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Characteristics of companies and innovations and their relations with barriers to innovation in the Brazilian services sector

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Abstract

Innovating is risky: there are many internal or external obstacles to the company and no guarantee of success. This research aimed to analyze the characteristics of companies and innovations and their relations with barriers to innovation in service companies. The study selected Brazilian companies that developed innovation activities between 2009 and 2014. The data on the barriers to innovation were retrieved from the Survey of Technological Innovation (Pintec), conducted by The Brazilian Institute of Geography and Statistics (IBGE). According to the theoretical framework on innovation research in emerging and developed countries, five hypotheses were drafted, and variables were selected to verify the barriers behavior through non-parametric tests. The results for hypothesis 1 indicate that companies controlled by national capital encountered more barriers than foreign companies between 2009 and 2011. Other characteristics did not present significant differences. Companies that simultaneously developed product and process innovations (hypothesis 2), those that have developed completely new innovations (hypothesis 3), and those that have introduced organizational and marketing innovations (hypothesis 4), demonstrated to face more barriers than other companies. The Technology-Based Knowledge-Intensive Business Services (T-KIBS) had greater barriers than other companies (hypothesis 5) between 2012 and 2014. The results suggest that companies need to modify their processes to generate entirely new products, preparing to face more difficulties to launch radical innovations. In addition, it was evident the importance of organizational and marketing innovations in fostering other types of innovation, especially in service companies.

Keywords: Service innovation. Innovation barriers. Emerging markets. T-KIBS. Survey of Technological Innovation.

Características de empresas e de inovações e suas relações com barreiras à inovação no setor de serviços brasileiro

Resumo

Inovar é arriscado: há muitos obstáculos internos ou externos à empresa e não há garantia de sucesso. O objetivo deste trabalho é analisar as características de empresas e de inovações desenvolvidas e suas relações com barreiras à inovação em empresas de serviços. Foram selecionadas empresas brasileiras que desenvolveram processos de inovação entre 2009 e 2014. As barreiras à inovação foram obtidas nos dados da Pesquisa de Inovação Tecnológica (Pintec) do IBGE. De acordo com o referencial teórico de pesquisas sobre inovação em países emergentes e desenvolvidos, foram elaboradas cinco hipóteses e selecionadas variáveis para verificar o comportamento das barreiras por meio de testes não paramétricos. Os resultados em relação à hipótese 1 indicam que, entre 2009 e 2011, as empresas com capital controlador nacional aferiram maiores barreiras do que as estrangeiras. As demais características das empresas não apresentaram diferenças significativas. As empresas que: lançaram conjuntamente inovações de produto e de processo (hipótese 2); desenvolveram inovações completamente novas (hipótese 3); e as que implantaram inovações organizacionais e de *marketing* (hipótese 4) indicaram maiores barreiras do que as demais empresas. Os Technology-Based Knowledge-Intensive Business Services (T-KIBS) conferiram maiores barreiras do que outras empresas (hipótese 5) entre 2012 e 2014. Os resultados sugerem que, para realizar inovações radicais, as empresas precisam modificar seus processos visando gerar produtos inteiramente novos, o que as faz enfrentar mais dificuldades. Também ressaltam a importância das inovações organizacionais e de *marketing* no fomento dos outros tipos de inovação, especialmente nas empresas de serviços.

Palavras-chave: Inovação em serviços. Barreiras à inovação. Economias emergentes. T-KIBS. Pintec.

Características de empresas y de innovaciones y sus relaciones con las barreras a la innovación en el sector de servicios brasileño

Resumen

Innovar es arriesgado: hay muchos obstáculos internos o externos a la empresa y no hay garantía de éxito. El objetivo es analizar las características de empresas y de innovaciones desarrolladas y sus relaciones con las barreras a la innovación en empresas de servicios. Se seleccionaron empresas brasileñas que desarrollaron procesos de innovación entre 2009 y 2014. Las barreras a la innovación se obtuvieron en los datos de la Encuesta de Innovación Tecnológica (Pintec) realizada por el IBGE. De acuerdo con el marco referencial teórico de investigaciones sobre innovación en países emergentes y desarrollados, se elaboraron cinco hipótesis y se seleccionaron variables para verificar, por medio de pruebas no paramétricas, el comportamiento de las barreras. Los resultados en relación a la hipótesis 1 indican que las empresas con capital controlador nacional tuvieron mayores barreras que las extranjeras entre 2009 y 2011. Las demás características de las empresas no presentaron diferencias significativas. Las empresas que lanzaron conjuntamente innovaciones de producto y de proceso (hipótesis 2), que desarrollaron innovaciones completamente nuevas (hipótesis 3), y las que implantaron innovaciones organizacionales y de *marketing* (hipótesis 4), señalaron mayores barreras que las demás empresas. Los *Technology-Based Knowledge-Intensive Business Services* (T-KIBS) enfrentaron mayores barreras que otras empresas (hipótesis 5) entre 2012 y 2014. Los resultados sugieren que, para realizar innovaciones radicales, las empresas necesitan modificar sus procesos para generar productos enteramente nuevos, y por eso enfrentan más dificultades. También resaltan la importancia de las innovaciones organizacionales y de *marketing* en el fomento de los otros tipos de innovación, especialmente en empresas de servicios.

Palabras clave: Gestión de la innovación. Innovación en servicios. Industria de software.

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INTRODUCTION

From the pioneer works by Schumpeter (1985) until the Manual of Oslo (OECD, 2018), innovation has been related to economic development. In emerging economies, such as Brazil, investment on innovation and its development mean better prospects for wealth, competitiveness, and growth in the long term.

However, innovating is a risky process: commercial success is not guaranteed, and there are many challenges along the way. Coad, Pellegrino and Savona (2015) note that the barriers to innovation are not just related to market failures, but may be connected to conditions that represent systemic failures that are difficult to overcome and can be seriously detrimental to business productivity. In addition to financial barriers, other factors to consider are the lack of accurate information on technology and markets, the lack of adequate skills, uncertainty about demand, and a highly concentrated market structure (COAD, PELLEGRINO and SAVONA, 2015).

This research analyzes the characteristics of companies and of innovations they developed, examining the relation between these characteristics and the barriers to innovation in companies operating in the service sector. The service sector was chosen because of its increasing participation in the economy (from a global average of 50% in the late 1960s to approximately 70% in 2010 (GALINARI and TEIXEIRA JÚNIOR, 2014). New transforming services in developing economies demonstrate how service innovation can drive economic development, despite limited infrastructure or resources in society (BARRETT, DAVIDSON, PRABHU et al., 2015).

The recent literature on barriers to innovation highlights research in developed countries (AMARA, D'ESTE, LANDRY et al., 2016; COAD, PELLEGRINO and SAVONA, 2015; DAS, VERBURG, VERBRAECK et al., 2018; D'ESTE, IAMMARINO, SAVONA et al., 2012) and barriers without distinction whether in the industrial or service sectors (COAD, PELLEGRINO and SAVONA, 2015; D'ESTE, IAMMARINO, SAVONA et al., 2012; SANDBERG and AARIKKA-STENROOS, 2014).

The study by Kühl and Cunha (2013) researched the barriers to innovation in Brazil distinguishing companies in the industrial and service sectors. However, there is a lack of studies emphasizing the service sector in emerging economies. It is unclear if the barriers to innovation are attributes of the companies, such as national or foreign source of capital, size, administrative autonomy, and operating in the international market; or if these barriers are related to the peculiarities of the innovations the companies develop, such as organizational and marketing innovation, or products or processes (both incremental or completely new) innovations.

This study examined companies in the service sector that developed innovation processes in the periods 2009-2011 and 2012-2014, with a particular focus on Technology-Based Knowledge-Intensive Business Services (T-KIBS) activities, which are prominent elements of the knowledge-based economy (MILES, 2005). The data was retrieved from the *Pesquisa de Inovação Tecnológica* (Pintec) (survey of technological innovation), which is the main research investigating and measuring the innovative processes in Brazilian companies and it is conducted by the Brazilian Institute of Geography and Statistics (IBGE).

This study seeks to contribute to the literature and fill the research gaps about the barriers to innovation in the Brazilian service sector, particularly regarding the T-KIBS. A better understanding of the barriers to innovation can help to improve the theories and the comprehension of the reasons why some companies do not engage more intensely in innovation. As emerging economies are fundamentally different from developed economies in institutional and economic structures, they represent an opportunity to expand and modify the theories of governance that have been built around the conditions observed in developed economies (BARRETT, DAVIDSON, PRABHU et al., 2015).

In addition to contributing to knowledge about the barriers to innovation in the service sector, this study can help companies, especially T-KIBS, to rethink their innovation strategies. The study of innovation in these activities is justified by the importance of the service sector in the economy and by the fact that T-KIBS within this sector are the fastest growing companies in most Western countries (DOROSHENKO, MILES and VINOGRADOV, 2014) and account for most of the innovations in services.

In addition to the introduction, this article is organized in four more sections. The following section presents the main theoretical concepts about innovation in services, barriers to innovation, and characterization of businesses. The third section introduces the methodology, followed by the analysis of the data in the fourth section. Finally, the fifth section presents the conclusion and final considerations.

THEORETICAL FRAMEWORK

Two main characteristics differentiate emerging economies from developed: limited resources (such as financial resources, skilled labor, and technology) and lack of infrastructure and sound institutions. The unpredictable nature of emerging markets (due to political, economic, and social instability) requires innovators to be able to improvise new solutions that adjust to changing circumstances, rather than following long-term, rigid plans (BARRETT, DAVIDSON, PRABHU et al., 2015).

Obstacles to product and process innovations in companies hamper innovation activities. According to the Oslo Manual (OECD, 2018), barriers to innovation prevent a non-innovative company from engaging in innovation activities or an innovative company from introducing specific types of innovation. Obstacles to innovation increase costs or create technical problems, but are often solvable.

Becheikh, Landry and Amara (2006), in a systematic review of empirical studies on innovation, note that the support of governments, professional bodies, and other institutions encourages companies to innovate. Such support may be in the form of grants, rewards, or loans. However, many factors may hamper innovation activities. The Oslo Manual (OECD, 2018) groups the external factors that drive or hinder innovation in three main categories: (i) the company's market environment (including customers, suppliers, and competitors); (ii) public policies (such as regulation, taxation, and public infrastructure); and (iii) the social environment (such as the consumer's ability to respond to innovation, the public opinion, and the level of trust among economic agents).

In order to analyze the importance Brazilian companies attribute to the barriers to implement innovations Kühl and Cunha (2013) conducted a study using data from Pintec 2005. The average importance that the various types of companies attribute – segmented by sector (industry or services), size, and if they produced innovation – is statistically different in most variables related to barriers to innovation. The most significant barriers evaluated in their study, for all groups, involve economic and financial issues, noting that the mean for the industry sector was higher than the mean for service. The authors speculate that this difference occurred because industries need more resources to innovate than companies in the service sector. In the case of size, the barriers pointed out by smaller companies were higher than those expressed by large companies in general terms; more specifically about economic obstacles (KÜHL and CUNHA, 2013).

D'Este, Iammarino, Savona et al. (2012) classify the barriers to innovation in two types: revealed and deterring. The revealed barriers are faced by companies engaging in innovation activities. In this case, the greater the effort to develop innovations, the greater their perception and recognition of the problems faced. As for the deterring barriers, they discourage or prevent companies from engaging in innovation activities.

Regarding the characteristics of the companies, the review conducted by Becheikh, Landry and Amara (2006), observed that the sources of capital and the size of the company are relevant variables. The authors found that some research support that a company is more innovative when it is controlled by foreign capital, whereas other studies demonstrate that this relation is negative or non-significant. In terms of size, more than half of the studies in the review indicated that a company's size is an explanatory variable for innovative behavior. The study by Ebersberger, Bloch, Herstad et al. (2012), who researched Austria, Belgium, Denmark and Norway, found that the size was only significant in two of those countries when observing commercial performance, and in only one country when observing the degree of novelty of innovation.

Research in emerging markets also examined the effects of the company's size. In Argentina, large companies are more likely to engage in innovation activities and to launch innovations in the market (CHUDNOVSKY, LÓPEZ and PUPATO, 2006). In Taiwan, the company's size is strongly related to its sales (LIN and CHEN, 2007). It is worth noting that the

Oslo Manual (OECD, 2018) recommends measuring the company's size based on the number of employees or full-time equivalents (FTE).

Ebersberger, Bloch, Herstad et al. (2012) used administrative autonomy (whether the company belongs to a corporate group) as a control variable. Hölzl and Janger (2013) observe that companies that are part of a corporate group do not find as many barriers to innovation as independent companies. The authors point out that industries perceive greater barriers to innovation than companies in the service sector.

Becheikh, Landry and Amara (2006) concluded that the variable orientation for the international or national market appeared in many studies and that export and internationalization have a positive effect on innovation. In Argentina, operating in the international market is positively associated with the company's tendency to engage in innovation activities and launch innovations in the market (CHUDNOVSKY, LÓPEZ and PUPATO, 2006). The study by Hölzl and Janger (2013), however, observed that exporting firms point to greater barriers to innovation than those that operate only in the domestic market. The Oslo Manual (OECD, 2018) recommends identifying the geographic coverage of the company's markets, classifying consumer markets as domestic and foreign. Observing the elements described above, the first hypothesis of this research is:

H1 – The characteristics of the company (source of capital, size, administrative autonomy, and operating in the international market) influence the barriers to innovation.

For Becheikh, Landry and Amara (2006), innovation research should clearly distinguish product and process innovations. The authors argue that several studies show that these two types of innovation follow different paths and do not necessarily have the same determinants. The Oslo Manual (OECD, 2018) defines product innovations as new or improved goods or services that differ significantly from the company's previous products or services, and that were introduced in the market. Process innovations refer to new or improved business processes applied to one or more business areas. These innovations must differ significantly from the company's previous business processes, and they have to be implemented in the company.

Thus, the second hypothesis is:

H2 – Companies that simultaneously develop product and process innovations affirm to face greater barriers to innovation.

Regarding the degree of novelty of innovation, the Oslo Manual (OECD, 2018) states that disruptive or radical innovations, as well as some types of economic impacts, are difficult to identify within the recommended observation period in research on innovation. Christensen (1997) distinguishes radical and disruptive innovations. Radical innovations use entirely new technology, and companies must develop technological capabilities, different from existing ones. Disruptive innovations, however, refer to simpler, more convenient or cheaper products that attract less demanding or unattended consumers and thus create a whole new market segment (CHRISTENSEN, RAYNOR and McDONALD, 2015). Moors and Vergragt (2002) assume that radical innovations imply the adoption of an entirely new production process for a company. In other studies, there is a combination of the two concepts: radical innovation is a novelty for both the company and the market.

As this work aims to map the barriers faced by companies in the service sector, developing innovation activities, an internal view was adopted regarding the degree of novelty. Instead of considering the novelty of innovation in the national or global market, the study observed the impact that the development of innovation caused within the company. Different groups were analyzed: the organizations that launched a product or implemented a completely new process, from the company (internal) point of view; and the organizations who released improvements to existing products or processes.

Das, Verburg, Verbraeck et al. (2018) studied companies in the financial services sector, emphasizing the internal barriers to innovation, i.e., the barriers that these companies are more likely to influence. The authors identified six main obstacles preventing disruptive and radical innovations: low exploration of new ideas; inertia caused by the architecture of local systems; lack of support from the organizational structure; excessive focus on risk prevention; lack of research and development; and the "not-invented-here" syndrome.

D'Este, Amara and Olmos (2016) carried out a research based on Spanish industries, finding that the greater the novelty of the innovation, the greater the probability of failure. The study by Sandberg and Aarikka-Stenroos (2014), comparing barriers

in different types of radical innovations, showed that innovations that are a novelty for the company, for the market or both; and the disruptive innovations, seem to face similar barriers. The barriers observed for radical innovations, however, are different from the ones for incremental innovations.

The third hypothesis, therefore, is:

H3 – The development of innovations that, in technical terms, are a novelty for the company, has a positive relation with the barriers to innovation.

Several studies considered organizational and marketing innovations as relevant factors influencing the performance of products and processes innovations. In a study conducted in Turkey, Gunday, Ulusoy, Kilic et al. (2011) concluded that organizational and marketing innovations not only prepare a suitable environment for other types of innovation but also have a substantial impact on their performance. In Taiwan, organizational innovations were also the most critical factor in explaining commercial performance among small and medium enterprises (LIN and CHEN, 2007). Castellacci (2008) points out that for companies in the service sector, organizational changes and training activities are central aspects of the innovative process, while formal R&D activities are relatively less important when these companies are compared to the manufacturing industries.

Thus, the fourth hypothesis is:

H4 – Companies that develop organizational and marketing innovations demonstrate greater barriers to innovation.

Another element analyzed is knowledge-intensive business services. As the standard of living evolves in developed and developing economies, citizens' expectations and demand for services such as health, education, and entertainment rise, boosting growth in the sector of personal services. Concurrently, the intricacy of intra-organizational structures and inter-organizational value networks creates new demands for internal or outsourced professional coordination services (BARRETT, DAVIDSON, PRABHU et al., 2015).

According to Miles, Kastrinos, Bilderbeek et al. (1995), Knowledge-Intensive Business Services (KIBS) involve economic activities that seek knowledge creation, accumulation, or dissemination. KIBS have emerged to help other companies deal with issues that require external sources of knowledge. The growth of KIBS reflects the organizations' demand for knowledge to cope with changing technologies and social conditions (MILES, 2005). Studies on innovation systems, and especially on service innovation, show that KIBS are playing a central role for innovation as knowledge carriers, mediators, and producers in the economy (STRAMBACH, 2008).

The research by Amara, D'Este, Landry et al. (2016) shows that KIBS are dedicated to different forms of innovation and challenges vary according to the type of innovation. KIBS point out financial barriers as particularly important regarding the development of product or process innovations and knowledge barriers when it comes to organizational and marketing innovations.

Considering the KIBS activities, there are two groups of companies: those providing traditional professional services and those that provide technology-based professional services (T-KIBS). Miles, Kastrinos, Bilderbeek et al. (1995) exemplify these groups, listing as traditional professional services activities such as marketing and advertising; training; building services; management consultancy; accounting and bookkeeping; and legal services. As for technology-based professional services, the authors list services such as computer networks; software development; computer-related services (facilities management, for instance); and R&D consultancy.

Therefore, the fifth hypothesis is:

H5 – T-KIBS present more barriers to innovation.

The T-KIBS variable was included among the categorical variables of this study to identify whether there are significant differences regarding barriers to innovation between the T-KIBS-related CNAE 2.0 (Brazilian national code of economic activity) divisions and the other service sector divisions researched at Pintec. Based on Miles, Kastrinos, Bilderbeek et al. (1995) categorization, the following divisions were considered when forming the T-KIBS: 62 (activities of information technology services) and their subdivisions; 63.1 (data processing, internet hosting, and other related activities); and 72 (research and development).

Appendix 1 presents a table summarizing the various studies cited in this article, including the references, the markets studied, the variables analyzed, and the main conclusions.

METHODOLOGY

The probability sampling technique adopted in the *Pesquisa de Inovação Tecnológica* (Pintec) (survey of technological innovation) – study conducted by the Brazilian Institute of Geography and Statistics (IBGE) – stratifies the population according to the size of the company (established by the number of employees) and the main economic activity as described in the CNAE 2.0. In the service sector samples, Pintec sought to ensure reliable estimates from the states that participate with at least 5% of the value-added of these activities (IBGE, 2013, 2016).

This study used statistical software STATA to treat Pintec’s microdata for the periods 2009-2011 and 2012-2014. The database was standardized regarding missing values, and the observations containing extreme values were eliminated. The study selected only companies that, at the moment of the data collection, were operating or implementing the services researched by Pintec, according to Box 1.

Box 1
Services researched by Pintec in 2011 and 2014

| CNAE 2.0 | Services |
|-------------|---|
| 58+59.2 | Edition and music recording and edition. |
| 61 | Telecommunication |
| 62 | Activities of the information technology services. |
| 62.01 | Software development on demand. |
| 62.02 | Customized software development. |
| 62.03 | Non-customized software development. |
| 62.04+62.09 | Other information technology services. |
| 63.1 | Data treatment, Internet hosting, and other related activities. |
| 71 | Architecture and engineering services, tests, and technical analyses. |
| 72 | Research and development. |

Source: IBGE (2013, 2016).

Next, the research selected companies that developed innovation activities during the period analyzed in the study, which allowed the analyses of problems and barriers to innovation to be conducted with companies that invested in the development of innovative products or processes, regardless of whether companies managed to launch the innovation.

The 2011 database presents information on 639 companies, out of a population of 4,612 organizations that have developed innovation activities in the period 2009-2011. The 2014 database shows information on 958 companies, out of a population of 4,730 organizations that engaged in innovation activities in the period 2012-2014. To test the hypothesis presented, this study considers the barriers to innovation as a dependent variable. The independent variables are the source of capital, size, administrative autonomy, operating in the international market, type of innovation, the novelty of the innovation, organizational and marketing innovations, and T-KIBS.

The measurement of the dependent variable “barriers to innovation” (BI) was carried out based on the answers respondents provided to the questions in the section “problems and barriers to innovation” in the questionnaire applied in the Pintec research (Box 2). Points were assigned according to the answers given, as follows: high = 3; average = 2; low = 1; and not relevant/not observed = 0. The points were summed per company, so that the higher the sum, the greater the barriers.

Box 2

Items of the questionnaire about problems and barriers to innovation

| Mark the importance of the factors that hindered the company's innovation activities: |
|--|
| 176 – Excessive economic risks. |
| 177 – Innovation's high costs. |
| 178 – Scarce adequate funding sources. |
| 179 – Organizational rigidity. |
| 180 – Lack of qualified personnel. |
| 181 – Lack of information on technology. |
| 182 – Lack of information on markets. |
| 183 – Scarce opportunities for cooperation with other companies/institutions. |
| 184 – Difficulty to adjust to standards, norms, and regulations. |
| 185 – Consumers do not strongly respond to new products. |
| 186 – Scarcity of adequate external technical services. |
| 187 – Centralization of innovative activity in other companies of the corporation group. |

Source: IBGE (2013, 2016).

To identify the main characteristics of the companies and innovations, the study used the responses to the Pintec questionnaire, listed in the items below and appendix 2 and 3. The categorical independent variables related to the characteristics of the companies were defined as follows.

1 – Source of the capital that controls the company: Becheikh, Landry and Amara (2006) and Chudnovsky, López and Pupato (2006) used this variable in their analyses. The answer to question 1 of the questionnaire used in Pintec ("source of the capital that controls the company") is restricted to 'national' or 'foreign' (when the company answered that the capital was national and foreign, it was considered as 'foreign').

2 – Size: this aspect was defined by the number of employees, using question 8 of the Pintec questionnaire: "how many people were employed in your company on 12/31/2011?" (or "on 12/31/2014?"). The answers were classified in three groups, as recommended in the Oslo Manual (OECD, 2018) to determine companies' size: from 10 to 49 employees; 50 to 249; and more than 250 employees.

3 – Administrative autonomy: the studies by Becheikh, Landry and Amara (2006), Chudnovsky, López and Pupato (2006), D'Este, Iammarino, Savona et al. (2012), and Ebersberger, Bloch, Herstad et al. (2012) evaluated this feature. The possible answer to item 3 in Pintec "your company is" are two: "independent" or "part of a corporation group."

4 – Market orientation: The Oslo Manual (OECD, 2018) recommends the use of this variable and studies such as Becheikh, Landry and Amara, (2006), Chudnovsky, López and Pupato (2006), D'Este, Iammarino, Savona et al. (2012), Ebersberger, Bloch, Herstad et al. (2012), Lin and Chen (2007), used the variable to assess the influence of internationalization. There are two possibilities (national or international) in Pintec's questionnaire (question 5, "what was the main company's market between 2009 and 2011?" or "between 2012 and 2014?"). If the answer was "state," "regional," or "national," the research considered the market as 'national.' If the answer was "Mercosur," "United States," "Europe," "Asia," or "other countries," it was considered 'international.'

5 – Type of innovation: In their analysis, Amara, D'Este, Landry et al. (2016), Becheikh, Landry and Amara (2006), Castellacci (2008), Chudnovsky, López and Pupato (2006); Gunday, Ulusoy, Kilic et al. (2011), Lin and Chen (2007) and Sandberg and Aarikka-Stenroos (2014), established the differences between products and processes innovations. The types of innovation were identified using the responses to the items "product innovation," "process innovation," and "incomplete or abandoned projects" of the Pintec questionnaire (questions 10, 11, 15, 22, and 23), listed in Appendix 3. Among the companies that have developed innovation activities, there are four possibilities:

- 1: companies that innovated in product and process;
- 2: companies that innovated only in product;

- 3: companies that innovated only in process; and

- 4: companies that abandoned (or presented unfinished) innovation projects.

6 – Novelty of innovation: two possibilities were considered (new or improved), using the answers to Pintec's questions 13.1 ("In technical terms, this product is") and 19.1 ("In technical terms, this process is"). If the company answered "completely new to the company" on at least one of the two issues, it was considered that it implemented an unprecedented innovation (product or process). If the company answered "improving an existing (product or process)" in both questions, it was considered as having implemented only incremental innovations. The impacts of the novelty of innovation were analyzed by Lin and Chen (2007) and Sandberg and Aarikka-Stenroos (2014).

7 – Organizational and marketing innovations: explored by Amara, D'Este, Landry et al. (2016), Castellacci (2008), Gunday, Ulusoy, Kilic et al. (2011), Lin and Chen (2007) and Sandberg and Aarikka-Stenroos (2014). There are two possibilities ('implemented' or 'not implemented') according to answers to questions 188 to 192 of the part 'organizational and marketing innovations' of the Pintec questionnaire (Appendix 2). If the company answered yes to any of the 6 questions, it was considered as 'implemented.' When answering no to all 6 questions, it was considered as 'not implemented.'

8 – Technology-Based Knowledge-Intensive Business Services (T-KIBS): According to the companies' classification in the CNAE 2.0 observed in the database, there are two possibilities (TKIBS or other services). The T-KIBS encompasses divisions 62, 63.1, and 72, following the categorization proposed by Miles, Kastrinos, Bilderbeek et al. (1995). 'Other services' include the other divisions in CNAE 2.0.

The data was analyzed in five steps:

1) Analysis of the internal consistency of the questions that form the construct 'barriers to innovation' (BI), using the Cronbach's alpha. Internal consistency is the degree to which items of a research questionnaire are measuring the same underlying attribute. The most commonly used statistic for that is the Cronbach's alpha coefficient, where higher values indicate greater reliability (PALLANT, 2005). The study calculated the Cronbach's alpha for the set of questions forming the construct BI, which presented 0.8080 (2011) and 0.7946 (2014). Based on Nunnally and Bernstein (1994) who recommend a minimum level of 0.7, it is possible to say that the result obtained is consistent.

2) Calculation of the variable BI by company, to analyze its behavior in the databases (Shapiro-Wilk and Shapiro-Francia normality tests).

3) Classification of enterprises by type of innovation. The bases were identified through four distinct groups: product and process innovation; product innovation only; process innovation only; and abandoned or incomplete innovation projects.

4) Composition of the other categorical independent variables used in the analyzes: the source of the controlling capital; size; administrative autonomy; market orientation; the novelty of product innovation; the novelty of process innovation; the novelty of innovation; organizational and marketing innovations; and T-KIBS.

5) Analysis of the results of the Wilcoxon-Mann-Whitney and Kruskal-Wallis tests to determine whether there are differences in the distribution of BI by groups formed by several categorical variables in the innovative bases of 2011 and 2014. Non-parametric methods are almost as good and powerful as parametric methods. In cases where the data are nominal or ordinal or in cases where the assumptions required by the parametric methods are not met, only nonparametric methods are adequate (ANDERSON, SWEENEY and WILLIAMS, 2005).

These analyses seek to investigate how the barriers are related to the characteristics of the companies and the innovations developed, and whether there are significant differences in the groups studied.

RESULTS AND ANALYSIS

This section presents the analyses of the microdata collected from the Pintec. Table 1 presents the values of the variable BI observed.

Table 1
Barriers to innovation – Pintec 2011 and 2014

| Variables | Average | Standard deviation | Minimum value | Maximum value |
|-----------|---------|--------------------|---------------|---------------|
| BI – 2011 | 7.920 | 9.075 | 0 | 30 |
| BI – 2014 | 10.630 | 9.830 | 0 | 34 |

Source: Elaborated by the authors.

The companies were classified based on the categorical variables according to the answers retrieved from the Pintec questionnaire, as described in the methodological procedure. The characteristics of the companies in the service sector of the bases of 2011 and 2014 are detailed in Table 2.

Table 2
Services database according to the categorical independent variables

| Variables | | Pintec 2011 | | Pintec 2014 | |
|--|----------------------|-------------|-----|-------------|-----|
| | | Total | % | Total | % |
| Source of the controlling capital | National | 565 | 88% | 852 | 89% |
| | Foreign | 74 | 12% | 106 | 11% |
| Size | Small | 168 | 26% | 303 | 32% |
| | Medium | 293 | 46% | 454 | 47% |
| | Large | 178 | 28% | 201 | 21% |
| Administrative autonomy | Independent | 480 | 75% | 759 | 79% |
| | Part of a group | 159 | 25% | 199 | 21% |
| Market orientation | National | 620 | 97% | 943 | 98% |
| | International | 19 | 3% | 15 | 2% |
| Types of innovation | Product and process | 337 | 53% | 502 | 52% |
| | Only product | 114 | 18% | 152 | 16% |
| | Only process | 144 | 23% | 253 | 26% |
| | Abandoned/incomplete | 44 | 7% | 51 | 5% |
| Novelty of product innovation | Improved | 389 | 61% | 644 | 67% |
| | New | 250 | 39% | 314 | 33% |
| Novelty of process innovation | Improved | 451 | 71% | 676 | 71% |
| | New | 188 | 29% | 282 | 29% |
| Novelty of innovation | Improved | 294 | 46% | 492 | 51% |
| | New | 345 | 54% | 466 | 49% |
| Organizational and marketing innovations | Not implemented | 72 | 11% | 108 | 11% |
| | Implemented | 567 | 89% | 850 | 89% |
| T-KIBS | Other services | 267 | 42% | 397 | 41% |
| | T-KIBS | 372 | 58% | 561 | 59% |

Source: Elaborated by the authors.

The results of the Shapiro-Wilk and Shapiro-Francia tests suggested that the variable BI does not present normal behavior (P-value 0.00) both for the data from the Pintec 2011, and the Pintec 2014. This result was expected since some of the companies researched did not point out barriers to innovation (BI = 0). Considering the non-normal behavior of the variable and the fact that its scale is ordinal, Wilcoxon-Mann-Whitney tests were used for categorical independent variables containing two groups and Kruskal-Wallis for categorical independent variables containing three or more groups. Table 3 presents the results of the Wilcoxon-Mann-Whitney test to determine whether there are differences in the distribution of the barriers to innovation per group.

Table 3
Wilcoxon-Mann-Whitney tests results

| Categorical independent variables | Pintec 2011 z-value | Pintec 2014 z-value |
|---|------------------------|------------------------|
| Source of the controlling capital | 3.107*** | - |
| Administrative autonomy | - | - |
| Market orientation | - | - |
| Novelty of product innovation | -2.821*** | -1.840* |
| Novelty of process innovation | -3.610*** | -2.350** |
| Novelty of innovation | -3.634*** | -1.365* |
| Organizational and marketing innovation | -2.434** | -3.924*** |
| T-KIBS | - | -2.005** |

Source: Elaborated by the authors.

Note: (-) = non-significant

(*) = p<0.1

(**) = p<0.05

(***) = p<0.01

When observing the results, it is possible to reject the hypothesis of equality regarding the distribution of the barriers of innovation between companies whose controlling capital is national, and those controlled by foreign companies based on the data from the Pintec 2011. In the Pintec 2014, the variable BI did not present significant differences. Regarding the variables “administrative autonomy” and “market orientation,” the hypothesis of equal distribution for BI was accepted for the database of both studies Pintec, 2011 and 2014.

Companies that implement process innovations, product innovations and innovations with a high degree of novelty reported higher BI than companies implementing improved innovations in both Pintec studies. Table 4 shows the Kruskal-Wallis test results, applied to evaluate the hypothesis that the barriers to innovation have equal distribution function in the groups.

Companies that implemented organizational and marketing innovations indicate higher BI than companies that did not, both in 2011 and 2014. As for the T-KIBS variable, in 2011, there was no significant difference. However, on the database of 2014, the results suggest the rejection of the hypothesis of equal distribution of BI between the groups ‘T-KIBS’ and ‘other services.’

Table 4
Kruskal-Wallis tests results

| Categorical independent variables | Pintec 2011 χ^2 | Pintec 2014 χ^2 |
|-----------------------------------|----------------------|----------------------|
| Size | - | - |
| Types of innovation | 25.135 *** | 23.160*** |

Source: Elaborated by the authors.

Note: (-) = non-significant

(***) = p<0.01

The Kruskal-Wallis tests showed that there is no statistically significant difference in the distribution function of the variable BI among the three groups per size (by the number of employees) simultaneously, in both Pintec studies, 2011 and 2014.

Regarding the variable “types of innovation” the tests showed that, in both the 2011 and the 2014 databases, there is a statistically significant difference in the distribution function of the BI variable among the four groups of innovation types simultaneously. In the comparison between each group, in 2011 only groups 1 (product and process) and 3 (process only) presented significant difference amongst them. In 2014, the groups that were significantly different were:

- groups 1 (product and process) and 2 (product only), indicating that companies that implemented product and process innovations in the period 2012-2014 scored significantly higher BI than companies that only developed product innovations in the same period; and
- groups 1 (product and process) and 3 (process only), indicating that the companies that implemented product and process innovations in the period 2012-2014 scored BI significantly higher than companies that only developed process innovations in the same period.

CONCLUSIONS

The analysis indicates perceptions of the companies participating in the Pintec survey and offers some answers to the hypotheses presented in this article.

For the first hypothesis (**H1**), stating that characteristics of the company (source of capital, size, administrative autonomy, and operating in the international market) influence the barriers to innovation, in the period 2009-2011, the companies controlled by national capital presented higher numbers regarding BI than the ones observed in the case of companies controlled by foreign capital. In the period 2012-2014, however, there were no significant differences. Other studies present heterogeneous results regarding the effect of the source of capital that controls the company on innovation (BECHEIKH, LANDRY and AMARA, 2006).

When examining the companies' size, there was no significant difference in BI among the groups separated by size, in both periods. This result diverged from the findings of Kühl and Cunha (2013). In other studies relating the companies' size to innovation activities, the results were heterogeneous (BECHEIKH, LANDRY and AMARA, 2006; EBERSBERGER, BLOCH, HERSTAD et al., 2012).

For the variable 'administrative autonomy', the results showed that being part of a corporate group makes no difference for companies in the sector of service when it comes to BI, in the two periods analyzed. This result is consistent with the study by Ebersberger, Bloch, Herstad et al. (2012) in which administrative autonomy was not significant about innovation in three of the four European countries studied. It diverges, however, from the results observed by Hölzl and Janger (2013).

In both Pintec analyzed, companies that are oriented to the international market presented similar numbers regarding BI as the companies serving the national market, which is a different result from that found by Hölzl and Janger (2013). Although export and internationalization have a positive effect on innovation (BECHEIKH, LANDRY and AMARA, 2006; CHUDNOVSKY, LÓPEZ and PUPATO, 2006), the results suggest that this is not the case when it comes to problems and barriers related to innovation in companies in the service sector in Brazil.

The second hypothesis (**H2**) that states that companies that simultaneously develop product and process innovations affirm to face greater barriers to innovation was confirmed. The results showed a higher score of the variable BI in companies engaged in product and process innovation than in those that implemented only product innovation (for the period 2012-2014) or only process innovation (for the periods 2009-2011 and 2012-2014). Assuming that companies often have to modify processes to generate entirely new products for the market when engaged in radical innovation, it is understandable that the companies that carried out both types of innovation, at the same time, face more barriers than those that implemented only one type.

The results showed that companies that have implemented new innovations, regardless of product or process, have presented higher BI than companies that implemented incremental innovations, based on improvements. This result was observed in both Pintec periods and confirmed the third hypothesis (**H3**). These findings are in line with the study by Sandberg and

Aarikka-Stenroos (2014), which show that barriers to radical innovations are more pronounced than barriers to incremental innovations; and to D'Este, Amara and Olmos (2016), that relate the degree of novelty of innovation with the greatest possibility of failure.

The results confirmed the fourth hypothesis (**H4**), stating that companies that develop organizational and marketing innovations demonstrate greater barriers to innovation. Companies developing these innovations presented higher BI than the others in both periods. This is a consistent result, even more, when considering the importance of organizational and marketing innovations in the innovations' performance (GUNDAY, ULUSOY, KILIC et al., 2011; LIN and CHEN, 2007) and in promoting other types of innovation, especially for companies in the service sector (CASTELLACCI, 2008).

As for the fifth hypothesis (**H5**), the T-KIBS companies registered higher BI than companies from other areas of the service sector only in the period 2012-2014, partially confirming the hypothesis.

Therefore, it is possible to conclude that, in the service sector, the characteristics of companies do not have a decisive influence on the barriers to innovations. The challenges to innovative activities are related to the characteristics of innovations developed regarding the novelty and type. The challenges are observed, particularly when companies simultaneously develop novel products and processes innovations and implement organizational and marketing innovations.

The article contributes to the literature on innovation in the service sector, examining the relationship between barriers and various characteristics of companies and their innovations. According to Coad, Pellegrino and Savona (2015), there is a lack of empirical support for the role of the barriers to innovation within the literature on the issue. The findings of this work can contribute to forming a theoretical framework on barriers to innovations in companies in the service sector operating in emerging economies.

This study intends to provide subsidies for technology management policies applied to the service sector, encouraging investments according to the type of organization or innovation. As a recommendation for future research, it is suggested a more in-depth analysis of the conclusions regarding the barriers to innovation, observing the particularities of radical or incremental innovations, and barriers regarding the companies' size (among other variables), taking into account the economic context in the two periods of the Pintec.

Among the research's limitations, the use of the Pintec databases restricted the study to the questionnaire and data repertoire of that survey, which was not developed and specially collected for this study. In addition, the use of the data from the Pintec does not allow the verification in the primary source, i.e., the companies interviewed by the IBGE. Notwithstanding, it was possible to access a comprehensive sample of companies and their respective information on innovation, and the use of this data allows comparisons with other countries that develop research with the same methodology.

FINAL NOTE: This study used data from the *Pesquisa de Inovação Tecnológica* (Pintec) (survey of technological innovation), for the years 2011 and 2014, conducted by the Brazilian Institute of Geography and Statistics (IBGE). The database researched is restricted to use of the IBGE personnel, and the authors obtained authorization to conduct the analysis presented in this article. The results, analyses, and interpretations presented in this work are the responsibility of the authors and do not intend to be official statistics or represent the official view of the IBGE.

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APPENDIX 1

Box A Synthesis of the studies in the theoretical framework

| References | Studied markets | Variables analyzed | Main conclusions |
|---------------------------------------|--|---|---|
| Amara, D'Este, Landry, et al. (2016) | Canada: small, medium, and large enterprises offering. Technology-Based Knowledge-Intensive Business Services. | Size; company's age; type of innovation (product, process, strategic, organizational, and marketing); technology-based or traditional (T-KIBS or KIBS). | The barriers that KIBS found vary according to the type of innovation. Financial obstacles are more relevant to the development of products or processes innovation. The knowledge obstacles are more relevant in organizational and marketing innovations. |
| Becheikh, Landry and Amara (2006) | Europe, the Americas, and Asia: companies in the industrial sector. | Size; company's age; type of innovation (product or process); administrative autonomy, source of capital; market orientation (national or international); market strategy. | Research on innovation must separate the product and process innovations. Some studies argue that foreign sources of capital have a positive relation with innovation; some studies point out that this relation is negative or not significant. More than half of the studies showed a relation between the size and the innovative behavior. Orientation toward the international market has a positive effect on innovation. |
| Castellacci (2008) | Europe: small, medium and large enterprises in the sectors of industry and services, comprising 24 European countries. | Size; sector of the economy; type of innovation (product, process, organizational, and marketing); the intensity of investments in innovation; collaborative arrangement. | For companies in the service sector, organizational changes and training activities are crucial in the innovative process. As for the industries, the crucial activities in the innovative process occur in the formal area of R&D. |
| Chudnovsky, López and Pupato (2006) | Argentina: small, medium and large enterprises in the industrial sector. | Size; sector of the economy, administrative autonomy, market orientation (national or international); source of capital; the intensity of investments in innovation; type of innovation (product or process). | Large companies are more inclined to engage in innovative practices and launch innovation in the market. The operations in international markets are associated with the development of innovative practices and launching innovations. |
| Coad, Pellegrino and Savona (2015) | United Kingdom: small, medium, and large enterprises, except companies in primary sectors and construction. | Size; age; market orientation (national or international); employees with superior education; organizational innovation. | The main obstacle is financial, but other significant challenges are the lack of accurate information about technology and markets, the scarcity of appropriate skills, uncertainty about demands and a highly concentrated market structure |
| Das, Verburg, Verbraeck et al. (2018) | Europe: innovative projects in large companies in the financial sector. | Type of innovation (disruptive or radical); bottom-up or top-down origin; market (retail, commercial, or small and medium enterprises). | The main challenges are the low exploration of new ideas; inertia caused by the systems' local architecture; lack of support from the organizational structure; emphasis on risk prevention; absence of R&D; and the "not-invented-here" syndrome |

Continue

| References | Studied markets | Variables analyzed | Main conclusions |
|---|---|---|--|
| D'Este, Amara, and Olmos (2016) | Spain: small, medium and large enterprises in the industrial sector. | Size; administrative autonomy; industry sector; business strategy, source or R&D (internal or external); type of innovation (radical, product, or process); collaborative arrangements; growth rate. | The higher the degree of novelty of the innovation, the higher the chances of failure. |
| D'Este, Iammarino, Savona et al. (2012) | Europe: small, medium, and large enterprises in the sectors of industry and services. | Size; administrative autonomy; start-ups; and orientation toward the international market. | The barriers to innovation can be evident or obstructive. Companies that adopt innovation practices face evident barriers, and those that do not adopt such practices face obstructive barriers. |
| Ebersberger, Bloch, Herstad et al. (2012) | Austria, Belgium, Denmark, and Norway: small, medium, and large enterprises in the sectors of industry and intensive knowledge that developed activities related to innovation. | Size; country; administrative autonomy; market orientation (national or international); the intensity of investments in R&D. | The size was significant for commercial performance in two of the studied countries and the degree of novelty of innovation in one of the countries. |
| Gunday, Ulusoy, Kilic et al. (2011) | Turkey: small, medium, and large companies in the industrial sector. | Size; age; type of innovation (product, process, organizational, and marketing). | Organizational, products and marketing innovations have a substantial impact on the innovation's performance. Organizational innovations are the ones that impact the most. |
| Hölzl and Janger (2013) | Europe: small, medium, and large enterprises in the sectors of industry and services. | Size; country; administrative autonomy; sector of the economy (industry or services); companies that developed innovations and companies that did not develop innovations; the source of R&D (internal or external); market orientation (national or international); growth rate. | Industries recognize more barriers regarding innovation than services. Exporting companies indicate more barriers to innovation than those that do not export. Companies that are part of a holding do not perceive as many barriers as independent companies. |
| Kühl and Cunha (2013) | Brazil: small, medium, and large enterprises in the sectors of industry and services. | Size; sector of the economy (industry or services); companies that developed innovations and companies that did not develop innovations | The greater barriers involve economic and financial issues. There were differences regarding the relevance of the barriers, according to the size of the company. |
| Lin and Chen (2007) | Taiwan: small and medium enterprises in the sectors of industry and services. | Size; age; sector of the economy (industry or services); the source of R&D (internal or external); market orientation (national or international); type of innovation (radical or incremental, product/process, strategic, organizational, and marketing). | The size of the company has a strong relation with its results in sales. The organizational innovations were the most significant explanatory factor for the company's commercial performance. |
| Sandberg and Aarikka-Stenroos (2014) | Small, medium, and large enterprises in the sectors of industry and services. | Size; market sector; innovation activities; type of innovation (radical, disruptive, incremental, product, process, organizational, and marketing). | Radical innovations for companies, and disruptive innovations for the market face similar barriers. Barriers for radical innovations are greater than the ones for incremental innovations. |

Source: Elaborated by the authors.

APPENDIX 2

Box B

Questions on organizational and marketing innovations – Pintec

| For the period between 2009 and 2011 (or 2012 and 2014), did the company implement any of the activities listed below? | |
|---|--------|
| 188 – New managerial techniques to improve work routines and practices and the use and exchange of information, knowledge, and skills within the company. | Yes/No |
| 189 – New techniques of environmental management to treat effluents, reduce waste, reduce CO ₂ emission, and others. | Yes/No |
| 190 – New methods of organization of work to better distribute responsibilities and decision-making power. | Yes/No |
| 190.1 – Significant changes about other companies, public institutions, and nonprofit organizations, such as the establishment, for the first time, of alliances, partnership, outsourcing, or subcontracting activities. | Yes/No |
| 191 – Significant changes in marketing concepts/strategies, such as new media or techniques to promote products; new forms of inserting products in the market or selling channels; or new methods to establish prices for the commercialization of goods and services. | Yes/No |
| 192 – Significant changes regarding aesthetic, design, or other subjective changes to at least one of the products. | Yes/No |

Source: IBGE (2013, 2016).

APPENDIX 3

Box C

Questions on product innovation – Pintec

| | |
|---|--------|
| 10 – Between 2009 and 2011 (or 2012 and 2014), did the company introduce a new or significantly improved product (good or service), which was a novelty for the company, but already existing in the national market? | Yes/No |
| 11 – Between 2009 and 2011 (or 2012 and 2014), did the company introduce a new or significantly improved product (good or service) to the national market? | Yes/No |

Source: IBGE (2013, 2016).

Box D

Questions on process innovation – Pintec

| 15 – Between 2009 and 2011 (or 2012 and 2014), did the company introduce: | |
|--|--------|
| 1 – A new or significantly improved method of manufacturing or producing goods or services? | Yes/No |
| 2 – A new or significantly improved logistic system or new delivery method for its inputs, goods, or services? | Yes/No |
| 3 – New or significantly improved equipment, software, or techniques in activities to support production? | Yes/No |

Source: IBGE (2013, 2016).

Box E

Questions on incomplete or abandoned projects – Pintec

| | |
|---|--------|
| 22 – At the end of 2011 (or 2014), did the company have an incomplete project to develop or introduce a new or improved product or process? | Yes/No |
| 23 – In the period between 2009 and 2011 (or 2012 and 2014), did the company carry out a project to develop or introduce a new or improved product or process, which was abandoned? | Yes/No |

Source: IBGE (2013, 2016).