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Knowledge-intensive business services and innovation performance in Brazil

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Abstract

Purpose – The purpose of this paper is to identify the way different economic sectors in Brazil use knowledge-intensive business services (KIBS) and explore which features of KIBS use are associated with better innovation outcomes.

Design/methodology/approach – Clusters and regression analyses were used to analyze data from the national innovation survey (PINTEC) from 2014.

Findings – The results show that most of the 55 sectors of the Brazilian economy studied make little use of KIBS, but industries in which firms that interact with KIBS providers also have better innovation performance and offer more innovative offerings. The relationship with higher education institutions and research institutes proved particularly relevant, while the interaction with consultancy firms seems to be a strategy that leaves firms "stuck in the middle".

Originality/value – The outcomes confirm the arguments of the literature that the use of KIBS has positive outcomes for customer firms. More importantly, however, the paper complements the existing literature by showing that the type of KIBS used in each country is relevant to understand firms' innovation performance. The outcomes can guide firms and public policy initiatives oriented at the articulation of the national innovation system.

Keywords Innovation performance, Knowledge-intensive business services (KIBS), KIBS use patterns

Paper type Research paper

1. Introduction

Knowledge-intensive business services (KIBS) like consulting, external R&D, software design, have long been recognized for their potential to generate and foster innovation in national and regional innovation systems (Figueiredo, Neto, Quelhas, & de Matos Ferreira, 2017; Fischer, 2015; Hertog, 2000; Miles, Kastrinos, Flanagan, Bilderbeek, Den Hertog, Huntink, & Bouman, 1995; Miozzo, Desyllas, Lee & Miles, 2016). The intensive interaction among the parties during the development and implementation of these services enables the exchange of knowledge, information and ideas (Lehrer, Ordanini, DeFillippi, & Miozzo, 2012). Such interaction leads to the development of firms' capabilities and the adoption of innovative business models (Hu, Lin & Chang, 2013). KIBS, thus, function as source

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innovation inputs and facilitators of creative efforts for customers and partners (Hertog, 2000).

Different aspects of the role of KIBS in innovation systems have been investigated in the context of the OECD countries and other advanced economies (Doloreux & Shearmur, 2013; He & Wong, 2009; Hu et al., 2013; Huggins, 2011; Koch & Stahlecker, 2006). Empirical evidence shows that KIBS also play a vital role in emerging economies (Fischer, 2015), a context in which these services currently display a significant and growing economic importance (Miles, Belousova & Chichkanov, 2018).

In the case of Brazil, in 2014 (IBGE, 2018), KIBS accounted for 20 per cent of the value added. National studies discuss the growth of the KIBS market in Brazil and the extent to which these firms facilitate knowledge diffusion among players of the system (Bernardes & Andreassi, 2007), which leads to the creation of qualified work positions, income generation (Freire, 2006) and regional development (Jesus, 2005). Empirical evidence also shows that the purchase of KIBS in Brazil leads to more technological innovation in service firms (Kubota, 2009) and that innovative firms use more KIBS than their less innovative ones (Freire, 2006). While the existing literature shows the economic and innovation-related benefits associated with the use of KIBS, a better understanding of the patterns of use of KIBS in the Brazilian economy is still missing. Such knowledge helps shape and refine our understanding of the role KIBS play in the national innovation system (Freel, 2016).

This paper, therefore, has two primary research objectives:

(1) explore the way different economic sectors in Brazil use KIBS, taking into account relevant aspects of their innovation profile; and

(2) evaluate to what extent the use of KIBS is associated with firms¨ innovation performance.

An exploratory analysis of data from the national research on technological innovation of 2014 (PINTEC, 2014) was carried out to discover the patterns of KIBS use in different sectors of the Brazilian economy. This version of PINTEC has data on the innovative activity of Brazilian firms from 2012 to 2014.

The contribution of this paper is threefold. First, it adds additional evidence to the existing literature on the importance of KIBS as a source of innovation for their customers, confirming the findings of previous studies (Doloreux & Shearmur, 2013; Freire, 2005; Hu et al., 2013; Teixeira & Santos, 2016) with data from the Brazilian economy. The research outcomes also reveal that the type of KIBS hired matters to stimulate the innovation outcomes of customer firms. Finally, the pattern of KIBS use in Brazil differs from the ones identified in other economies, like Portugal and Canada, suggesting that the country effect needs to be further investigated in the literature. The knowledge on how firms use KIBS in the Brazilian economy also indicates aspects of the national innovation system that need to be improved, guiding policymakers on how to promote more extensive use of KIBS to stimulate innovation in the country.

This paper is organized as follows. It begins with a review of the different types of KIBS and the way these firms operate. The role of KIBS in innovation systems and their impact on firms' innovative activities is then discussed. The subsequent sections describe the methods adopted and the research results. The paper then concludes by offering directions for future research.

2. Theoretical background

Knowledge-intensive business services (KIBS) are offerings supplied to private and public organizations that use knowledge as the primary input (Muller & Doloreux, 2009). Such

services tend to be labor-intensive, as employees embody a significant share of this knowledge and providers need to employ a skilled workforce (Morris & Empson, 1998). Individuals use their intellectual capital to diagnose customers' needs, determine a solution, recommend a course of action and implement it (Bettencourt, Ostrom, Brown, & Roundtree, 2002). Firms may also need other non-human assets, such as inventories, equipment and installations, to deliver the services (Nordenflycht, 2010). In the management literature, three different terms are used to refer to these services: KIBS, professional services and integrated solutions.

The term KIBS is mainly used in the innovation literature, which focuses on the role of KIBS providers as suppliers of knowledge in innovation systems (Muller & Doloreux, 2009). Professional services are a category of KIBS, in which the primary knowledge base comes from a profession. Professions are standardized bodies of knowledge shared among all the professionals of a similar kind, which are accredited and regulated by the relevant authorities and follow specific norms of conduct and ethics (Lowendahl, Revang, & Fosstenlokken, 2001). Miles et al. (1995) use the term professional KIBS (p-KIBS) to refer to services delivered by professionals and technology-based KIBS (t-KIBS) to indicate services that rest upon or develop technical knowledge of various kinds.

Integrated solutions are a subtype of t-KIBS (Santos, 2013). The distinctive trace of integrated solutions is that providers design and supply customized equipment used in and combined with services of different kinds to deliver the functionality expected by the customer (Nordin & Kowalkowski, 2010). The relationship between these different types of KIBS can be represented with a Venn diagram, as presented in Figure 1 (Santos, 2013). Consulting services are t-KIBS, as their knowledge base are not regulated like professions, but they are at the intersection because they share many features with professional services, e.g. the path to expertise acquisition, organizational structure, and use of codes of ethics (Morris & Empson, 1998).

2.1 Knowledge-intensive business services production process and their role in innovation systems

KIBS are facilitators, sources and carriers of innovation in innovation systems (Hertog, 2000; Miles et al., 1995). A better understanding of the production process of KIBS in necessary to understand why such firms adopt these three roles, as their actions on how to identify, select and solve customers' problems affect how value and innovation are created (Desyllas, Miozzo, Lee & Miles, 2018). In KIBS delivery processes, providers have to identify customers

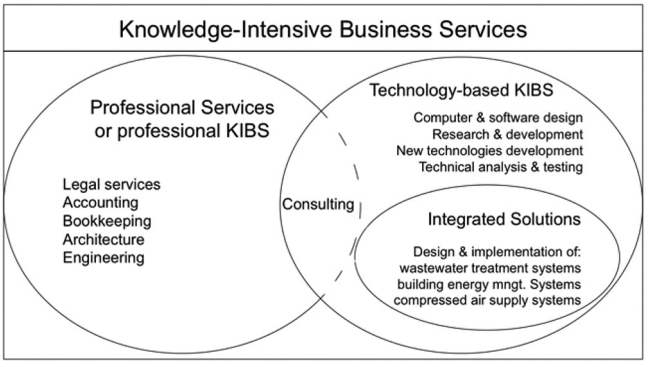

Figure 1.
Types of KIBS

Source: Santos (2013)

need, define a course of action that will address these needs and propose it to the customer (Bettencourt et al., 2002). Depending on the type of KIBS, the solution provided can take many forms. KIBS firms may help customers implement new processes or improve existing ones (Hertog, 2000), like a customized system to save energy in a building or a plan of action to reduce labor costs in an organization. KIBS firms providing R&D and other technological services can then contribute to the development of new technologies, products and services. As such, KIBS firm can be a source of innovation for customers (Hertog, 2000).

During the KIBS delivery process, customers and providers have to interact considerably (Lehrer et al., 2012). Although the buyer–provider interaction is a feature of services in general, it is even more critical in the case of KIBS (Correcher, Cusmano, & Morrison, 2009). In these services, customers and providers need to interact to define together the problem and negotiate what can be achieved (Silvestro, 1999). During such interaction, knowledge, ideas and information is transferred to customers (Muller & Zenker, 2001), who can then use these inputs to innovate. Buying KIBS also stimulates customers to interact more with other players (Lau & Lo, 2015) and use different additional sources of information and knowledge, e.g. reports, patent databases (Yam, Lo, Tang, & Lau, 2011). For these reasons, KIBS are also considered facilitators of the innovation efforts of their partners.

Every project requires the acquisition of new knowledge that is not owned by the firm or its employees (Muller & Zenker, 2001). New and existent knowledge bases are then combined and applied to define a solution to meet customers' needs (He & Wong, 2009). Professionals keep this knowledge in their repertoires and can use solutions adopted in the past to solve similar problems (Nachum, 1999). In this way, providers can serve different customers across industries (D'Antone & Santos, 2016). KIBS can, thus, also be innovation carriers because the ideas, information and knowledge originated in one firm or industry is transferred to other firms, sectors and countries (Hertog, 2000; Windrum & Tomlinson, 1999).

2.2 Knowledge-intensive business services use and innovation in customer firms

Literature shows that interaction with KIBS providers improves customers' business knowledge and the ability to reduce costs, facilitating the adoption of innovative business models (Hu et al., 2013). For instance, such interactions lead customers to improve their knowledge acquisition processes by stimulating the use of new knowledge from the headquarters and closer cooperation with other branches of the firm (Lau & Lo, 2015). Customer firms also learn to feed the inputs from different functional areas, customers and partners into the innovation process and to allocate money and human resources to the innovation activity (Yam et al., 2011).

Ultimately, the use of KIBS leads to the launch of more products and services and the implementation of new processes (Doloreux & Shearmur, 2013; Hu et al., 2013; Teixeira & Santos, 2016). It can promote the adaptation of existing offerings (Huggins & Johnston, 2012) and increases in sales due to the innovative products sold (Lau & Lo, 2015; Yam et al., 2011). Doloreux and Shearmur (2013), however, remark that the limited use of such services does not necessarily lead to reduced innovation performance. KIBS firms also enrich regional innovation systems, which tend to perform better with the presence of fast-growing KIBS firms (Corrocher & Cusmano, 2014).

Some factors influence the extent to which the use of KIBS can render such benefits. Authors highlight the importance of geographical proximity between customers and KIBS providers (Hu et al., 2013; Huggins & Johnston, 2012). Co-location among the parties enables face-to-face interaction, increases the frequency of meetings and facilitates knowledge transfer (Huggins, 2011; Koch & Stahlecker, 2006). As such, geographical proximity makes the transfer of knowledge and resources needed for innovation easier.

The type of KIBS provided also influences the innovation generated at the client firm. T-KIBS develop new technologies and implement changes, having more potential to promote innovation in customers¨ firms than p-KIBS (Miles et al., 1995). D'Antone and Santos (2016), in their turn, highlight that an accountancy firm can create a customized tax reporting method that improves the way its customer operates. As such, the extent to which KIBS are tailored and change customers' processes seems more relevant than the fact that they are 't-' or p-KIBS. In this vein, Landry, Amara, and Doloreux (2012) show that KIBS firms have a higher propensity to offer a more customized solution when they invest more in R&D, deal with advanced technologies and value a close interaction with network partners. More recently, Doloreux, Freel, and Shearmur (2016) added that the sales of technological solutions could foster technological innovation in customer firms, while the provision of solutions, like best practices or training, may lead to organizational innovation and change.

The literature has also looked at the profile of KIBS users. For instance, Hakanen (2014) found that the absorptive capacity of the team involved in the purchase of KIBS in the buying firms is relevant to enable the absorption and assimilation of the knowledge transferred by KIBS' firms. Freel (2016) analyzed a large sample of small and medium-sized companies and observed that the ones collaborating closely with KIBS also employ a higher percentage of graduate students, invest more in training, and launch more innovative (radical) offerings than the ones that do not buy KIBS. The author, however, did not find an association between internal R&D spending and the use of KIBS.

2.3 Knowledge-intensive business services use in Brazil

Empirical evidence in the context of emerging economies also shows that the use of KIBS improves the innovation performance in customer firms in these countries. Fisher (2015) analyzed the impact of KIBS foreign direct investment (FDI) in 39 emerging economies. He concluded that KIBS¨ FDI contributes more than the FDI from manufacturing multinational companies to increase the value added in service and manufacturing activities, improve export capacity and stimulate patenting activities. This finding confirms the importance of KIBS for innovation, even in countries marked by weaker institutions and institutional voids associated with insufficient innovation capacity (Khanna & Palepu, 2010).

In Brazil, KIBS accounted for 17 per cent of the revenues of the service sectors in 2014, 20 per cent of the value added and 10 per cent of the service-related workforce (IBGE; 2014). Jesus (2005) also points out that KIBS have the potential to promote regional development, an essential aspect for a country marked by considerable regional disparities. However, in Brazil, KIBS firms remain concentrated in the south and southwest regions (Guimarães & Meirelles, 2014) with limited impact in this sense.

The representativeness of KIBS sectors for the country's innovation system has already been discussed by Bernardes and Andreassi (2007). These authors also explore the role of KIBS as carriers, facilitators, and sources of innovation for the local economy, taking into account the particularities of the institutional context. Figueiredo et al. (2017) and Figueiredo, Ferreira, and Marques (2015), however, show that few studies explore the role of KIBS in promoting innovation in Brazil, in spite of the growing international literature on the topic. The few exceptions are the studies of Kubota (2009) and Freire (2006).

Similar to the literature in more developed countries, these two studies have identified that the use of KIBS in Brazil is associated with buyers' innovation activity. Freire (2006) observed that firms that innovate more tend to establish partnerships with KIBS firms and suppliers and to participate in information sharing networks. Kubota (2009), in his study, used data from the Research on Economic Activity of the State of São Paulo in 2001 to show

that the use of KIBS stimulates technological innovation in service sectors, like accounting, internet-based services, communication, advertising, legal and marketing services.

Both studies indicate that Brazilian firms using KIBS also have better innovation performance. However, no previous study evaluated the profile of KIBS users in Brazil. The next section shows the methods adopted to obtain a deeper understanding of the different ways in which firms in sectors of the Brazilian economy use these services.

3. Methods

3.1 Data and variables

Data were obtained from the 2014 national research on technological innovation (PINTEC, 2014). This version of PINTEC has data on the innovative activity of Brazilian firms from 2012 to 2014. Data were aggregated by sector. The sample was composed of 57 sectors (manufacturing = 47; services = 10). Three sets of variables were used for the analysis. The first set had the variables assessing the use of KIBS. PINTEC has two groups of variables to measure the use of KIBS. The first evaluates to what extent firms consider highly relevant to their innovative efforts the relationship with:

- higher education institutions and research institutes;
- capacitation and technical support centers;
- testing and certification institutes; and
- consulting companies and independent consultants.

The other group of variables captures to what extent firms use these partners as sources of information. Universities are not KIBS providers by definition, but the variables associated with their use were adopted in the analyses for two reasons. In less developed innovation systems, they tend to offer consulting services to companies at a lower billable hour (Pinto, Fernandez-Esquinas & Uyarra, 2015). Moreover, the PINTEC variables groups together universities with research institutes and the latter sells R&D services, being considered a KIBS.

The second set of variables measured the investments in innovative activity and the level of innovativeness of the products, processes and services launched. Despite the varying perspectives on the meaning of the concept of innovativeness, this term is most commonly used to represent the degree of newness of an innovation (Garcia & Calantone, 2002). The third set of variables measured innovation performance. Similar to the work of Doloreux and Shearmur (2013), this study does not see innovativeness as a metric of innovation performance. Innovation performance involves the launch of products and services and the implementation of productive and organizational processes. Innovativeness evaluates if the services, products and processes launched are incremental innovations, innovations new to the firm, or new to the market. Firms may obtain significant returns from the launch of multiple incremental innovations and, thus, have a good innovation performance. Conversely, the introduction of radically new offerings and processes may even lead to losses, due to the risks involved.

PINTEC data are displayed as a count of firms, product and processes, or the sum of revenues and investments associated with innovative activities. Variables were transformed into ratios to represent the investment in innovation and innovation performance. Table I presents the variables used in the analysis. None of the variables followed a normal distribution.

3.2 Data treatment

The variables on the use of KIBS were first submitted to an Exploratory Factor Analyses (EFA) to reduce the number of variables for the cluster analysis. The generalized least squares (GLS) method was used as an extraction method to fit unique variables into factors instead of finding one common factor. The equimax method was used to obtain orthogonal factors after the rotation for the cluster analysis. The EFA displayed adequate fit indexes. The Kaiser-Meyer-Olkin (KMO) was 0.616, and Bartlett¨s sphericity test was significant ($p < 0.01$) indicating good sample adequacy for the number of variables. The EFA extracted four factors with eigenvalues above one that accounted for 66 per cent of the data variability. Factor loadings above 0.3 are on Table II.

The EFA suggested the existence of four factors. The first factor represented the use of higher education institutions (HEI) and research institutes (RI) as partners and sources of information. This factor makes theoretical sense, as higher education institutions and research centers are one of the most relevant sources of external knowledge for innovative firms (Miozzo et al., 2016; Teixeira & Santos, 2016). The variables on the use of consultancy

Table I.
Variables used in the analysis

Category	Variable
Use of KIBS	% of companies that innovate and consider highly relevant the partnership with universities and research institutes
	% of companies that innovate and consider highly relevant the partnership with capacitation and technical support centres
	% of companies that innovate and consider highly relevant the partnership with testing and certification institutes
	% of companies that innovate and consider highly relevant the partnership with consulting companies and independent consultants
	% of companies that consider important for innovation the information coming from universities
	% of companies that consider important for innovation the information coming from research institutes and technological centres
	% of companies that consider important for innovation the information coming from consulting companies and independent consultants
	% of companies that consider important for innovation the information coming from capacitation and technical support centres
	% of companies that consider important for innovation the information coming from testing and certification institutes
Innovative activity	Investment in internal R&D/Investment in External R&D
	Average investment in R&D per company
	Average investment in software per company
	Average investment in machinery and equipment per company
	Average investment in training per company
	Use of intellectual property rights defence means/ no use of mechanisms
	Products new to the firm/products with incremental changes
	Processes new to the firm/processes with incremental changes
	Products new to the market/products new to the firm
	Processes new to the market/processes new to the firm
Innovation performance variables	Companies: with innovation/without innovation
	Companies: with product innovation/without innovation
	Companies: with process innovation/without innovation
	Companies: with organizational innovation/without innovation
	Companies: with new marketing strategies/without innovation
	Companies: with new work-organization strategies/without innovation

Variables and Factors' names	HEI* and RI as partners and information sources	Capacitation. technical support. testing and certification institutes as partners	Capacitation. technical support. testing and certification institutes as information sources	Consultancy firms and consultants as partners and information sources
Partnership with universities and research institutes	0.74			0.39
Importance of information coming from universities	0.92			
Importance of information coming from research institutes and technological centres	0.74		0.35	
Partnership with capacitation and technical support centres		0.96		
Partnership with testing and certification institutes	0.37	0.74		
Importance of information coming from capacitation and technical support centres			0.98	
Importance of information coming from testing and certification institutes			0.51	
Partnership with consulting companies and independent consultants		0.48		0.85
Importance of information coming from consulting companies and independent consultants			0.30	0.53

Notes: * HEI = higher education institutions; RI = research institutes

Table II. Variables and factor loadings

firms and independent consultants as partners and sources of information loaded on the fourth factor. This factor is also theoretically sound as consulting firms provide customers with managerial models that can lead to organizational and process innovation (Doloreux et al., 2016). The use of capacitation, technical support, testing and certification KIBS loaded into two factors; one for the use of these institutions as information providers and another to represent the relationship with these organizations. This outcome was unexpected, given that the two previous factors grouped the variables on the use of information and partnerships together. However, this different pattern may indicate that firms buy information from these providers, but not necessarily interact closely with them (and the other way around). On the other hand, customer firms usually engage in both activities with HEI and consulting firms.

A second EFA was used to analyze the innovation performance variables (see Table I – innovation performance variables). The procedure of the first EFA was replicated. The

Kaiser-Meyer-Olkin (KMO) was 0.848, and Bartlett¨s sphericity test was significant ($p < 0.01$) indicating good sample adequacy for the number of variables. The EFA extracted one factor with eigenvalue above five that accounted for 94 per cent of the data variability. Factor loadings were significant and above 0.9 for all variables.

The scores for the five factors of the EFAs were calculated using the regression method. The factors became the variables used in the following stages of the data analysis. The four factors assessing the use of KIBS were named: Use of HEI and RI as partners and sources of information; Use of capacitation, technical support, testing and certification institutes as partners; Use of capacitation, technical support, testing and certification institutes as sources of information; and Use of consultancy firms and consultants as partners and sources of information. The remaining factor was named ¨Innovation Performancé.

4. Data analysis

4.1 Knowledge-intensive business services use pattern in Brazil

Cluster analysis was used to group sectors according to the use of KIBS and, as such, the four variables created with the first EFA entered in the analysis (i.e. Use of HEI and RI as partners and sources of information; Use of capacitation, technical support, testing and certification institutes as partners; Use of capacitation, technical support, testing and certification institutes as sources of information; and Use of consultancy firms and consultants as partners and sources of information).

The guidelines of Hair, Anderson, Tatham, and William (2005) were followed. Initially, a regression analysis was calculated. The four factors were the independent variables and the percentage of companies with new products and processes as the dependent variable. The Mahalanobis distance indicated two significant outliers and these two sectors were eliminated from the analysis. The final sample had 55 industries. There was also no multicollinearity, as the rotation of the factors was orthogonal. The four variables were then standardized.

The hierarchical cluster analysis was calculated using the ward method, which tends to form clusters that are more concise and is good to uncover clusters of uneven sizes. The analysis of the agglomeration coefficient indicated that four clusters existed (C1 = 26 sectors; C2 = 10 sectors; C3 = 11 sectors; C4 = 8 sectors). An ANOVA analysis was performed to compare the means of the clustering variables across clusters. This analysis indicated that the means of each cluster differed significantly from each other at a 0.01 significance level. The variance homogeneity test indicated the variances were significantly different and the Games–Howell test was used to make the pair-wise comparisons (Table III).

The analysis of the clusters indicated the following pattern of KIBS use. Cluster 1 (Limited KIBS use), composed of 26 sectors, represent the industries that do not use any KIBS to support their innovation process. These industries score low in all four dimensions of KIBS use. Cluster 2 (Technical institutions and HEI partners) groups together sectors that work in partnership with capacitation, technical support, testing and certification institutes as partners and rely moderately on universities and research institutes. Cluster 3 (HEI partners) is composed of the sectors that rely extensively on the use of higher education institutions and research institutes as partners and sources of information, but very little on other types of KIBS. The fourth cluster (Technical institutions and consultancy partners) contains sectors that rely considerably on consultancy firms, but also use capacitation, technical support, testing and certification institutes as sources of information. The average values of the clustering variables were then used as seeds for a k-means cluster analysis, which produced similar results. Table IV shows the sectors belonging to each cluster.

	Limited KIBS use (C1, $n = 26$)	Technical institutions and HEI, RI partners (C2, $n = 10$)	HEI & RI parters (C3, $n = 11$)	Technical institutions and Consultancy partners (C4, $n = 8$)
Use of HEI and Research Institutes as partners and sources of information	−0.611	0.342	1.216	−0.112
Significant differences at 0.05 level: C1 - C2. C1 - C3. C2 - C3				
Use of capacitation, technical support, testing and certification institutes as partners	−0.365	1.727	−0.205	−0.683
Significant differences at 0.05 level: C2 - C1. C2 – C3. C2 – C4				
Use of capacitation, technical support, testing and certification institutes as sources of information	−0.427	0.253	−0.202	1.350
Significant differences at 0.05 level: C4 - C1. C4 - C2. C4 - C3				
Use of consultancy firms and consultants as partners and sources of information	−0.146	−0.190	−0.539	1.456
Significant differences at 0.1 level: C1 – C3. C1 – C4				

Table III.
Cluster means for KIBS use variables

Almost half of the segments of the national economy display a limited use of KIBS, indicating that many industries have limited access to the potential benefits associated with a closer interaction with KIBS. ICT-related sectors work closely with higher education and research institutes. Moreover, traditional industries, like food, beverages, automotive, pharmaceutical, chemicals, partner with capacitation, technical support, testing and certification institutes, but also work with universities. Perhaps, these industries have learned over time to rely more extensively on different partners.

Kruskal–Wallis one-way analyses of variance (ANOVA) and Mann–Whitney U-tests for pairwise comparisons were used to compare the medians of the variables of investments in innovation and innovativeness to observe the innovation activity of the different clusters (Table V).

The results did not indicate significant differences regarding investments in R&D, the investment in internal over external R&D and the ratio of radical to incremental new products launched. However, the median comparisons point towards three compelling aspects. First, sectors with limited use of KIBS invest significantly less on software, machinery, equipment and training than the ones that use HEI, RI and technical institutions as partners. There are two polar groups of sectors: one that invests little in innovation and interacts little with KIBS and another with a more innovative profile, which invests in innovation and relies on external sources of knowledge. These later mentioned sectors are able to implement more radical changes in their processes than the formers.

Second, these sectors with a more innovative profile do not create more innovative processes and products than the ones that work only with higher education institutions. The segments with strong ties with HEI and RI institutions, if compared to the sectors with limited investment in innovation and use of KIBS, can implement more changes that are new to the firm and in the industry. Moreover, the industries working mainly with HEI and RI are capable of creating more products new to the market than the ones distributing their attention between HEI and technical institutions. Finally, sectors that engage in

Limited KIBS use (C1, $n = 26$)		Technical institutions and HEI, RI partners (C2, $n = 10$)	HEI and RI parters (C3, $n = 11$)	Technical institutions and Consultancy partners (C4, $n = 8$)
clothing	textiles	automotive	customized software development	software development
Rubber and plastic	cleaning products, health and beauty products	medical equipment	bespoke software development	music recording and editing
automotive structures	extractive activities	beverages	gas and electricity	Communication devices
electronic components	maintenance and repairs	biofuels	computers and spare parts	medical and dental assistance instruments
electronics devices	agricultural OEM	oil and oil-related products	energy generators and transformers	transportation equipment
electrical devices	extraction and construction machinery	pharmaceutical	automotive parts and accessories	optronics
furniture	metallurgy	inorganic chemical products	cigarettes and cigars	siderurgy
paper and packaging	motors and pumps	synthetical fibers	organic chemical products	oil refinement
lamps and batteries	other types of machinery	paint-related products	printing and reproduction	
food products	other types of products	telecommunications	other information and communication technologies	
wood products	leather-based products		R&D	
metal products	architecture and engineering			
mineral-based products	data treatment and hosting			

Table IV.
Sectors classified in each cluster

collaborative activities with consultancy firms shows a similar innovation behavior to the other clusters. The only variable with a significant difference is the use of intellectual property rights protection mechanisms.

4.2 Innovation performance according to the knowledge-intensive business services use

A linear regression analysis was employed to answer the second research question. Innovation performance (factor resulting from the second EFA) entered in the model as a dependent variable and the scores of the four factors on KIBS use entered as independent variables. The evaluation of the quality of the regression models followed the guidelines of Hair et al. (2005). The scatterplots of the standardized and studentized residuals against the predicted variables showed no patterns, suggesting the homoscedasticity assumption was not violated. The boxplots of the Cook's distance indicated the absence of outliers. The R-squared was 0.309, suggesting that the model explained one-third to the data variability. The ANOVA test was significant (<0.01), confirming that a linear relationship existed between, at least, one of the four different types of KIBS use and innovation performance. The variance inflator factors for the four variables on the use of KIBS were all below 3, confirming the absence of multicollinearity. The only significant coefficient ($p < 0.01$) was for the variable HEI and RI as partners and

Variables*	Limited KIBS use ($n = 26$)	Technical institutions and Consultancy partners ($n = 8$)	HEI and RI parters ($n = 11$)	Technical institutions and HEI, RI partners ($n = 10$)	Significance
Investment in internal R&D/Investment in External R&D	6.98	5.56	6.46	9.01	0.71
Average invest. in R&D per company	1.393	4.200	3.935	2.995	0.11
Average invest. in software per company	90 (X)	142	161	274 (x)	<0.02
Average invest. in machinery and equipment per company	607 (X)	693	1.158	5.287 (x)	<0.01
Average invest. in training per company	35 (X)	85	62 (x)	151 (x)	<0.01
Use of IPR defence means/ no use of mechanisms	0.34 (X)	1.19 (x)	0.61	0.91	0.07
Products new to the firm/ products with incremental changes	0.81	0.69	0.99	0.64	0.42
Processes new to the firm/ processes with incremental changes	0.55 (X)	0.66	0.87 (x)	0.92 (x)	<0.03
Products new to the market/products new to the firm	0.25(X)	0.44	0.77 (x)	0.32 (X)	<0.02
Processes new to the market/processes new to the firm	0.09 (X)	0.19	0.26 (x)	0.14	<0.01

Notes: * a significant difference ($p < 0.03$) was identified between the means of the groups marked as with a "X" (capital x) and those of the groups marked with a "x" in the post hoc Mann–Whitney U-tests

Table V.
ANOVA Results for innovative activity

sources of information, indicating that a better product, process and organizational innovation performance is associated with the use of this kind of partner (Table VI).

5. Discussion

The research results enrich the current literature on the use of KIBS in different ways. First, they add additional evidence to the existing literature on the importance of KIBS as a source of innovation for their customers. In line with previous studies (Freel, 2016; Lau & Lo, 2015; Yam et al., 2011), this research indicates that firms interacting with KIBS providers also develop more processes and products new to the firm and the market. The results also show that the use of KIBS is associated with the launch of new products and services and the implementation of new processes, confirming the findings of previous studies (Doloreux & Shearmur, 2013; Freire, 2005; Hu et al., 2013; Teixeira & Santos, 2016). Additionally, similar to Freel (2016), this study found that more collaboration with KIBS goes hand-to-hand with higher investments in training, but not with internal R&D.

Second, the results reveal the need to consider the role that different types of KIBS play in stimulating innovation in customer firms. In Brazil, the relationship with higher education institutions and research institutes proved particularly relevant. Only the use of these two KIBS

providers was positively associated with a better innovation performance. On the other hand, the interaction with consultancy firms seems to be a strategy that leaves firms "stuck in the middle". Firms in the sectors with this KIBS use profile do not differentiate themselves significantly from firms that invest little in innovation nor from the ones that work with other types of KIBS. They do not display poor innovation returns but also do not stand out in any particular way. This research, therefore, complements previous studies arguing that the kind of solution purchased influences buyers' innovation returns (D' Antone & Santos, 2016; Doloreux et al., 2016).

Finally, the limited importance of consulting firms if compared to higher education institutions and research institutes in the Brazilian economy suggests that context matters. The findings of this study are in line with the ones of Teixeira & Santos (2016), who observed that universities and research institutes are essential sources of information and knowledge in Portugal. On the other hand, unlike Doloreux and Shearmur (2013) who studied the Canadian economy, this research did not find that the use of consultancy firms is associated with higher innovation returns.

One explanation for the different roles played by higher education institutions, research institutes, and consulting firms in the Brazilian economy is the distribution of these organizations in the national territory. The concentration of KIBS providers in the south and southeast of the country (Guimarães & Meirelles, 2014) leads to a smaller supply of consulting services throughout the country, while research institutes and higher education institutions are better distributed. Since, in less developed innovation systems, higher education institutions tend to offer consulting services at a lower billable hour (Pinto et al., 2015), universities and research institutes may end up rendering much of the service consulting firms could provide.

The research outcomes also offer some practical guidelines. They indicate that firms collaborating with universities and research institutes show the ability to innovate more and more radically, even at moderate levels of investment in software, machinery, equipment and training. As such, Brazilian firms should strengthen their ties with these types of KIBS, especially when radical innovation is the goal. Moreover, the fact that universities are relevant sources of innovation is not new. However, this study showed that, in Brazil, only 21 out of the 55 sectors analyzed work closely with these institutions and 26 industries do not interact with KIBS. Innovation policies should promote a closer university-firm link in the country. Actors focused on the articulation of the national innovation ecosystem, like SEBRAE, SINBRATEC or regional development agencies, should also develop training programs highlighting the importance of collaboration with these institutions.

Table VI. Regression coefficients

Variables	Unstandard. coefficients	Std. error	Standard. coefficients	Significance	VIF
Constant	0.01	0.12	*-*	0.92	*-*
HEI and RI as partners and sources of information	0.58	0.13	0.55	0.00	1.09
Capacitation, technical support, testing and certification institutes as partners	0.02	0.17	0.01	0.92	1.12
Capacitation, technical support, testing and certification institutes as sources of information	0.08	0.13	0.08	0.53	1.12
Consultancy firms and consultants as partners and sources of information	0.04	0.23	0.02	0.85	1.20

6. Concluding remarks

This paper analyzed the pattern of KIBS use in the industries of the Brazilian economy. An exploratory analysis of the data from the 2014 national innovation survey, using different statistical methods, showed how sectors of the Brazilian economy use KIBS, how firms using KIBS invest in innovation and the type of partnership associated with better innovation performance. Overall, the research outcomes confirm the arguments of the literature that the use of KIBS has positive results for customer firms. More importantly, the research findings enrich the current literature on the use of KIBS, by showing the role different types of KIBS play in stimulating innovation in customer firms is of relevance and may vary across countries.

Future research should explore in more detail the relationship between the different types of KIBS use, buying firms profiles and innovation outcomes. In this vein, researchers could examine the investments firms need to make to promote the use of KIBS and understand the innovation outcomes associated with different antecedents of KIBS use. A study to compare the use of KIBS across countries and evaluate the role played by home-country institutions would also enrich the current understanding of the importance of KIBS in innovation systems. Future studies could also assess the effectiveness of the different modes of university-firm links to explain how firms can benefit more from establishing these relationships. Moreover, future research could explore the hindering factors preventing university-firm ties from developing. This knowledge would help understand why this link in Brazil is weak and guide the actions of policymakers. Researchers could also compare the practices adopted to strength this link in different countries to identify mechanisms to promote such interaction in Brazil. Finally, future research could explore in more detail why the use of consulting firms has different implications for buying companies depending on their home country. In this way, it would be possible to understand why the use of consulting firms seems to have limited innovation impacts for Brazilian firms, while the international literature places these KIBS as essential innovation drivers.

More research is also needed to address the limitations of this study. The research used data from the PINTEC website. Albeit reliable, the database aggregates information at the sector level, and it would be interesting to have information at the firm level. Moreover, this research used data from the last edition of PINTEC; even so, the data available covers the period between 2012 and 2014. It would be interesting to update the results of the present research once the new edition of PINTEC is released. Future research could also use longitudinal data and evaluate changes in the use of KIBS in the Brazilian economy over time. Furthermore, the transformations performed in variables of the dataset aimed to create continuous variables to facilitate the statistical analysis. However, changes could have been executed differently, enabling other insights to emerge. Finally, the data analysis performed could not establish cause and effect relationships, and an intervenient variable may have influenced some of the findings. Future research could try to address this issue by using a different research design.

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