on, following the General Principle of the Least Effort (Fairthorne, 1969).

Lotka's law defines the existence of a vast proportion of scientific literature written by a small group of authors. On the other hand, the production of many authors that write few papers matches the publications of the small number of prolific writers; this gives rise to the law of inverse squares: yx = 6/p2 xa, where *yx* is the frequency of authors that publish an *x* number of papers, and *a* is a constant value for each scientific field (Alvarado, 2002).

For a better understanding of each of the laws and principles employed in the study, Table 2 shows their focus and application.

Farias' (2009) approach strengthens Bradford, Lotka and Zipf's, by defining bibliometric analysis as a broad theoretical reference obtained from databases, that looks for words and key terms, relevant authors and papers that are included in national and international journals, to create sufficient knowledge to be used in research.

Figure 1 shows the keywords structure used as a search engine in scientific databases, in order to find papers that answer the research question. This approach began by looking for articles that provided relevant information for the search of the first keywords and key terms related to the role of KIBS.

After identifying the first keywords and key terms related to KIBS' role, we collected articles published in ISI Web of Knowledge and Scopus indexed databases, by using the following keywords: (1) Knowledge creation; (2) Knowledge transfer; (3) KIBS; and (4) Innovation identified, based on the Boolean method "AND" and "OR". We found 318 articles related to the central research topic.

Table 2. Main laws and principles of Bibliometrics.

Laws and Principles	Study Focus	Application
Bradford's Law	Journals	Estimates journals' degree of relevance, in a agiven area of knowledge
Lotka's Law	Authors	Estimates authors' degree of relevance, in a agiven area of knowledge
Zipf's Law	Words	Automatic indexation of scientific and technological papers

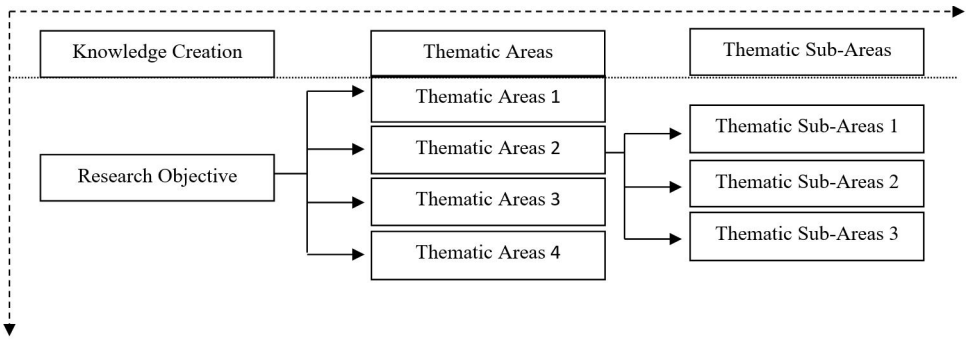

Figure 1. Keywords Tree. Source: Adapted from Farias (2009).

We exported and classified the pre-selected articles, using the software *EndNote™ X7*. They underwent a refinement process in which 164 articles were duplicated in the two databases. For this reason, we excluded 83 articles, thus remaining 235 articles for analysis.

Subsequently, in order to carry out the bibliometric analysis, we read the articles' titles and examined their alignment regarding the objective and contribution to the research.

All 235 documents examined showed alignment with the Knowledge Intensive Business Services (KIBS) theme and, therefore, went through the bibliometric analysis. Table 3 presents a synthesis of the elements used in the research.

In order to attain the research objective, we employed *VantagePoint*, a mining text software, to help data analysis through the use of construction techniques of matrices and maps that reveal trends and innovation signs. We also used partnerships between institutions and researchers (Palop et al., 2014), which allow to build a map with the authors' affiliation countries, the "Aduna Cluster".

We also conducted a co-citation analysis, to measure the degree of connection between two or more articles, by counting the number of documents that quote these papers simultaneously (Small, 1973).

We used QSR Nvivo ™ 10 software, a qualitative analysis program that offers tools for the in-depth study of unstructured data, contributing to the lexical analysis of the words that were most evidenced in the bibliographic bases, thus creating a word cloud.

After this stage, we exported all articles to the French site *TreeCloud.org*, in order to form a "word tree", with words arranged as clouds that reflected their semantic proximity inside the text.

Table 3. Research Synthesis.

Elements	Complements
Period of analysis	2000-2017
Databases examined	*Scopus* and ISI Web of Knowledge
Keywords used	Knowledge creation, Knowledge transfer and Innovation.
Método	Bibliometrics (Boolean "AND" and "OR")
Identified articles	318
Articles excluded for duplication	83
Examined articles	235
Types of databases	International: Scopus and ISI

4 Context of KIBS bibliometric analysis

To highlight the relevance of the research theme and reach the proposed objective, we established a timeline from the analysis of Scopus and ISI Web of Knowledge databases, and evaluated the concentration of publications on the theme over time.

We consider the period from 2000 to 2017, because 2000 was the first year that this topic appeared in global scientific bases. We classified the analyses in Productivity Analysis, Productive Authors' Analysis, Co-citation Analysis, Lexical Analysis and Keywords Analysis.

4.1 Productivity analysis

Regarding productivity, we used *VantagePoint* software to carry out text mining (Palop & Vicente, 1999), for building technical matrices and trend maps, which strengthens the uniqueness of the topic in the defined context. We also sought to anticipate the productivity of authors, organizations and countries, evaluating possible trends on the topic, besides the authors' countries of affiliation (Figure 2).

To identify the Affiliation Networks, we used the "*Aduna Cluster*" map, created by *VantagePoin*t, which showed, through the amount of spheres, the number of articles produced individually by the authors and those produced in co-authorship.

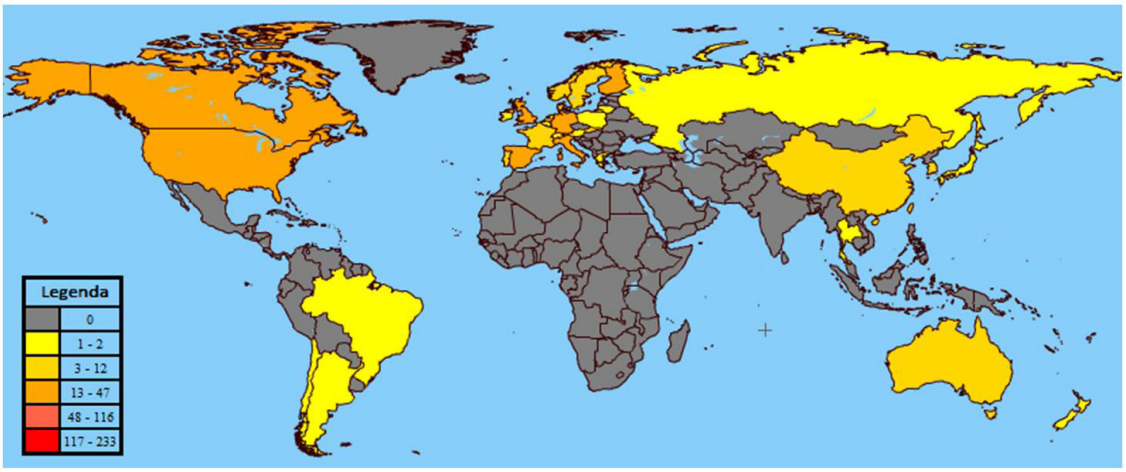

Figure 2. Authors' countries of affiliation map. Source: VantagePoint data (2017).

D. Doloreux, R. Grandinetti, R. Shearmur e N. Toivonen were the authors with the highest number of published papers, respectively, 12, 6, 6 and 6.

However, we observed that all publications by R. Shearmur were together with D. Doloreux, who, in turn, has a much larger network of co-authorship. The same occurs with R. Grandinetti, who produced four of his articles with three other authors.

4.2 Productive authors' analysis

We found other authors who are quite productive, but always publish individually, as V. Baláž and S. Liu, with four articles each, and R. Huggins and M. Rodriguez, with three publications each, as shown in Figure 3.

4.3 Co-citation analysis

The co-citation analysis was able to measure the degree of connection of two or more articles, through the number of documents that quote these papers simultaneously (Small, 1973).

Figure 4 shows the relationship between co-citation of the most relevant authors, with a significance factor above 0.5. We notice that the largest number of citations are linked to the authors Muller, Zenker, Miles, and Den Hertog.

4.4 Lexical analysis

With the use of the software QSR Nvivo™ 10 we conducted a lexical analysis of the words that were most evident in the bibliographic bases, by filtering all abstracts of the 235 articles. From these summaries, we created a "word cloud", composed by those words more frequently mentioned in the texts, as shown in Figure 5.

The most frequent words relate to the central theme of the analysis (KIBS), and were identified as *innovation*, *KIBS services*, *knowledge* and *business*.

This clearly demonstrates the synergy between the English term KIBS and the meaning of its translation into Portuguese: Knowledge Intensive Business Services.

4.5 Keywords analysis

The following step was to validate the highest frequency words, since some of them, although often found, might not be related to the research objectives. Such words could also relate to each other, and were assessed according to their proximity/distance, from the map created by *VantagePoint*, as shown in Figure 6.

The central topics address KIBS relationship with innovation, knowledge management, knowledge, globalization, performance, competitiveness and creativity.

5 Results

We observed from the initial analysis that there was a significant increase of publications in the years 2007 and 2008, with the highest concentration between 2012 and 2013. Thus, the topic in question has received attention very recently, and most of the papers were published between 2007 and 2014, if we observe the concentration since the beginning of publications, from 2001 until 2017. We chose 2001 because this was the year of the first publication in a scientific journal. In 2000, the first paper was presented at an international conference. Hence, we made the comparison between papers published in international scientific journals.

Several authors are responsible for scientific contributions on KIBS, with their research and publications, sometimes a little more intense than in

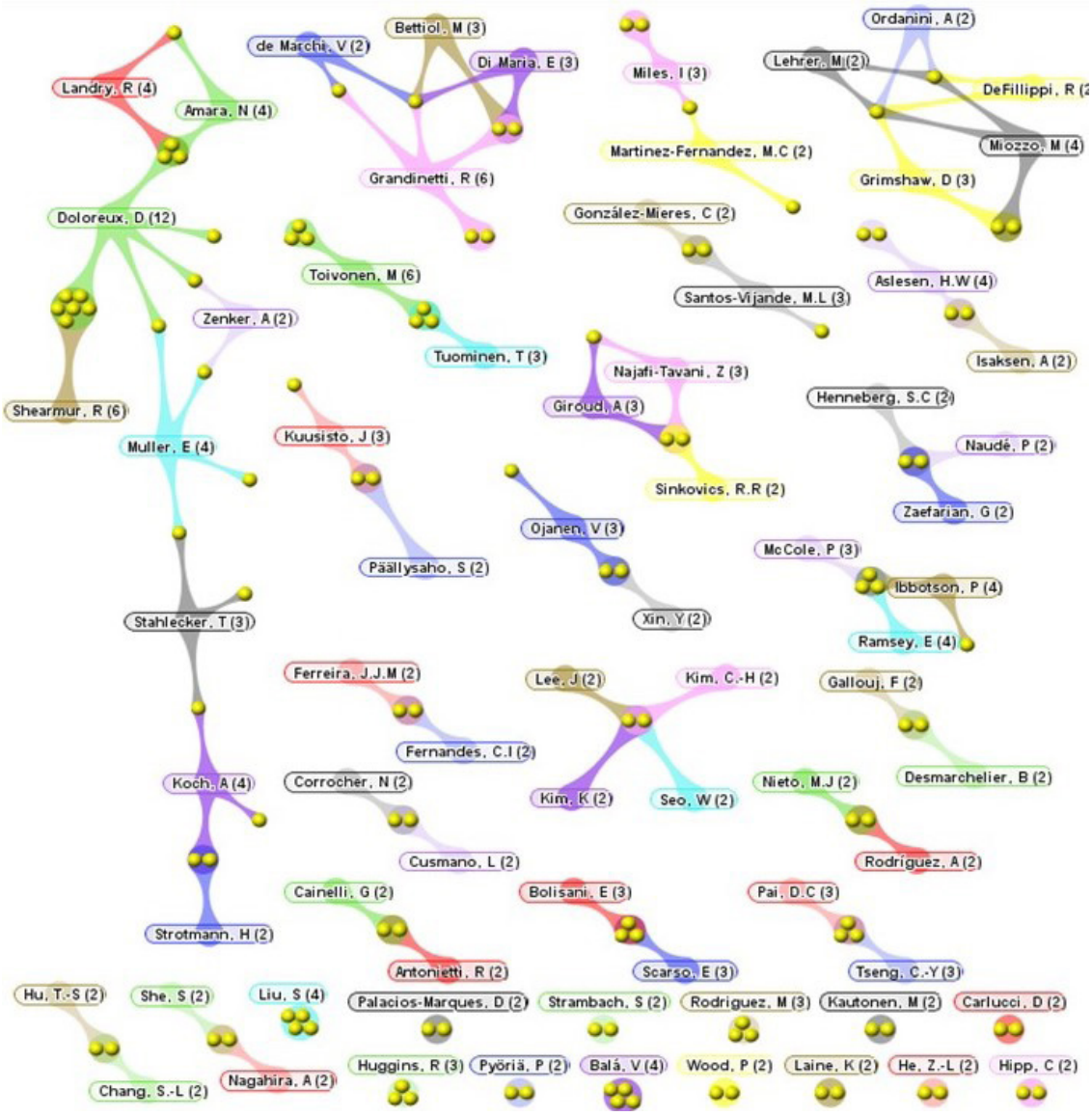

Figure 3. Map of the relationships between authors' papers. Source: VantagePoint data (2017).

other periods, such as in 2007/2008 and 2012/2013. We noticed an initial concentration in 2005 due to the papers by Muller, who since 2009 did not keep pace with publications. Nevertheless, Muller is still considered an author of great relevance in the scientific research on KIBS.

In the first period mentioned, authors investigated KIBS' attributes and roles (Simmie & Strambach, 2006; Ferreira & Quadros, 2006; Smedlund & Toivonen, 2007; Muller & Doloreux, 2009; Doloreux et al., 2008; Yam et al., 2010), while others studied the protection of innovations through patents and KIBS (Bader, 2008; Amara et al., 2008), and their technological contribution (Kubota, 2009; Guimarães & Meirelles, 2014).

In the second term, we notice that publications are composed of studies carried out by Mukkala & Tohmo (2013), and Mas-Tur & Soriano (2013), who focus on KIBS' attributes and start-up companies for capacity improvement. Others address the variables, differences and mainly innovation management capacity in KIBS (Hipp et al., 2013; Asikainen, 2013), besides the transfer and diffusion of knowledge from geographic and technological distances and in networks (Najafi-Tavani et al., 2014; Rodriguez, 2014).

Today we see that researchers such as Zenker, Bilderbeek and Kastrinos refer to the continuity of Miles's research, but Miles and Den Hertog remain as current references.

There are several empirical articles of great value for the study, such as the one by Muller & Doloreux

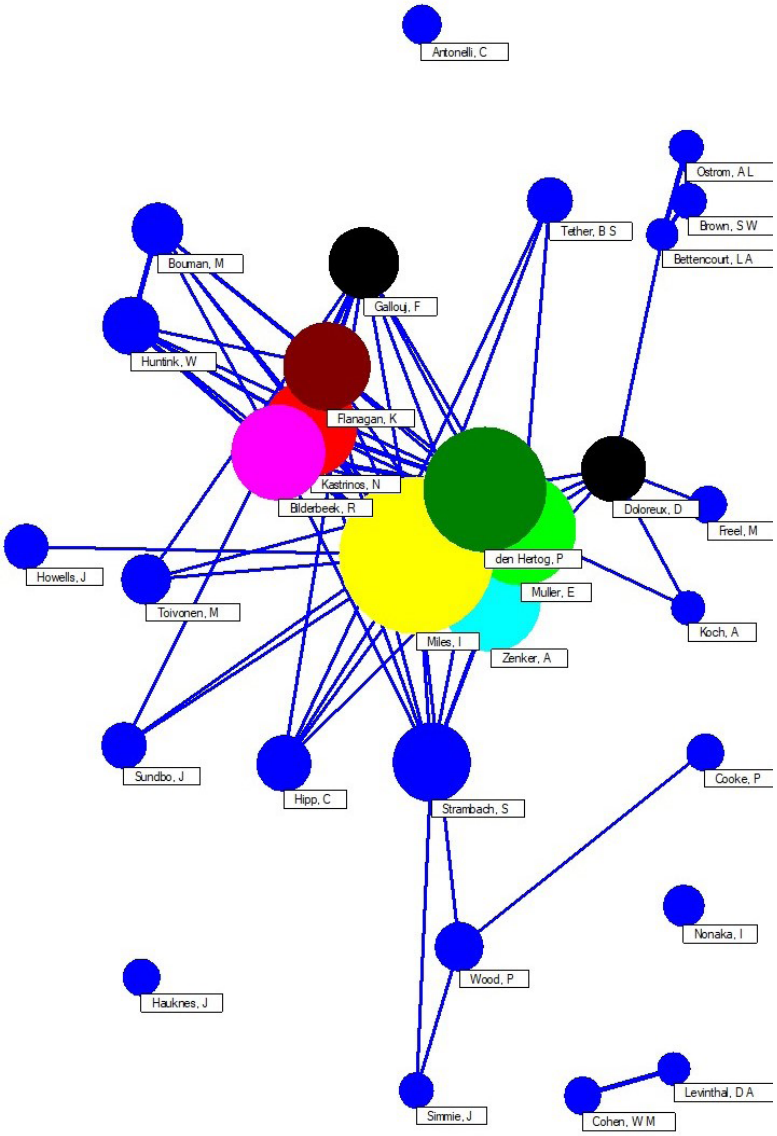

Figure 4. Co-citation map. Source: VantagePoint data (2017).

(2009), which presented the features and role of KIBS in the innovation system. The paper concluded that KIBS depend heavily on professional knowledge; they are primary sources of information and knowledge, or use knowledge to provide intermediary services for their customers' production processes; and they are a relevant source of competitiveness for businesses.

The motivation for Miozzo & Grimshaw (2005) was the empirical analysis of IT (Information Technology), in which they explored the lessons for modularity that can be drawn from the outsourcing of knowledge intensive services (KIBS).

According to Muller & Zenker (2001), in previous years knowledge intensive business services received an increased attention, and their paper presents an overview of the role and function of KIBS in innovation

Figure 5. Word Cloud resulting from lexical analysis. Source: Data from QSR Nvivo™ 10.

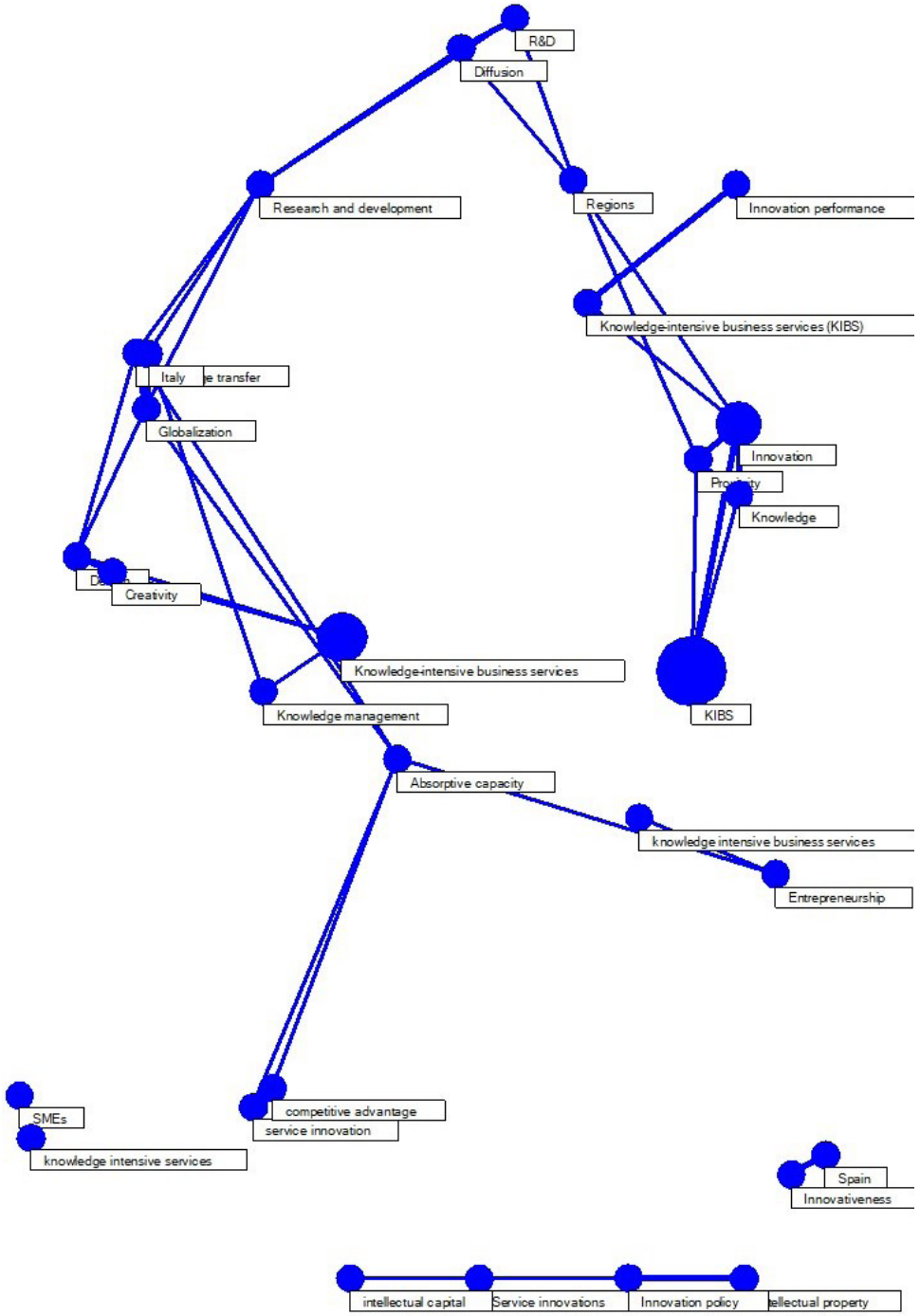

Figure 6. Proximity of Keywords. Source: Data from QSR Nvivo™ 10.

systems, as well as activities for the production of knowledge, transformation and diffusion.

Amara et al.'s (2008) research approach focused on the protection of knowledge intensive innovations, from a multivariate model defined as Probit (MVP), which simultaneously considered many methods of intellectual property (IP) protection. As a result, they concluded that patents, project patterns' registers, trademarks, secrecy, and lead-time are legal and informal methods that are used together to protect companies from competitors.

Yam et al. (2010) studied innovation sources, technological innovation capacity and performance in Hong Kong manufacturing industries. They also explored the dual role of KIBS as external and internal sources of innovation, concluding that externally

available information affects a company's ability to innovate, while external expert organizations only affect resource allocation.

Bader (2008) studied legal protection strategies in emerging business areas, such as the service industry sector. In particular, he considered patents as a means of protecting innovations in services, especially those with intensive use of knowledge. This contribution focuses on the opportunities and risks of intellectual property management.

Miles (2005) studied knowledge intensive business services, which he considered as fast growing areas in the European economy, and increasingly important for their contribution to the performance of economic sectors.

Simmie & Strambach (2006) tried to develop a theoretical explanation for the role of services in innovation, in postindustrial societies. They argue that the role of KIBS in innovation can be theoretically understood in terms of evolutionary and institutional economics, where urban organizations are dependent systems that need to operate as part of a network for knowledge production and transfer.

Thus, Smedlund & Toivonen (2007) introduced the concept of knowledge intensive business services in the context of regional networks, and analyzed the roles of KIBS in development, especially from the point of view of regional intellectual capital. They also mentioned that production networks should emphasize explicit knowledge, while development networks should focus on tacit knowledge. They also highlight that innovation networks must stress the human potential, by providing the needed information as sources of innovation and facilitators in the process.

Corrocher et al. (2009) investigated the variety of patterns in different typologies of knowledge intensive services, through the case of Lombardy, a developed manufacturing Italian area where industrial activities were undergoing a widespread transformation in their content, through higher knowledge. They identified four KIBS profiles in innovation: interactive, product, conservative and techno-organizational.

Koch & Strotmann (2006) contributed with a multivariate empirical analysis of the determinants of performance after KIBS entry. They arrived at growth equations, from functional links to knowledge providers, customers and cooperation partners, and their impact on the performance of the initiating KIBS.

Aslesen & Isaksen (2007) compared the relevance of two complementary approaches as analytical tools, regarding the exchange of knowledge intensive services in innovation processes. The first approach focuses on the importance of business specialists' knowledge for the innovation process, and the second concerns a wider set of sectors as potentially relevant providers of knowledge-intensive services. They analyzed two Norwegian sectors very different in knowledge, agriculture and software industry.

Doloreux et al. (2008) carried out a large-scale survey of 1,124 KIBS companies in Quebec, Canada, exploring the extent to which KIBS from various sectors and regions differ in their attributes and use of innovation practices. The results revealed that KIBS show different innovation features and behavior in all sectors.

Consoli & Elche-Hortelano (2010) critically approached a conceptual flaw in the widespread literature that portrays KIBS as a homogeneous group of activities, based on the analysis of official occupational data in the United States. They concluded that there are different routes for analyzing the composition of industries and sectors, such as the outputs (products and innovations) or the inputs (labor, capital and materials).

Doloreux & Shearmur (2010) contribute with the relationship between space and innovation, where they argue that few papers consider the wider context in which companies operate. They believe that innovation varies both in a continuous space and in different territories.

However, innovation is affected by information collected from companies, according to Guimarães & Meirelles (2014). They identified agglomerations of a specific type of KIBS, the Technological (T-KIBS), from the calculation of Location Quotients (LQ) of each city and by using a software that showed a high dispersion of LQ values, which confirmed the differences of activities in relation to the market and to the manufacturing process.

6 Conclusion and managerial implications

6.1 Conclusion

Through a literature review on the role of knowledge-intensive business services in economic development, we observed that during the period 2000-2017 there were two concentrations of publications on KIBS. The first group of papers analyzed the roles, attributes and protection of innovations through patents; and the second examined their technological contributions, capacity for innovation management, transfer and diffusion of knowledge (Cooke & Leydesdorff, 2006; Den Hertog, 2000; Muller & Zenker, 2001; Miles, 2008), considering the geographic, technological and network distances (Doloreux & Laperrière, 2013).

In the first group, the empirical investigations and applications addressed one type of KIBS (*p-KIBS*, related to professional services), while in the second they focused on *t-KIBS*, regarding technological base use (Miles et al., 1995).

This shows that KIBS' first approach focused on understanding their role in economic development,

and the second on how to contribute to the economic development itself.

Another finding is the prevailing relationship in the areas of business, management and economics, by developing approaches for the pursuit of innovation, competitiveness and mainly of economic development, either through variation in a continuous space and in different territories, which is affected by data collection from companies (Guimarães & Meirelles, 2014).

Thus, we met both the objective and the question raised in the study. Since the beginning of studies on this topic, KIBS has played a clear and relevant role in fostering innovation and economic development, by crossing different areas of science to constitute an interdisciplinary theme.

6.2 Managerial implications

Economic development is a link between firms and civil society (knowledge workers). Both seek to align personal and organizational interests, to achieve common, practical and economic goals. KIBS stand between companies and civil society, and they are firms that conduct their services with the intensive use of knowledge, increasing competitiveness and accelerating development, and consequently the economy.

This study's conclusion and its managerial implications do not exhaust the research theme. There is a wide future field for research on KIBS, their roles, ways of operating and contributions for the economic development of firms in the provision of knowledge intensive services.

An interesting line for future research could be to assess KIBS 'contribution to different sectors and segments of the economy, such as the service sector, or the tourism segment.

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