Revista Brasileira de Inovação
ISSN 2178-2822
DOI: https://doi.org/10.20396/rbi.v20i00.8656133

ARTICLE

Technological and Organizational Innovation for Knowledge-Intensive Business Services in Brazil

* *André Luiz da Silva Teixeira*
Universidade Federal de Alfenas (UNIFAL-MG), Varginha, MG, Brazil
E-mail: andre.teixeira@unifal-mg.edu.br

** *Vanessa Criscuolo Parreiras de Oliveira*
Universidade Estadual de Campinas (UNICAMP), Campinas, SP, Brazil
E-mail: vparreiras@uol.com.br

*** *Philipe Scherrer Mendes*
Universidade Federal de Minas Gerais (UFMG), Belo Horizonte, MG, Brazil
E-mail: philipescherrer@gmail.com

**** *Daniel Paulino Teixeira Lopes*
Centro Federal de Educação Tecnológica de Minas Gerais (CEFET-MG), Belo Horizonte, MG, Brazil
E-mail: daniel.lopes@cefetmg.br

***** *Márcia Siqueira Rapini*
Universidade Federal de Minas Gerais (UFMG), Belo Horizonte, MG, Brazil
E-mail: msrapini@cedeplar.ufmg.br

Received: 04 August 2019 Revised version: 17 March 2020 Accepted: 07 July 2020

Abstract

This paper aims to analyze the empirical relationship between the technological (TI) and organizational innovations (OI) of innovative Brazilian firms classified as Knowledge-Intensive Business Services (KIBS), and discusses their different determinants, the role of persistence, and a possible two-way relationship between these three types of innovation. A sample of 595 firms was empirically analyzed using the Brazilian Innovation Survey (PINTEC) and the Annual Survey of Services (PAS) from 2009 to 2014. The results reveal a "cross-influence" between OI and TI: internal OI are induced by prior product TI while the former induce process TI. Cumulative effects are observed for these three types of innovation, especially for product TI. The findings also indicate that different innovations are fostered by different organizational characteristics and innovative efforts, therefore identifying the limited role of internal R&D efforts.

Keywords | Knowledge-Intensive Business Services (KIBS); Technological innovations; Organizational innovations; Innovation Survey; PINTEC

1. Introduction

The importance of the service sector in terms of both products and the generation of jobs has grown significantly since the middle of the last century. In 2016, this sector comprised 73.4% of the added value in the countries comprising the European Union (Eurostat) and constituted 75.8% of the Gross Domestic Product in Brazil in 2018 (IBGE).

Despite the involvement of a wide and heterogeneous set of subsectors and segments, some services are highly innovative, and are characterized by the intense generation and use of information and knowledge. These sectors are known as Knowledge-Intensive Business Services (KIBS). Their rise is perceived as a by-product of modern knowledge economies, in which increasing specialization induces a need for professional agents in external knowledge markets (CONSOLI; ELCHE-HORTELANO, 2010).

These KIBS play unique roles in the innovation system as "problem solvers" for advanced manufacturing firms and infrastructure services based on information and communication technologies (ICTs) (CASTELLACCI, 2008). Moreover, KIBS act as "intermediary firms" that specialize in knowledge screening, business analysis and professional consulting (CONSOLI; ELCHE-HORTELANO, 2010). These sectors also drive the innovative process of their customers (HERTOG; BILDERBEEK, 2000; PINA; TETHER, 2016).

The differentiated role of KIBS in the Innovation System has demanded new approaches to the conceptualization and analysis of their innovative processes and impact in the value generation of other sectors (KON, 2004). The new edition of the Oslo Manual (OECD; EUROSTAT, 2018) and the constant growth in the number of service firms in the Brazilian Innovation Survey (PINTEC) are examples of efforts in this direction.

The increased relevance of organizational innovation *vis-à-vis* technological innovation is among the peculiarities of the innovative process in KIBS. Several studies have indicated that innovation strategies of firms are generally better understood regarding both technological and organizational innovations (BARTOLONI; BAUSSOLA, 2018; HERVAS-OLIVER *et al.*, 2017; TAVASSOLI; KARLSSON, 2015). Organizational innovations can occur alongside, before, or after technological innovations, and are considered fundamental to supporting firm performance and growth (NELSON; SAMPAT 2001). Organizational innovations are even more

important for the service sector and occur independently of technological innovations in many cases (EVANGELISTA; VEZZANI, 2010).

This article empirically analyzes how technological (TI) and organizational (OI) innovations occur in Brazilian KIBS, discusses their different determinants, the role of persistence, and a possible two-way relationship between these two types of innovation. Here, the concept of persistence is similar to that of cumulativeness (DOSI, 1988), in which the implementation of a given type of innovation in year *t* increases the likelihood that a firm will implement the same type of innovation in the following *t + 1* period. For example, the concept of a two-way relationship addresses how the implementation of OI can both induce and be induced by a given TI. Thus, it seeks to fill the existing gaps in both the literature on KIBS and the relationship between TI and OI, especially in the context of a developing country, such as Brazil.

This article includes five more sections beyond this introduction. The next section discusses the innovative process in KIBS. The third section discusses persistence, cumulativeness, and the possible two-way relationship between organizational and technological innovations. The fourth section describes the methodology and database used and the fifth section discusses the empirical results. The empirical analysis was performed by crossing-referencing two databases at the firm level – PINTEC and the Annual Survey of Services (*Pesquisa Anual de Serviços* – PAS) – for the period between 2009 and 2014. The last section concludes the work.

2. Innovation process in Knowledge-Intensive Business Services (KIBS)

KIBS have played an increasingly dynamic and central role in the knowledge-based economy (OECD, 2005). This classification includes both KIBS that use new technologies focused on technical and administrative knowledge, such as engineering, architecture, marketing, advertising, and financial and legal consulting, and those that develop new technologies, such as computer networks, telecommunication services, and research and development (R&D) (MILES, 2005). These sectors can be classified as Traditional Professional Services when they are intensive users of new technologies, whereas they are deemed New-Technology-Based KIBS when they are based on technology (MULLER; ZENKER, 2001; MILES *et al.*, 1995).

In general, KIBS have a significant share in added value and employ more qualified human resources compared to other sectors of the economy (BERNARDES; KALLUP, 2006; TORRES FREIRE, 2006). KIBS are especially relevant for the

present study due to their role as a "facilitator" of the innovative process of firms from other sectors of the economy (HERTOG; BILDERBEEK, 2000). KIBS are primary sources of knowledge and provide information on intra-firm operations and the external environment, proposing paths for technological progress, and even implementing solutions in partnership with their customers. Both the learning through the relationship with external agents and the facilitation of these interactions are characteristics of KIBS (BERNARDES; KALLUP, 2006; MILES, 2005).

Hertog and Bilderbeek (2000) explore this aspect further and consider KIBS as "bridging institutions" in the National Innovation System (NIS). In the authors' view, KIBS act as "carriers" when transferring innovation from a firm or industry to the customer, even when they are not generating the innovation itself. KIBS are also creators and sources of innovation, playing a key role in initiating and developing user innovation, which typically results from an interactive process. However, the characteristics of innovative process of KIBS differ from those of manufacturing sectors, which are more commonly discussed.

One of the most significant differences refers to what should be considered a product, process, or organizational innovations in KIBS. According to Sundbo and Gallouj (1998), the definition of organizational innovations in KIBS is not significantly different from that used in the manufacturing industry. The authors define organizational innovations as new generalized forms of organization or management, such as the introduction of total quality control or more independent teams with greater decision-making power. In turn, technological process innovations encompass the renewal of procedures required to produce and deliver a service, which can be divided into two categories: innovations in the production ("back office") or delivery processes ("front office"). Finally, product innovations encompass innovations in a given market (*e.g.* when ICT firms start offering banking services) or market innovations, which reference new behavior in the market, such as identifying a new segment or entering another industry.

Corrocher, Cusmano and Morrison (2009) propose two additional types of innovation specific to KIBS: interactive and techno-organizational innovation. The first is characterized by the interaction with customers and other firms. The second is related to the incorporation of external technology and is based on other sources of innovation, such as organizational change and investments in human capital. These and other studies confirm the heterogeneity of innovation strategies in KIBS.

Service firms generally direct their innovative efforts to less formalized activities, such as marketing, the acquisition of know-how, and other disembodied technologies

(HIPP; GRUPP, 2005; EVANGELISTA, 2006; SILVA NETO *et al.*, 2014). We can infer from Jensen *et al.* (2007) that the service sector is better characterized by the "doing-using-interacting" learning mode, which relies on interaction and experience-based know-how instead of the production and use of codified scientific and technological knowledge. Therefore, service innovation enables the "softer" aspects of innovation based on skills and interorganizational cooperation practices (TETHER, 2005). However, this does not mean that internal R&D efforts are not relevant to KIBS. According to Leiponen (2012), the innovative performance of Finnish services is favored by investments in R&D[1], training, and external knowledge acquisition. Furthermore, some KIBS are focused on conducting R&D in other sectors.

In short, KIBS are heterogeneous, idiosyncratic and important actors in a National Innovation System (NIS), acting as generators, drivers, and diffusers of innovations (CONSOLI; ELCHE-HORTELANO, 2010; HERTOG; BILDERBEEK, 2000; PINA; TETHER, 2016). Thus, it is important to advance the understanding of the peculiarities of their innovative process, especially in a developing NIS, such as Brazil.

3. Interaction and cumulative effects between organizational and technological innovation

The combination of organizational and technological innovations is considered favorable to the firm performance, in terms of both revenue and employment growth (SAPPRASERT; CLAUSEN, 2012). Moreover, the implementation of organizational innovations persistently induces the implementation of technological innovations over time (LE BAS; MOTHE; NGUYEN-THI, 2015).

This persistence references the fact that firms implement the same type of innovation in different years, which can be a result of cumulative innovation. That is, the search for innovations in a given moment is directed by innovations implemented in the past to solve related problems (DOSI, 1988). Cumulativeness or persistence may occur to a lesser extent in organizational innovations (GANTER; HECKER, 2013b; TAVASSOLI; KARLSSON, 2015). These two terms – persistence and cumulativeness – are treated as synonyms in the present study.

In this section, a review is performed on studies that empirically analyze the relationship between OI and TI using databases following the definitions of the

1 Leiponen (2012) suggests that some previous studies may have failed to find the connection between R&D and service innovation results because most studies disregarded time lags, which can be particularly important for smaller service firms.

Oslo Manual (FINEP/OECD, 2005). This restriction is necessary to guarantee a minimum "comparability" with the PINTEC data used here. Table 1 presents the definitions of this edition of the Oslo Manual, and Table 2 summarizes the results.

TABLE 1
Definitions of innovation - Oslo Manual (FINEP/OECD, 2005)

Type of Innovation	Definition
Organizational innovation	Implementation of a new organizational methods in the business practices, organization of the workplace, or external relations of a given firm (p. 61).
Product Innovation	Introduction of a new or significantly improved good or service regarding its characteristics or intended uses (p. 57).
Process Innovation	Implementation of a new or significantly improved production or distribution method (p. 58).

Source: FINEP/OECD (2005). Prepared by the authors.

TABLE 2
Summary of empirical articles on the relationship between Organizational Innovation (OI) and Technological Innovation (TI)

Relationship OI vs. TI	Authors	Country	No. of firms	Period	Sector	Database
Are Interdependent or Complementary	Carboni and Russu (2018)	Europe	13.000	2007-2009	Industry	CIS
	Bartoloni and Baussola (2018)	Italy	3.000	1998-2012	Industry	Italian Innovation Survey
	Tether; Tajar (2008)	Europe	2.500	2002	Industry; Services	Innobarometer
	Hervas-Oliver *et al.* (2017)	Spain	12.563	2004-2006	Industry; Services	CIS
	Tavassoli and Karlsson (2015)	Sweden	574	2002-2012	Industry; Services	CIS

(continued)

TABLE 2
Summary of empirical articles on the relationship between Organizational Innovation (OI) and Technological Innovation (TI)

(continued)

Relationship OI vs. TI	Authors	Country	No. of firms	Period	Sector	Database
OI induce product and process TI	Camisón and Villar-López (2014)	Spain	144	2005	Industry	Iberian Balance Sheet Analysis System
	Ganter and Hecker (2013a)	Germany	2.933	2005	Industry; Services	CIS
	Ganter and Hecker (2013b)	Germany	984	2002-2008	Industry; Services	CIS
OI induce product TI	Cozzarin (2017)	Canada	3.000	2009-2012	Industry	Survey of Innovation and Business Strategy
	Camisón and Villar-López (2014)(1)	Spain	144	2005	Industry	Iberian Balance Sheet Analysis System
	Le Bas, Mothe and Nguyen-Thi. (2015)	Luxembourg	287	2004-2008	Industry; Services	CIS
OI induce process TI	Cozzarin (2017) (Negative relationship)	Canada	3.000	2009-2012	Industry	Survey of Innovation and Business Strategy
	Ganter and Hecker (2013a)	Germany	2.933	2005	Industry; Services	CIS
	Le Bas, Mothe and Nguyen-Thi(2015)	Luxembourg	287	2004-2008	Industry; Services	CIS
TI induce OI	Ganter and Hecker (2013b)	Germany	984	2004-2008	Industry; Services	CIS

Source: Prepared by the authors
(1) This effect is mediated by process innovation.

In general, a larger number of studies address the induction of TI by OI than of OI by TI. Moreover, the first group of studies did not address the relationship between these innovations, and instead only examined the effect of their complementarity on the firm's performance in terms of profitability, revenue, productivity, etc. (CARBONI; RUSSU, 2018; BARTOLONI; BAUSSOLA 2018; TETHER; TAJAR, 2008; HERVAS-OLIVER *et al.*, 2017). Such complementarity references the influence of both OI and TI adoption over this performance without analyzing how one type of innovation influences the adoption of another.

The studies assessing the relationship between TI and OI revealed divergent results. Some studies found that OI induce both product and process innovation (GANTER; HECKER, 2013a; 2013b; CAMISÓN; VILLAR-LÓPEZ, 2014). Others found that OI can only induce process (LE BAS; MOTHE; NGUYEN-THI, 2015) or product innovation (COZZARIN, 2017), although the latter relationship can be mediated by the former (CAMISÓN; VILLAR-LÓPEZ, 2014). These OI can then be influenced by prior technological innovations (GANTER; HECKER, 2013b) or R&D efforts (CARBONI; RUSSU, 2018)

Moreover, Table 2 also reveals that the studies do not limit their analysis to KIBS and their specificities, nor do they address the context of developing countries. Differences between national contexts can obstruct the realization of a definitive conclusion on the relationship between OI and TI (GANTER; HECKER, 2013a). Only a few studies examining the persistence of these innovations are dedicated to developing countries, such as that of Suarez (2014), who considers the instability of the environment as a determinant of the difficulty in analyzing the persistence of investments and innovations.

Therefore, the present study seeks to make an empirical contribution to these two gaps in the literature: first, analyze the relationship between OI and TI exclusively in KIBS; second, analyze this relationship in a developing country, such as Brazil. The next section presents the database and the methodology used herein.

4. Database, methodology, and variables

The binary logit model was constructed using a database comprising cross-referenced information at the firm level, which was collected from PINTEC and PAS to analyze the determinants of the implementation of different innovations (on product, process, and on internal and external organizational processes). The following subsections discuss this model, the selected variables, and the general characteristics of the database used.

4.1 Econometric model

The use of the binary logit model allows us to determine the probability of implementing a given innovation, but conditioned on a vector of explanatory variables with a logistic distribution. According to Wooldridge (2002), this model can be understood as follows:

$y^* = x\beta + \varepsilon$; such that $y = 1\ if\ y^* > 0$ or $y = 0\ if\ y^* \leq 0$

with y^* = an unobservable latent variable (innovative capacity, in this case); x = the vector of k dependent variables; β = the vector of k parameters to be estimated; e ε = the error term, with a logistic distribution, a zero mean, and constant variance.

From this we obtain:

$$\Pr(y = 1/x) = \Pr(y^* > 0|x) = \Pr[(\varepsilon > -x\beta)|x]$$
$$= G(x\beta) = \exp(x\beta)/[1 + \exp(x\beta)]$$

This model is estimated by maximizing a log-likelihood function to obtain the estimated parameters such that the probability of observing the "y" values is as high as possible. Further details are found in Wooldridge (2002).

4.2 Selected variables and expected behaviors

Table 3 shows the variables used. The explanatory variables are lagged within a given period in relation to the dependent variables to assess a possible "maturation" of the impact. The explanatory variables are divided into four groups.

The first group – previous innovations – seeks to evaluate how different previous innovations affect the chances of implementing innovations in the future, thus seeking to identify the influence exerted by OI on TI and vice versa. As seen before in Table 2, these variables can be complementary and a two-way relationship between them is possible: although OI affect TI, they are also affected by them. Thus, a positive effect is expected between OI and TI. However, three points should be noted.

First, the option to use time-lagged explanatory variables can be understood as a methodological strategy for addressing a possible simultaneity between OI and TI. If OI affected and were affected by TI, this endogeneity would have to be addressed via an instrumental variable (IV) or a two-stage least square (2SLS) estimation. The decision to use the lagged variable causes the 2011 indicators to exogenously affect the 2014 indicators.

TABLE 3
Variables used

Group	Code	Description	Period	Source
		Dependent variables		
Innovation in 2012-2014	Internal_OI	= 1 if innovation is implemented in management techniques or work organization; = 0 ow*.	2012-2014	
	External_OI	= 1 if innovation is implemented in external relations; = 0 ow.	2012-2014	
	Product_TI	= 1 if innovation is implemented in products; = 0 ow.	2012-2014	
	Process_TI	= 1 if innovation is implemented in processes; = 0 ow.	2012-2014	
		Explanatory variables		
Previous Innovation (2009-2011)	Internal_OI_t1	= 1 if innovation is implemented in management techniques or work organization in the past period; = 0 ow.	2009-2011	PINTEC
	External_OI_t1	= 1 if innovation is implemented in external relations in the past period; = 0 ow.		
	Product_TI_t1	= 1 if innovation is implemented in products in the past period; = 0 ow.		
	Process_TI_t1	= 1 if innovation is implemented in processes in the past period; = 0 ow.		
Innovative efforts (%)	eff_int_R&D_t1	100*Internal R&D expenditures/Net sales revenue	2011	
	eff_ext_R&D_t1	100 * Expenditures for the acquisition of external R&D/Net sales revenue		
	eff_Training_t1	100 * Training expenditures to innovate/Net sales revenue		
	eff_embedd_ knowled_t1	100 * Expenditures for the acquisition of machines, equipment, or software to innovate/Net sales revenue		
	eff_intro_inn_t1	100 * Expenditures for the Introduction or Distribution of innovations in the market/Net sales revenue		

(continued)

TABLE 3
Variables used

(continued)

Group	Code	Description	Period	Source
		Explanatory variables		
Organizational characteristics	perc_R&D_workf_t1	100*Number of employees in R&D/Total enterprise employees (%)	2011	PINTEC
	org_rig_t1	= 1 if "organizational rigidity" was an obstacle considered of high or medium relevance for the firm's innovative process; = 0 cc	2009-2011	
	conc_inn_activ_t1	= 1 if the "concentration of the innovative activity in another firm of the group" was an obstacle considered of high or medium relevance for the firm's innovative process; = 0 ow	2009-2011	
Financial income	fin_rev_t1	The ratio between "Revenue from financial operations" and "Net sales revenue" (average between 2009 and 2011)	2009 and 2011	PAS
Control Variables	1.ict	= 1 if the firm belongs to the Telecommunications sector (CNAE 61); = 0 ow	2012-2014	PINTEC
	2.ict	= 1 if the firm belongs to the Information Technology Services or Information Service Provision sectors (CNAE 62 or 63); = 0 ow		
	K_internac	= 1 if the origin of the firm's controlling capital is international; = 0 ow		
	K_mix	= 1 if the origin of the firm's controlling capital is mixed (national and international); = 0 ow		
	N	= 1 if the firm is based in the Northern region; = 0 ow		
	NE	= 1 if the firm is based in the Northeastern region; = 0 ow		
	SE	= 1 if the firm is based in the Southeastern region (except for the State of São Paulo, which was the omitted category); = 0, ow		
	CO	= 1 if the firm is based in the Central-West region; = 0 ow		
	S	= 1 if the firm is based in the Southern region; = 0 ow		
	ln_workf	Ln of Number of employees		

Source: Prepared by the authors Note: *"ow" means "otherwise."

Second, unlike the existing studies reviewed in the third section, we decided to divide organizational innovations into two groups: internal OI (encompassing innovations in management techniques and work organization) and external OI (which include innovations in external relations)[2]. This division is relevant because recent efforts (see the Oslo Manual 4th Edition (OECD; EUROSTAT, 2018)) have increasingly incorporated the importance of external arrangements for innovation in KIBS. For example, Witell *et al.* (2017) found that relations with external partners influence the results of service innovation. These partnerships are a means of rendering inbound and outbound knowledge viable, which is crucial to the innovative efforts of KIBS. One example is found in the partnerships between firms in industrial sectors and KIBS ones, which offer opportunities for downsizing, risk outsourcing, the creation of services that complement the goods produced, and knowledge sharing (BUSTINZA, 2019). As seen in the second section, interaction with customers is prominent in KIBS firms. Therefore, addressing the potential for KIBS firms to innovate in external relations (external OI) is important for the purposes of this article.

Finally, analyzing the effect of persistence or cumulativity is another important aspect of this first group of variables. This is done by inserting the "lagged" dependent variable as an explanatory variable. For example, firms' implementation of internal OI during the prior period (2009-2011) is among the determinants of that of the internal OI between 2012 and 2014[3]. The same is true for other innovations. The persistence or cumulative effect is expected to emerge in all types of innovations.

The second group of variables assesses the role played by different expenditures on innovative activities in the generation of technological or organizational innovations. The time-lagged indicators are measured in relation to the net sales revenue. As discussed in the second section of this article, in-house R&D efforts may not play a central role in KIBS (e.g. PINA; TETHER, 2016) *vis-à-vis* efforts to acquire

2 According to the Oslo Manual 3rd edition (FINEP/OECD, 2005, p. 63), innovations in external relations include the "implementation of new ways of organizing relations with other firms or public institutions, such as the establishment of new types of collaborations with research organizations or customers, new methods of integration with suppliers, and the *outsourcing* or subcontracting of business activities in production, procuring, distribution, recruiting and ancillary services for the first time."

3 The hypothesis asserting that the inclusion of the time-lagged dependent variable causes a problem of serial correlation of the error term, thereby making it endogenous, is not discarded. However, based on the correlation matrix between the variables and the identification of a low cumulative value of the Brazilian innovative process, the current understanding holds that the inclusion of this variable does not cause a serious methodological problem that nullifies the result obtained. Furthermore, as will be shown in the presentation of the results, the comparison between the model without the time-lagged dependent variable versus the model that includes it reveals little change in the coefficients, which also supports the low effect that a serial correlation would have, thus justifying the implementation of this lagged variable.

external knowledge. However, Doloreux, Shearmur and Rodriguez (2018) found that R&D efforts and the use of external market-related information sources (e.g. customers and suppliers) positively affect the OI and the TI of KIBS firms, which indicates some complementarity between in-house R&D efforts and those expended to acquire external knowledge. Therefore, although R&D may have some effect, it may be weaker than that of other innovative efforts that are more focused on external knowledge acquisition, especially in the Brazilian context.

Among these efforts, those related to training are expected to have an important effect on both types of innovation, given the importance of the tacit knowledge and the skills of individuals for the products offered by KIBS. Following this reasoning and in an effort to overcome the "still dominant industrialist and technological approaches" in the analyses of R&D in terms of services (DJELLAL *et al.*, 2003, p. 415), the number of R&D employees may be more relevant than R&D spending. This variable is found in the third group, which is focused on organizational characteristics.

Regarding the organizational characteristics, we assessed whether the firms' perception (in 2009-2011) of the obstacles to innovate in terms of their general organization (organizational rigidity and concentration of activities in other firms within the group) encouraged or discouraged the accomplishment of innovations in the following period, especially organizational innovations. These variables can also be considered proxies for the characteristics of a firm's organizational structure, which can positively or negatively affect innovation. In a meta-analysis of studies published between 1960 and 2009, Damanpour and Aravind (2012) found the negative effects of the formalization and concentration of innovative activity, while specialization and differentiation yielded a positive effect. In the present study, it is impossible to say whether such an effect is positive or negative, given the sector characteristics and also because both the concentration of innovative activities in other firms of the group and organizational rigidity tend to limit innovative choices and activities. While the last two aspects can have a positive effect because they guide the search process of firms and reduce uncertainties, they also reduce a firm's flexibility to react to changes in the environment, hampering the implementation of technological or organizational innovations. Further, an additional element for OI exists: OI can be implemented to counter organizational rigidity that was previously observed.

The fourth group analyzes the effect of financial characteristics on the innovative process. This is carried out based on the ratio between the financial income and the sales revenue. Hypothetically, a two-way effect exists: conversely, it can favor innovation by providing resources to them (self-financing of innovation); on the other hand, its high importance compared to the sales revenue may be indicative of increasing "financialization" of the firm, which induces less uncertain and short-term strategies (MAZZUCATO, 2014), thus discouraging the implementation of innovations.

Finally, regional (large Brazilian regions) and sectorial control variables and variables related to the size of the firm and the origin of its controlling capital are included.

4.3 Database description

The data were obtained by cross-referencing the microdata – *i.e.* information at the firm level – from both PINTEC and PAS. PAS collects economic and financial information from non-financial business services firms in Brazil. All firms with over 20 employees were interviewed, and random sampling was carried out for those below than that (IBGE, 2013a). PINTEC collects information related to the innovative activities of firms in Brazil every three years, encapsulating the sectors of industry, electricity, and gas, and some KIBS. These KIBS are focused on editing, recording, and music editing; telecommunications; activities related to information technology services; data processing, web hosting, and other related activities; architectural and engineering services; technical testing and analysis; and R&D.

In the present study, the database comprises the service firms simultaneously present in PINTEC 2011 and 2014 who were interviewed by PAS 2009 and 2011[4]. This selection resulted in a data from 595 firms.

Table 4 provides a general description of this sample, which primarily comprises large firms (over 100 employees), linked to R&D activities or ICTs and that have low organizational and decision-making rigidity, but mainly implement internal OI. Moreover, most firms were based in the southeastern region and were controlled by national capitals.

4 This period selection was compatible with PINTEC 2011 and enabled the definition of indicators used to measure variation within the three-year period of analysis (2009-2011).

TABLE 4
Description of the generated database - 2009 to 2014

Variable	No.	%[1]
Type of innovation implemented in 2012-2014		
TI in Product	222	37.3
TI in Process	236	39.7
Internal OI	391	65.7
External OI	107	18.0
Type of innovation implemented in 2009-2011		
TI in Product	232	39.0
TI in Process	246	41.3
Internal OI	415	69.7
External OI	164	27.6
Organizational characteristics		
Organizational rigidity (org_rig_t1 = 1)	79	13.3
Concentration of innovative activity in another firm (conc_inn_ activ_t1 = 1)	44	7.4
Firm size (in terms of the number of employees)		
<= 49	47	7.9
50-99	79	13.3
100-249	218	36.6
250-499	119	20.0
>= 500	132	22.2
Sector (CNAE code)		
Editing and recording and music editing (58 or 59.2)	97	16.3
Telecommunications (61)	53	8.9
Activities related to information technology services (62)	221	37.1
Activities related to information service provision (63)	39	6.6
Architectural, engineering, and technical testing and analysis services (71) or Scientific R&D (72)	185	31.1
Origin of controlling capital		
National	496	83.4
International	71	11.9
Mixed	28	4.7
Region		
North	8	1.3
Northeast	62	10.4
São Paulo	238	40.0
Southeast (except for São Paulo)	147	24.7
Central-West	35	5.9
South	105	17.6
Total number of firms	**595**	

Source: Microdata from PINTEC 2011 and 2014 and PAS 2009 and 2011. Prepared by the authors.
(1) Percentage calculated based on the total number of firms (595).

5. Presentation and discussion of results

Table 5 presents the results of the Logit models. Positive coefficients indicate the variable's positive effect on the firm's innovative capacity (latent variable for innovation that is implemented) and, thus, also on the probability that the innovation will be implemented. Table 5 does not show the probability, but the linear effect on the latent variable innovative capacity (followed by the standard error in parentheses).

Different estimates were carried out to analyze the robustness of the results. Initially, different specifications were tested for each of the four types of innovations analyzed by including or removing "additional" variables related to innovative efforts and organizational characteristics. Two "additional" innovative efforts were considered: (a) to acquire embedded knowledge (machines, equipment, or software) and (b) to introduce and distribute the innovations in the market. The "additional" organizational characteristics were as follows: the percentage of workers in R&D (perc_R&D_workf_t1), organizational rigidity as an important obstacle to innovation (org_rig_t1), and the concentration of innovative activities in another firm within the group as an important obstacle to innovation (conc_inn_activ_t1). Thus, four types of models were estimated:

1. "complete" – with additional organizational characteristics and innovative efforts;
2. without additional innovative efforts but with additional organizational characteristics;
3. without the additional organizational characteristics and with the additional efforts;
4. without the organizational characteristics and without the additional innovative efforts.

The results of these four models were compared for each type of innovation, and no substantial changes were found in the estimated coefficients between the models (*i.e.* there was no change in sign of the significant coefficients, and those that were significant at the 5% level remained as such in the estimates). Thus, Model 1 ("complete") was chosen for all types of innovation.

This analysis of robustness was replicated for the specifications that considered the lagged dependent variable, *i.e.* that considered the possible cumulative effect, in which the implementation of a given innovation in 2009-2011 may influence the likelihood that a firm will implement the same innovation in 2012-2014. Based on this analysis, the "complete" model was again chosen.

Thus, Table 5 provides two specifications for each type of innovation analyzed: for the first, cumulativity is not considered and for the second, cumulativity is considered. Generally, the results do not significantly change between such specifications, except for the relationship between product innovation and previous process innovation, which will be explained later. We will now present the theoretical and empirical implications of significant results at the 10% level of significance (highlighted in gray).

The first group of variables comprises **previous innovations**. Two general results are highlighted: (1) the "cross" influence between TI and OI and (2) the limited effect of cumulativity.

We consider the following regarding the *first overall result*. First, innovations in external relations do not affect or are affected by other organizational or technological innovations. This result may reflect a variable defined in a highly generic and broad manner[5], thus encompassing different types and forms of partnerships with varying purposes and effects on the firm's innovative capabilities (LEE; MIOZZO, 2019).

Second, the prior implementation of **product TI** favors the implementation of both process and product TI and *internal OI* in the next period. However, this **product TI** is not significantly favored by other previous organizational or technological innovations. The implementation of previous internal or external OI does not induce **product TI** in the period 2012-2014, while process TI in 2009-2011 affects the development of **product TI** in 2012-2014 only in the model without lagged product innovation.

Conversely, it should be noted that the previous *internal OI* favor the implementation of the process TI in the period that follows, but the opposite is not true. As stated above, *internal OI* are only favored by previous **product TI**.

In short, the influences observed between technological and organizational innovations are similar to those found by Ganter and Hecker (2013b). Although **product TI** favor the implementation of *internal OI*, *internal OI* only contribute to the implementation of process TI. Therefore, it is argued that a "cross-influence" exists between internal OI and TI in the Brazilian context.

One possible interpretation of this "internal OI affecting process TI" relationship is based on the concept of capabilities. Internal OI can contribute to a better diffusion of intra-firm knowledge, which favors firms' absorptive and technological

5 PINTEC 2011 defines innovations in external relations as "significant changes in relations with other firms or public and non-profit institutions, such as the establishment of alliances, partnerships, outsourcing, or subcontracting activities for the first time" (IBGE, 2013b, p. 217).

capabilities (COHEN; LEVINTHAL, 1990), thus increasing the likelihood that they will implement technological innovations, especially process innovations. The "product TI inducing internal OI" relationship can be explained by the logic of "complementary assets" (TEECE; PISANO; SHUEN, 1997) since product innovation could require new internal organizational processes (e.g. those related to learning and sharing knowledge) such that its potential is truly exploited.

The *second overall result* regarding previous innovations relates to the limited effect of cumulativity, i.e. the effect of past innovation on the same type of innovation in the future. Only product innovations were significantly affected by the same innovation in the past period, as found by Ganter and Hecker (2013b) and Tavassoli and Karlsson (2015). While external OI are not affected by their past innovations, internal OI and process TI are only affected at the 10% significance level and to a lesser extent than that of previous product TI. This is aligned with the findings of Le Bas, Mothe and Nguyen-Thi (2015).

It is likely that this greater cumulativeness in product TI is owing to the fact that the products in the analyzed KIBS are more customizable; as such, product innovations can be marginal but occur frequently over time, or a new product that is launched today can result in several new "by-products" derived from it in the future. This new product could act as a "standard platform" for future product innovations.

Regarding **innovative efforts**, some results also differ based on the type of innovation. The first is the effect of efforts to acquire embedded knowledge (machines, equipment, or software), which positively affect the implementation of internal OI. However, in contrast to the findings of Makó *et al.* (2011), we found that these same efforts negatively affect the development of external OI. The first result can be explained by the need for organizational changes to absorb and use the acquired embedded knowledge. The second result can thus be explained by the fact that the acquisition of this embedded knowledge can cause a firm to become dependent on only one supplier or customer, thus forcing it to maintain the already existing relationship and therefore not promoting external OI. In addition, despite their access to external knowledge, firms may also have been unable to develop themselves, and were therefore not seeking and benefiting from new partnerships.

TABLE 5
Determinants of Technological or Organizational Innovations in KIBS in Brazil - 2009-2014

Explanatory variables		Dependent variables and models							
		Internal_OI		External_OI		Product_TI		Process_TI	
		1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2
Previous innovation	Internal_OI _t1		0.445(1)	0.454	0.391	0.374	0.244	0.652(3)	0.604(2)
			(0.242)	(0.290)	(0.299)	(0.299)	(0.310)	(0.251)	(0.254)
	External_OI _t1	0.075	-0.016		0.353	0.232	0.197	-0.222	-0.283
		(0.242)	(0.248)		(0.288)	(0.254)	(0.256)	(0.249)	(0.254)
	Product_TI _t1	0.592(2)	0.521(1)	0.632	0.613		1.130(3)	1.210(3)	1.041(3)
		(0.286)	(0.284)	(0.385)	(0.385)		(0.281)	(0.267)	(0.282)
	Process_TI _t1	0.317	0.255	-0.053	-0.088	0.523(2)	0.170		0.489(1)
		(0.270)	(0.267)	(0.317)	(0.317)	(0.246)	(0.264)		(0.258)
Innovative efforts	eff_int_R&D _t1	0.005	0.005	0.011	0.010	0.005	0.006	0.007	0.007
		(0.007)	(0.006)	(0.008)	(0.008)	(0.005)	(0.005)	(0.005)	(0.005)
	eff_ext_R&D _t1	-0.059	-0.058	0.077	0.074	-0.119(1)	-0.135(1)	-0.046	-0.042
		(0.100)	(0.094)	(0.075)	(0.078)	(0.072)	(0.074)	(0.076)	(0.072)
	eff_Training _t1	-0.291	-0.279	0.564	0.583	-0.044	-0.069	-0.023	-0.033
		(0.200)	(0.201)	(0.383)	(0.381)	(0.082)	(0.079)	(0.096)	(0.092)
	eff_embedd_knowled_t1	0.052(1)	0.053(1)	-0.093(1)	-0.097(1)	-0.008	-0.008	0.010	0.006
		(0.031)	(0.031)	(0.051)	(0.051)	(0.021)	(0.020)	(0.017)	(0.018)
	eff_intro _inn_t1	-0.055	-0.062	-0.420(2)	-0.421(2)	-0.009	-0.062	-0.216(1)	-0.213(1)
		(0.097)	(0.097)	(0.212)	(0.206)	(0.108)	(0.108)	(0.116)	(0.115)
Organiz. Charact.	perc_R&D_workf_t1	0.003	0.003	-0.004	-0.004	0.009(3)	0.005(1)	0.002	0.000
		(0.003)	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
	org_rig _t1	0.075	0.084	0.148	0.171	0.770(2)	0.795(3)	0.711(2)	0.661(2)
		(0.332)	(0.326)	(0.397)	(0.396)	(0.318)	(0.302)	(0.335)	(0.334)
	conc_inn_ activ_t1	0.238	0.207	-1.353(2)	-1.426(2)	0.221	0.099	0.071	0.052
		(0.544)	(0.515)	(0.648)	(0.666)	(0.376)	(0.346)	(0.397)	(0.402)
Financial income	fin_rev _t1	-0.001	0.000	-0.004	-0.004	-0.000	-0.000	0.011	0.013
		(0.002)	(0.002)	(0.004)	(0.004)	(0.002)	(0.002)	(0.013)	(0.017)

(continued)

TABLE 5
Determinants of Technological or Organizational Innovations in KIBS in Brazil - 2009-2014

(continued)

Explanatory variables		Dependent variables and models							
		Internal_OI		External_OI		Product_TI		Process_TI	
		1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2
Control variables	1.ict	0.497	0.506	0.531	0.543	1.224(3)	1.226(3)	0.599	0.619
		(0.398)	(0.391)	(0.428)	(0.433)	(0.372)	(0.377)	(0.412)	(0.422)
	2.ict	0.498(2)	0.481(2)	0.016	0.009	1.318(3)	1.300(3)	1.063(3)	1.068(3)
		(0.237)	(0.239)	(0.299)	(0.301)	(0,248)	(0,253)	(0,243)	(0,244)
	K _internac	-0,340	-0,317	-0,225	-0,247	-0,136	-0,231	-0,526	-0,499
		(0,323)	(0,327)	(0,405)	(0,401)	(0,321)	(0,355)	(0,351)	(0,346)
	K_mix	0,146	0,133	0,306	0,336	-0,024	0,043	0,136	0,157
		(0,505)	(0,514)	(0,596)	(0,594)	(0,418)	(0,421)	(0,442)	(0,451)
	N	-2,181(2)	-2,147(2)	0,170	-0,041	-1,062	-1,121	0,735	0,654
		(1,035)	(1,081)	(1,204)	(1,284)	(1,129)	(1,192)	(0,823)	(0,876)
	NE	-0,297	-0,303	0,266	0,201	-0,011	0,140	1,047(2)	1,077(2)
		(0,351)	(0,363)	(0,441)	(0,446)	(0,546)	(0,546)	(0,450)	(0,461)
	SE	0,359	0,345	0,719(2)	0,698(2)	-0,032	0,004	0,411	0,409
		(0,272)	(0,272)	(0,302)	(0,298)	(0,291)	(0,297)	(0,269)	(0,271)
	CO	0,136	0,103	-0,053	-0,112	0,262	0,353	0,222	0,263
		(0,463)	(0,490)	(0,528)	(0,537)	(0,472)	(0,482)	(0,432)	(0,438)
	S	0,756(2)	0,735(2)	0,982(3)	0,977(3)	0,178	0,148	0,764(2)	0,751(2)
		(0,319)	(0,319)	(0,350)	(0,353)	(0,318)	(0,325)	(0,314)	(0,311)
	ln_workf	0,404(3)	0,397(3)	0,292(2)	0,287(2)	0,153	0,169(1)	0,291(3)	0,282(3)
		(0,099)	(0,101)	(0,114)	(0,115)	(0,099)	(0,102)	(0,092)	(0,093)
	Constant	-2,27(3)	-2,45(3)	-3,96(3)	-3,94(3)	-3,01(3)	-3,19(3)	-3,9(3)	-3,91(3)
		(0,608)	(0,632)	(0,697)	(0,701)	(0,693)	(0,716)	(0,554)	(0,560)
Number of firms		**595**	**595**	**595**	**595**	**595**	**595**	**595**	**595**

Source: Prepared by the authors based on microdata from PINTEC 2011 and 2014 and PAS 2009 and 2011. (1) indicates significance at the 10%; (2) indicates significance at the 5%; (3) indicates significance at the 1%.
Note: "Organiz. Charact." is an abbreviation for "organizational characteristics"; the gray color highlights the significant coefficients.

The efforts to introduce and distribute innovations in the market, possibly associated to a *learning by doing*, negatively affect the likelihood that a firm will implement innovations in external relations and production processes. The first result suggests that such efforts cause a firm to be less dependent on new types of external relations to test and launch its product on the market. In contrast, the second implies that distribution efforts reduce a firm's ability to implement new production processes. However, according to a study by the European Commission (2000, p. 13), knowledge and innovations can be generated by a process of "learning without formal research," such as learning by doing. Thus, the negative effect of learning by doing on process TI needs further clarification.

Finally, R&D efforts affect product innovations, but only in specific situations. Efforts to acquire external R&D negatively affect the likelihood that a firm will implement product innovation (even at the 10% significance level), while efforts to realize internal R&D do not affect product innovation. However, product innovations depend on the percentage of workers employed in R&D activities[6].

Other organizational characteristics can contribute to this result. KIBS firms that implement product innovations are more rigid in terms of organization and more dependent on the skills of individuals in R&D than on other organizational processes (emphasizing that no previous organizational innovation has affected product innovations). This rigidity also helps firms implement process TI. Our findings differ from those of Damanpour and Aravind (2012), who found that more organic, flexible organizational structures positively affect innovation. Therefore, these results reflect the importance of the skills of the labor force in implementing product innovations and the relevance of a greater guidance that results from a high level of organizational rigidity, thus reducing the uncertainty in this innovative process.

Regarding the effect of other organizational characteristics, firms with innovative activities concentrated on other firms within the group are less likely to implement external OI. This concentration reduces the firm's autonomy for cooperative arrangements because its technological strategy becomes dependent of decisions made by another firm. (CHEN, 1997).

In short, internal R&D spending is less relevant for the innovation of KIBS firms (LEIPONEN, 2012), as other innovative efforts and organizational characteristics yield a larger contribution.

6 It is noteworthy that the correlation between R&D efforts and the share of the R&D workforce was only 0.166.

Finally, firms belonging to the Telecommunications Sector ("1.ict") are more likely to implement product innovation than those in other sectors. Firms belonging to the Information Technology Services or Information Services Provision sectors ("2.ict") are more likely to implement internal OI, product TI, or process TI.

6. Conclusion

This article aimed to empirically analyze the relationship between technological and organizational innovations in Brazilian KIBS firms and discussed their different determinants, the role of persistence, and a possible two-way relationship between these two types of innovations. These services are important innovators, inducers, and diffusers of innovation within a NIS. However, the discussion regarding its peculiarities in the context of a developing NIS, such as that of Brazil, is still incipient. The results revealed that different innovations have different determinants and relationships in Brazilian KIBS.

First, product innovation depends less on organizational innovation and more on previous product innovations, on the skills of individuals in R&D (rather than spending), and on a more rigid organizational structure that drives the generation of new products more strictly. This first result confirms the previous hypothesis that the skills of individuals in R&D may be more important than spending for KIBS, given the importance of the individual abilities in these sectors. Process innovation is not explained by innovative efforts (except for the negative effect of efforts linked to the introduction and distribution of innovations in the market), but by organizational aspects, such as organizational rigidity and internal OI.

OI are affected by innovative efforts aimed at acquiring embedded knowledge (machines, equipment, and software): internal OI are positively affected and external OI are negatively affected. Although the acquisition of such knowledge generally favors TI in industry, it favors the generation of internal OI in KIBS. These internal OI are also favored by the internal OI in the previous period and previous product innovations. External OI are unique in that they are not explained by previous innovations, and are negatively affected by efforts to introduce and distribute innovations and the concentration of innovative activities in other firms within the group.

In summary, a "cross-influence" between OI and TI was identified in Brazilian KIBS: while product TI affect internal OI, internal OI only influence process TI.

To improve these results, it is necessary to expand the time and sectoral horizons used in this analysis and also incorporate the new methodological recommendations provided in the latest edition of the Oslo Manual (OECD; EUROSTAT, 2018).

Therefore, this study contributes to the literature by filling gaps related to the specificities of the KIBS innovative process and the two-way relationship between organizational and technological innovations in the context of a developing country, such as Brazil. Furthermore, more studies should be conducted to deepen the theoretical explanations for the cross-influence between TI and OI and the influence of the specific characteristics of Brazilian KIBS and NIS revealed by these results.

However, this study has limitations, which indicate opportunities for future research. Further studies can examine the relationships among the innovations and their lags through the Instrumental Variables, Two-Stage Models, or methods that are more robust to possible endogeneity between these variables. Moreover, multinomial probit models can be used to assess the possible contemporary correlation between different OI and TI. Furthermore, the PINTEC sample tends to be biased towards firms with a prior high innovative potential. This bias tends to be more evident in the present study, which considered only firms that are concomitantly present in two PINTECs Surveys (2011 and 2014).

References

BARTOLONI, E.; BAUSSOLA, M. Driving business performance: innovation complementarities and persistence patterns. *Industry and innovation*, v. 25, n. 5, p. 505-525, 2018.

BERNARDES, R. KALLUP, A. A emergência dos serviços intensivos em conhecimento no Brasil. *In*: BERNARDES, R.; ANDREASSI, T. (org.). *Inovação em Serviços Intensivos em Conhecimento*. São Paulo: Saraiva, 2006. p. 117-155.

BUSTINZA, O.F. Product–Service Innovation and Performance: The Role of Collaborative Partnerships and R&D Intensity. *R&D Management*, v. n. 1, p. 33-45, 2019.

CAMISÓN, C.; VILLAR-LÓPEZ, A. Organizational innovation as an enabler of technological innovation capabilities and firm performance. *Journal of Business Research*, v. 67, p. 2891-2902, 2014.

CARBONI, O.A.; RUSSO, P. Complementarity in product, process, and organizational innovation decisions: evidence from European firms. *R&D Management*, v. 48, n. 2, p. 210-222, 2018.

CASTELLACCI, F. Technological paradigms, regime and trajectories: manufacturing and service industries in a new taxonomy of sectoral patterns of innovation. *Research Policy*, v. 37, p. 978-994, 2008.

CHEN, S-H. Decision-making in research and development collaboration. *Research Policy*, Amsterdam, v. 26, n. 1, p. 121-135, 1997.

COHEN, W.M.; LEVINTHAL, D.A. Absorptive Capacity: A New Perspective on Learning and Innovation. *Administrative Science Quarterly*, v. 35, n. 1, p. 128-152, 1990.

CONSOLI, D.; ELCHE-HORTELANO, D. Variety in the knowledge base of Knowledge Intensive Business Services. *Research Policy*, v. 39, p. 1303-1310, 2010.

CORROCHER, N.; CUSMANO, L.; MORRISON, A. Modes of innovation in knowledge-intensive business services evidence from Lombardy. *Journal of Evolutionary Economics*, v. 19, p. 173-196, 2009.

COZZARIN, B.P. Impact of organizational innovation on product and process innovation. *Economics of Innovation and New Technology*, v. 26, n. 5, p. 405-417, 2017.

DAMANPOUR, F.; ARAVIND, D. Organizational Structure and Innovation Revisited: From Organic to Ambidextrous Structures. *In*: MUMFORD, M. (org.). *Handbook of Organizational Creativity*. New York: Elsevier, 2012. p. 483-513.

DJELLAL, F.; FRANCOZ, D.; GALLOUJ, C.; GALLOUJ F.; JACQUIN, Y. Revising the definition of research and development in the light of the specificities of services. *Science and Public Policy*, v. 30, n. 6, p. 415-429, 2003.

DOLOREUX, D.; SHEARMUR, R.; RODRIGUEZ, M. Internal R&D and external information in knowledge-intensive business service innovation: complements, substitutes or independent? *Technological and Economic Development of Economy*, v. 24, n. 6, p. 2255-2276, 2018.

DOSI, G. Sources, procedures and microeconomic effects of innovation. *Journal of Economic Literature*, v. 26, p. 1120-1171, 1988.

EUROPEAN COMMISSION. *Innovation Policy in a Knowledge-Based Economy*. Luxembourg: MERIT/EC Enterprise Directorate-General, 2000.

EVANGELISTA, R. Innovation in the European service industries. *Science and Public Policy*, v. 33, n. 9, p. 653-668, 2006.

EVANGELISTA, R.; VEZZANI, A. The economic impact of technological and organizational innovations: A firm-level analysis. *Research Policy*, v. 39, p. 1253-1263, 2010.

FINEP/OCDE. *Manual de Oslo*: Diretrizes para coleta e interpretação de dados sobre inovação. 3. ed. 2005. Disponível em: https://www.finep.gov.br/images/apoio-e-financiamento/manualoslo.pdf. Acesso em: 20 out. 2019.

GANTER, A.; HECKER, A. Deciphering antecedents of organizational innovation. *Journal of Business Research*, v. 66, n. 5, p. 575-584, 2013a.

GANTER, A.; HECKER, A. Persistence of innovation: Discriminating between types of innovation and sources of state dependence. *Research Policy*, v. 42, n. 8, p. 1431-1445, 2013b.

HERTOG, P.D.; BILDERBEEK, R. The new knowledge infrastructures: the role of technology-based knowledge-intensive business services in National Innovation Systems. *In*: BODEN, M.; MILES, I. *Services and the knowledge-based economy*. London: Continuum, 2000.

HERVAS-OLIVER, J.-L.; SEMPERE-RIPOLL, F.; BORONAT-MOLL, C.; ROJAS-ALVARADO, R. On the joint effect of technological and management innovations on performance: increasing or diminishing returns? *Technology Analysis* & *Strategic Management*, p. 1-13, 2017.

HIPP, C.; GRUPP, H. Innovation in the service sector: The demand for service-specific innovation measurement concepts and typologies. *Research Policy*, v. 34, n. 4, p. 517-535, 2005.

IBGE. *Pesquisa Anual de Serviços 2011*. Rio de Janeiro: IBGE, 2013a

IBGE. *Pesquisa de Inovação 2011*. Rio de Janeiro: IBGE, 2013b.

IBGE. *Pesquisa de Inovação 2014*. Rio de Janeiro: IBGE, 2016.

JENSEN, M.B.; JOHNSON, B.; LORENZ, E.; LUNDVALL, B.A. Forms of knowledge and modes of innovation. *Research Policy*, v.36, p. 680-693, 2007.

KON, A. *Economia de serviços*: teoria e evolução no Brasil. Rio de Janeiro: Elsevier, 2004.

LE BAS, C.; SCELLATO, G. Firm innovation persistence: a fresh look on the frameworks of analysis. *Economics of Innovation and New Technology*, v. 23, p. 423-446, 2014.

LE BAS, C.; MOTHE, C.; NGUYEN-THI, T.U. The differentiated impacts of organizational innovation practices on technological innovation persistence. European *Journal of Innovation Management*, v. 18, n. 1, p. 110-127, 2015.

LEE, H.; MIOZZO, M. Which types of knowledge-intensive business services firms collaborate with universities for innovation? *Research Policy*, v. 48, p. 1633-1647, 2019.

LEIPONEN, A. The benefits of R&D and breadth in innovation strategies: a comparison of Finnish service and manufacturing firms. *Industrial and Corporate Change*, v. 21, n. 5, p. 1255-1281, 2012.

MAKÓ, C.; CSIZMADIA, P.; ILLÉSSY, M.; IWASAKI, I.; SZANYI, M. *Organizational Innovation and Knowledge Use Practice*: Cross-Country Comparison. Discussion Paper. Institute of Economic Research Hitotsubashi University Tokyo, 2011. Disponível em: http://www.ier.hit-u.ac.jp/Common/publication/DP/DPb38.pdf. Acesso em: 10 maio 2019.

MAZZUCATO, M. *O estado empreendedor*: desmascarando o mito do setor público vs. setor privado. São Paulo: Portfolio-Penguin, 2014.

MILES, I. Innovation in Services. *In*: FAGERBERG, J.; MOWERY, D.; NELSON, R. *The Oxford Handbook of Innovation*. Oxford: Oxford University Press, 2005. p. 433-458.

MILES, I.; KASTRINO, S. N.; BILDERBEEK, R.; HERTOG, P.D.; FLANAGAN, K.; HUNTINK, W.; BOUMAN, M. *Knowledge intensive business services*: users, carriers and sources of innovation. Brussels, Belgium: European Commission, 1995. (EIMS Publication, n. 15).

MOTHE, C.; THI, T.U.N. Non-technological and technological innovations: do services differ from manufacturing? An empirical analysis of Luxembourg firms. International *Journal of Technology Management*, v. 57, n. 4, p. 227-244, 2012.

MULLER, E.; ZENKER, A. Business services as actors of knowledge transformation and diffusion: some empirical findings on the role of KIBS in regional and national innovation systems. *Research Policy*, v. 30, n. 9, p. 1501-1516, 2001.

NELSON, R.; SAMPAT, B. Making sense of institutions as a factor shaping economic performance. *Journal of Economic Behavior and Organization*, v. 44, p. 31-54, 2001.

OCDE. ORGANIZAÇÃO PARA A COOPERAÇÃO E O DESENVOLVIMENTO ECONÔMICO. *Promoting innovation in services*. Paris: OECD, 2005. Disponível em: http://www.oecd.org/sti/inno/35509923.pdf. Acesso em: 1 maio 2019.

OECD; EUROSTAT. *Oslo Manual 2018*: Guidelines for Collecting, Reporting and Using Data on Innovation. 4th ed. The Measurement of Scientific, Technological and Innovation Activities. Paris/Eurostat, Luxembourg, OECD Publishing, 2018.

PAVITT, K. Sectoral Patterns of Technical Change: Towards a Taxonomy and a Theory. *Research Policy*, v. 33, p. 343-373, 1984.

PINA, K.; TETHER, B. Towards understanding variety in knowledge intensive business services by distinguishing their knowledge bases. *Research Policy*, v. 45, p. 401-413, 2016.

SAPPRASERT, K.; CLAUSEN, T.H. Organizational innovation and its effects. *Industrial and Corporate Change*, v. 21, n. 5, p. 1283-1305, 2012.

SILVA NETO, F.C.C.; OLIVEIRA, V.C.P.; RAPINI, M.S.; CHIARINI, T. Inovação em serviços intensivos em conhecimento em Minas Gerais uma análise exploratória da PINTEC/IBGE, 2008 e 2011. *In*: SEMINÁRIO SOBRE A ECONOMIA MINEIRA, 16., 2014, Diamantina, MG. *Anais* [...]. Diamantina/MG: Cedeplar, 2014.

SUNDBO, J.; GALLOUJ, F. Innovation in services in seven European countries: the results of work packages 3-4 of the SI4S project. *Research Report*. Université Lille 1, CLERSE; Roskilde University, 1998. Disponível em: https://hal.archives-ouvertes.fr/hal-01111911. Acesso em: 10 maio 2019.

SUÁREZ, D. Persistence of innovation in unstable environments: Continuity and change in the firm's innovative behavior. *Research Policy*, v. 43, n. 4, p. 726-736, 2014.

TAVASSOLI, S.; KARLSSON, C. Persistence of various types of innovation analyzed and explained. *Research Policy*, v. 44, n. 10, p. 1887-1901, 2015.

TEECE, D.J.; PISANO, G.; SHUEN, A. Dynamic capabilities and strategic management. *Strategic Management Journal*, v. 18, n. 7, p. 509-533, 1997

TETHER, B. Do services innovate (differently)? Insights from the European Innobarometer survey. *Industry and innovation*, v. 12, n. 2, p. 153-184, 2005.

TETHER, B.; TAJAR, A. The organizational-cooperation mode of innovation and its prominence amongst European service firms. *Research Policy***,** v. 37, n. 4, p. 720-739, 2008.

TORRES FREIRE, C.E. Um estudo sobre os serviços intensivos em conhecimento no Brasil. *In*: DE NEGRI, J.A.; KUBOTA, L.C. (org.). *Estrutura e Dinâmica do Setor de Serviços no Brasil.* Brasília: IPEA, 2006. p. 107-132.

WITELL, L.; GEBAUER, H.; JAAKKOLA, E.; HAMMEDI, W.; PATRICIO, L.; PERKS, H. A bricolage perspective on service innovation. *Journal of Business Research*, v. 79, p. 290-298, 2017.

WOOLDRIDGE, J.M. *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA: MIT Press, 2002.

Authors' contribution:

A. Literature review and problematization: André Luiz da Silva Teixeira, Vanessa Criscuolo Parreiras de Oliveira, Daniel Paulino Teixeira Lopes, Márcia Siqueira Rapini

B. Data collection and statistical analysis: André Luiz da Silva Teixeira, Philipe Scherrer Mendes

C. Preparation of figures and tables: André Luiz da Silva Teixeira, Philipe Scherrer Mendes, Daniel Paulino Teixeira Lopes

D. Manuscript development: André Luiz da Silva Teixeira, Philipe Scherrer Mendes, Vanessa Criscuolo Parreiras de Oliveira, Daniel Paulino Teixeira Lopes, Márcia Siqueira Rapini

E. Bibliography selection: Vanessa Criscuolo Parreiras de Oliveira, Daniel Paulino Teixeira Lopes, Márcia Siqueira Rapini

Conflicts of interest: the authors declare that there is no conflict of interest.

Funding: This paper was written within the scope of the Project "Organizational and technological innovation in the information technology sector – description, characterization, and analysis in firms in Minas Gerais", funded by Fundação de Amparo à Pesquisa do Estado de Minas Gerais – FAPEMIG, Process APQ-03078-15. The translation of this manuscript from Portuguese to English was funded by Centro Federal de Educação Tecnológica de Minas Gerais (CEFET-MG), Brazil