Open innovation and performance in the service sector

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Abstract

Purpose – Organizations that decide to invest in innovation must define how this will be done: internally, externally or in a hybrid way, developing internal research and establishing partnerships with other agents of the innovation system. This paper aims to analyze whether the service companies' intensity of openness and innovation efforts are related to their innovative and financial performances. Open innovation assumes that organizations should use external and internal resources as they develop new technologies.

Design/methodology/approach – The study used data from the survey of technological innovation (Pintec). As regards innovations, it was considered the commercial and operational innovation performances and the innovative novelty performance. As regards financial performance, it was considered the overall net sales per employee. The intensity of open innovation was measured by the combination of breadth and depth (diversity and importance of the interfaces). The innovative effort was measured by spending on innovation activities. Regressions were applied to evaluate a set of hypotheses.

Findings – The results indicate that companies with a greater orientation toward open innovation presented better scores. The results also lead to the conclusion that foreign firm ownership structure and being part of a corporate group were the factors that caused the greatest impact on financial performance in the service sector.

Practical implications – The study provides empirical data on the importance of open innovation in improving organizations' performance, especially the breadth of open innovation.

Originality/value – The study contributes to expanding the research field addressing the relationship between service innovation and performance.

Keywords Performance, Open innovation, Service innovation, Survey of technological innovation

Paper type Research paper

1. Introduction

Developing or not developing innovation activities is an important decision of a company to make because it entails an investment whose financial returns are usually obtained in the

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medium or long term; thus, they are not always successful. When the organization decides to invest in innovation, it must define how it shall be done as follows: totally inside the company with the establishment of a sector or professionals responsible for innovation activities; totally outside the company with the acquisition of patents and/or through the hiring of research and development (R&D) companies; or in a hybrid way, by developing research internally and concomitantly interacting with the market and establishing cooperative partnerships and relationships with other agents pertaining to the innovation system. To help companies making such complex decision, our paper aims at is as follows:

- analyzing the intensity of open innovation activities of companies operating in the service sector and innovative efforts; and

- evaluating how such intensity relates to the innovative and financial performance of organizations.

The intensity of open innovation activities involves the importance given by companies to external sources of information, the use of external suppliers in innovative activities, and the importance of external partnerships and collaborations in the development of innovations. The innovative effort encompasses investments in R&D and in innovation activities. Innovative performance encompasses operational performance and the degree of innovation; financial performance, in our study, will be measured by net sales per employee.

With the growth of the service sector, the need to discover new sources of competitive advantage in the sector – including innovation – has been drawing researchers' attention. The new innovation opportunities boosted by communication and information technologies and the economic growth potential of service innovation in developing economies – in spite of resource scarcity – emphasized the service sector over the past years (Barrett, Davidson, Prabhu, & Vargo, 2015). As result, the importance of research in the field of services and the need to develop new understandings of services have never been so evident (Ostrom, Parasuraman, Bowen, Patrıcio, & Voss, 2015).

The growing number of academic studies on service innovation reflects the increase in the interest of several research areas and the priority occupied by the subject in service studies (Witell, Snyder, Gustafsson, Fombelle, & Kristensson, 2016; Witell, Gebauer, Jaakkola, Hammedi, Patricio, & Perks, 2017). The focus of our research is the service sector because of the importance of the market share of this sector in the economy, which represented more than 70% of the gross domestic product (GDP) in Brazil in 2015 (Ministério da Indústria, Comércio Exterior e Serviços, 2021), and because there is still little research dedicated to the analysis of the relationship between service innovation and performance (Ferraz & Santos, 2016).

According to Fagerberg (2005), innovation is a potent explanatory factor that lies behind the differences in performance among companies, regions and countries, and it is essential for long-term growth. Innovation tends to agglomerate into a few market segments, which consequently end up growing more quickly. Thus, the arguments showed so far support the accomplishment of our study, which aims at analyzing how innovation occurs in the service sector and its impact on the innovative and financial performance of companies.

2. Theoretical framework

2.1 Open innovation and performance

The dynamics and the configuration of the strategies and activities related to innovation have been changing and evolving as time goes by. Chesbrough (2003a) explains that the logic underlying the traditional innovation paradigm used to be guided by the need of a strong vertical integration. In other words, it was necessary to carry out every activity

internally is as follows: selection of tools and materials, conception and manufacturing, sales, services and support. Outside the sectors related to research and development (R&D), knowledge was quite sterile considering the few qualified alternatives in the market. According to such logic, the emergence of the internal and closed R&D laboratory used to be considered a strategic business investment (Chesbrough, 2003a).

The traditional innovation perspectives base on ownership and control as the essential promoters of strategic success. The focus lies mostly inside the company or inside the value chain in which the company is inserted. These perspectives do not focus on the potential value of external resources that are not owned by the company; they can, however, generate value for the company (Chesbrough & Appleyard, 2007).

Differently, in the open innovation paradigm, valuable ideas may emerge from within or outside the company; the same way, they may reach the market from the in or outside of the company (Chesbrough, 2003a). Instead of limiting research exclusively to create new knowledge, the research practices adopted may also include the access to and the integration of external knowledge. Thus, the organization may benefit from the better use of internal and external knowledge at the same time by combining knowledge in new different ways to generate new products or services (Chesbrough, 2003a).

Justifying larger investments in internal innovation activities has become a challenge for companies considering the high costs of the development of innovation, in addition to diminishing product life cycles. In such scenario, open innovation can be a solution because it makes use of external resources in the development of new projects and allows the company to profit from the commercialization of ideas in diverse channels or companies operating in different markets (Stal, Nohara, & Chagas, 2014).

These external resources – for example, volunteer collaborators, innovation communities, ecosystems and networks – are increasing sources of value creation (Chesbrough & Appleyard, 2007). The power of openness in terms of value creation is related mostly to one characteristic inherent in knowledge is as follows: it can be re-used and boost increasing returns. In addition, the breadth and depth of aggregated knowledge may overcome the individual contribution of knowledge from one collaborator (Chesbrough & Appleyard, 2007). However, Chesbrough (2003b) observes that not every industry has migrated or intends to migrate to the open innovation model. In agreement with the author, different businesses can be placed within a continuum, from basically closed to completely open. Companies vary in the intensity in which they can track, evaluate and assimilate inputs external to the innovation process (Dahlander & Gann, 2010).

The emphasis on openness and interaction in innovation studies shows a broader tendency in organizational behavior research; it suggests that the network of relationships between the company and the external environment plays a relevant role in performance (Laursen & Salter, 2006). These studies indicate that the customary explanatory variables of innovation performance such as R&D expenses and size, need to be further developed by research that focuses on how the differences in search and exploration strategies give rise to the heterogeneity of performance in companies (Laursen & Salter, 2006).

Laursen and Salter (2006) have empirically-related the breadth and the depth of external exploration to innovative performance; they defined the breadth of external exploration as the amount of distinct search channels that a company uses in its innovative activities – the depth of external exploration was defined as the degree to which companies intensively absorb innovative ideas from different channels and sources. The authors concluded that companies that have open exploration strategies – i.e. that search widely and deeply – tend to be more innovative. However, they also found out that the benefits of openness are subject

to decreasing returns, which indicates that there is a point at which further exploration becomes unproductive.

Ebersberger, Bloch, Herstad and Velde (2012) expanded Laursen and Salter's (2006) notions of breadth and depth to develop a set of indicators that capture more dimensions of open innovation. Open innovation practices were organized in terms of breadth and depth, namely, exploration (search for new information and ideas), external supply (acquisition of knowledge or market solutions), collaboration (relationship with partner organizations involving knowledge exchange) and technology commercialization/protection (via intellectual property) (Ebersberger et al., 2012).

The use of open innovation practices was summed up by Ebersberger et al. (2012) in the following:

- breadth indicator of open innovation, which encompasses all breadth dimensions of open innovation practices; and
- depth of open innovation, which summarizes all depth indicators. The combination between breadth and depth gives the company's total open innovation indicator.

Most part of literature sees R&D and internal capacities as a complement necessary to the openness of ideas and external resources, not as a substitute. The challenge is to find the correct proportion between external and internal sources of innovation (Dahlander & Gann, 2010). Considering the strong connection between absorption capacity and R&D expenses, according to Cohen and Levinthal (1990), Laursen and Salter (2006) assume that companies with high intensity levels of R&D are more capable to explore several sources in terms of breadth and depth. Thus, R&D intensity, which is measured by R&D expenditures divided by sales, was considered by the authors as a complementary matter in the external exploration toward innovative performance.

Even though these indicators bode well with the effects stemming from innovations carried out by companies, it is important to remember that several firms' characteristics can influence results. Some other control variables were analyzed by Laursen and Salter (2006) such as market orientation (if the main market of the company is local, regional or international) and size (measured by the number of employees) The same way, Ebersberger et al. (2012) considered as control variables as follows:

- the intensity of R&D;
- international or national market orientation;
- if the company is part of a corporation or a company cluster; and
- the size of the company (measured by the number of employees).

Considering that small-sized companies are provided with few resources to invest in R&D, they can benefit from open innovation through the establishment of external partnerships (Stal et al., 2014).

On the one hand, Laursen and Salter (2006) measured innovative performance as the portion of the company's turnover related to products new to the world market. On the other hand, Ebersberger et al. (2012) used the following two measures to evaluate innovation performance: the novelty of innovation; i.e. if companies introduced a product innovation that is also new to the market, and innovation performance; i.e. the share of sales relating to product innovation.

Considering that innovation is not an end, companies that implement new or improved products or process are expected to have better performance in comparison to non-innovative companies. The positive relationship between innovation and entrepreneurial

performance has been demonstrated in several empirical studies. The results, however, vary according to the country and the economy sector under investigation. In the service sector, R&D is often diffuse, it rarely fits in specific departments and it is more commonly carried out by flexible project groups (Djellal & Gallouj, 2000).

Prajogo (2006) explored the relationship between innovation and business performance and analyzed this relationship in industrial and service companies. In industrial companies, new technologies and pioneering companies had a stronger effect on business performance. On the other hand, service companies benefited from the quantity of new products introduced in the market.

Crépon, Duguet and Mairesse (1998) proposed a conceptual approach – which later on became a reference – to evaluate the relationship between productivity, innovation and R&D at the company level, influencing several further research. Considering that the company must decide if it wants to innovate or not, the authors developed a model that relates is as follows:

- the determining factors in the company's decision to carry out R&D;
- intensity of R&D to innovation results; and
- innovation results to productivity improvement.

Richard, Devinney, Yip and Johnson (2009) define organizational performance as a sort of efficiency indicator. According to the authors, organizational performance comprehends the following three specific areas related to corporate results:

- financial performance (profit, return on investment, return on assets, etc.);
- product performance in the market (market share, sales, etc.); and
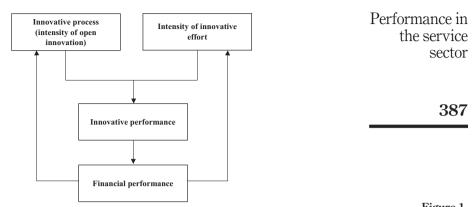- shareholder return (economic value added, total shareholder return, etc.).

Venkatraman and Ramanujam (1986) affirm that business performance is a subset of the general concept of organizational effectiveness. Business performance encompasses financial and operational performance.

2.2 Model and hypotheses
When deciding to innovate, the company must determine the intensity of its innovative effort; i.e. how much the company will invest in innovation activities and how this innovative effort will be carried out (totally inside the company or through external sources in lesser or greater degree). Next, it is necessary to measure the innovation results to verify if they are determined by the intensity and/or by the type of innovative effort. It is also important to verify if the results related to innovation influence the company's performance in financial or productivity terms. Finally, the innovation process must contain feedback loops. Financial performance can affect all stages of a company's innovation process. Thus, the innovation process must be tested simultaneously in every stage above mentioned, including their interrelations (Kemp, Folkeringa, DeJong, & Wubben, 2003).

Our study relates innovative process (represented by the intensity of open innovation), the intensity of innovative effort (measured by R&D expenditures and expenses in other innovation activities) and innovation results (measured through innovative performance) to the financial performance of the company. We chose herein the service sector because of its differentiated innovative dynamics, its relevance in the economy and the need to expand research on the sector. Figure 1 summarizes the approach proposed in our study.

The characteristics of the sector exert influence on the innovation capacity and on the positioning of companies in terms of product and market (Pitassi, 2012). Innovations carried

Source: Research data

Figure 1.
Analytical model

out by service companies are usually different from industrial sectors' and can, therefore, be organized differently. The process of service innovation is usually an interaction process, internally and externally. It is considered an interaction with external actors, especially customers; it is considered an internal interaction process due to the integrative process that involves managers and employees through different interaction patterns, formal and informal (Sundbo & Gallouj, 2000). In addition, only a few companies are involved in formal R&D activities; thus, research that focuses only on this sort of company – or that only consider R&D expenditures – are prone to bias (Crépon et al., 1998).

The aim of our study is to analyze the relationship between the intensity of openness of innovative activities, innovative effort and innovative and financial performance of service companies. Assuming that open innovation is related to innovative performance and that the latter is also influenced by the intensity of innovative effort – in addition to the effect on financial performance – we included the constructs related to innovative performance in the analysis of the relationship. To achieve such goals, we developed the following hypotheses:

H1. Financial performance (FP) is positively related to the intensity of open innovation (IOI).

H2. Financial performance (FP) is positively related to the intensity of innovative effort (expenses in R&D and in other innovative activities).

H3. Financial performance (FP) is positively related to innovative performance [degree of novelty and commercial and operational performance of the innovation (OPI)].

In addition, to verify if the breadth and depth of open innovation act differently in the financial performance of companies and to establish the relevance of each construct, we added two other hypotheses (*H1a* and *H1b*) in which the following two indicators were considered separately in the place of the consolidated open innovation indicator:

H1a. Financial performance (FP) is positively related to the breadth of open innovation (BOI).

H1b. Financial performance (FP) is positively related to the depth of open innovation (DOI).

The Survey of Innovation (abbreviated as the Pintec), which is carried out with the support of the funding authority for studies and projects (abbreviated as the FINEP) and the Ministry of Science, Technology and Innovation, is the main Brazilian survey related to knowledge and measurement of innovation processes accomplished by companies in Brazil. Pintec collects every three years information on innovations directly from the companies through interviews carried out by employees of the Brazilian Institute of Geography and Statistics (abbreviated as the IBGE) according to methodological guidelines and recommendations of the Oslo manual and Statistical Office of the European Communities (Eurostat), consolidated in the community innovation survey (CIS) [Instituto Brasileiro de Geografia e Estatistica (IBGE), 2016]. We used herein data referring to the three-year term 2012–2014 provided by Pintec to analyze the innovation activities in the Brazilian service sector.

3. Method
For the quantitative analysis, we used the statistical package STATA to analyze the database provided by Pintec. As filters for this database, we selected only active companies operating in the service sector, according to the classification [1] below as follows:

- editing, editing integrated with printing, sound recording and music editing activities (No. 58 and No. 59.2);
- telecommunications (No. 61);
- activities involved in information technology services, including customized software development, customizable software, non-customizable software, etc. (No. 62);
- data processing, internet hosting and other related activities (No. 63.1);
- architecture and engineering services, tests and technical analysis (No. 71); and
- scientific research and development (No. 72).

The data analysis was accomplished in seven stages.

3.1 Analysis of the Pintec micro database to verify the existence of outliers and missing values
The entire database was standardized in relation to missing values. After the analysis and elimination of outliers, the database had information on 2,056 companies with operating status, which represents a population of 11,564 companies in the service sector.

3.2 Cronbach's Alpha analysis of the elements that form the constructs and indicators proposed
Cronbach's alpha determines the internal consistency or average correlation of items in a survey to estimate their reliability. The higher the score, the more reliable the scale created (Santos, 1999). Alphas above 0.7 are considered consistent according to Nunnally and Bernstein (1994); therefore, questions that presented lower factor loads or that exerted a negative contribution to the reliability of the factor were removed – including the indicator commercial performance of innovation, which was also rejected.

3.3 Calculation of indicators

After validation, the indicators related to the constructs proposed herein were calculated for each company in the database, namely, intensity of open innovation (breadth, depth and total); intensity of innovative effort (investments in R&D and innovation activities); innovative performance (degree of novelty and OPI); and financial performance of companies.

Regarding the dimension external exploration of open innovation, to calculate breadth (BEE) and depth (DEE) indicators, we used the answers to the questions about the importance and location of information sources. In the dimension external supply, to calculate breadth (BES) and depth (DES) we used the answers to the questions about innovation activities.

In the dimension collaboration, to calculate breadth (BC) and depth (DC), we used the answers to the questions about who developed the innovation, the importance and the location of collaborative partners and the areas (objects) of cooperation. Due to the low internal consistency of the Cronbach' alpha of a unique indicator to measure the depth of collaboration, we divided this indicator into the following two other variables: DC1 (question on who developed the innovation and about the importance of cooperation partners) and DC2 (questions about the areas of cooperation).

To calculate the breadth indicators (BEE, BES and BC), we considered the number of questions about the importance of information sources/suppliers/collaborative partners with high, medium or low scores and used a binary scale, namely, irrelevant/did not develop = 0; and low/medium/high = 1. In addition, questions about the location of the source or partner added 1 point in the breadth when the location was abroad.

To calculate depth indicators (DEE, DES, DC1 and DC2), we considered the number of questions about importance of information sources/suppliers/collaborative partners with high scores attributed and also used a binary scale, namely, high = 1; and irrelevant/did not develop/low/medium = 0. In addition, questions about cooperation objects added 1 point in depth when the partner presented one or more cooperation objects. In addition, in the case of DC1, we also considered the answers to the questions about who developed the innovation; 1 would be added if the innovation was developed in cooperation with other companies or institutes.

By consolidating breadth indicators, we obtain the breadth of open innovation (BOI), which is composed of the sum of the following indicators: breadth of external exploration (BEE), breadth of external supply (BES) and breadth of collaboration (BC). The same way, the depth of open innovation (DOI) is composed of the sum of the following indicators: depth of external exploration (DEE), depth of external supply (DES) and depth of collaboration (DC1 and DC2). The indicator of intensity of open innovation (IOI) is composed of the sum of indicators of breadth of open innovation (BOI) and depth of open innovation (DOI).

Regarding the indicators that measure the intensity of innovative effort, the variable IRD – intensity of R&D – was measured by dividing R&D expenses by net sales revenues; and the variable IEIA – intensity of expenditures on innovation activities – was measured by dividing the total expenditures on innovation activities (including R&D) by net sales revenues.

Considering the indicators of innovative performance, to calculate the OPI, we considered the importance of the impacts of innovation. To calculate the commercial performance of innovation (CPI), we used the questions related to the commercial results of innovation (internal net sales and exports). Due to a low Cronbach's alpha, the variable CPI could not be used in our analysis. To calculate the degree of novelty of the innovation (DNI), we

considered the result of the sum of the scores attributed to the questions on process and product innovation.

Regarding the financial performance (FP) indicator, the only information available in Pintec's survey that relates to the global results of companies is net sales. Thus, due to the lack of other information related to financial performance, we used the net sales per number of employees to use an index that considers the size of the company.

3.4 Classification of companies by type of innovation

The database was identified by the following five different groups: TI1 – companies innovating in product and process; TI2 – companies that innovate only in product; TI3 – companies that innovate only in process; TI4 – companies that abandoned or did not finish innovation projects; TI5 – companies that did not accomplish any innovation activity.

Companies that implemented product and process innovation (TI1), jointly with the ones that implemented only product or only process innovation (TI2 and TI3), are provided with all the indicators and constructs elaborated herein, which refer to open innovation, innovation activities and the relationship with innovative and financial performance. On the other hand, companies provided only with abandoned or incomplete projects (TI4) do not have any indicators related to innovative performance, namely, operational (OPI) and degree of novelty (DNI). However, as they developed innovation activities, they have a few indicators related to open innovation, in addition to financial performance.

Companies that did not innovate (TI5) have no indicators related to open innovation, innovation activities, nor indicators related to innovative performance. These companies presented only the indicator related to the financial performance of the company (FP).

3.5 Composition of the intervening variables used in the model

Variables used is as follows: SCC – source of the controlling capital (national or foreign); AA – administrative autonomy (independent or part of a group); TM – target market (national or international); S – size (from 10 up 49 employees [S1], from 50 up to 249 employees [S2]; more than 250 employees [S3]); and MOI – marketing and organizational innovation (implemented or not). Table 1 presents the list of the constructs used in our research.

3.6 Analysis of the main characteristics of the database

The mean and the standard deviation were calculated per TI (type of innovation) group and the total mean of the main constructs.

3.7 Regression analysis

Regression analysis to evaluate the construct financial performance according to the intensity of open innovation (breadth, depth and total) and the intensity of innovative effort (R&D and innovation activities expenditures) with indicators of innovative performance and intervening variables.

The hypotheses *H1*, *H2* and *H3* were assessed through multiple linear regression including intervening variables, as according to the following equation below (where: α is the constant term; β_i, δ_i and λ_i are the regression coefficients; and ε the residual):

$$(H1; H2; H3) FP = \alpha + \beta_0 IOI + \delta_1 SCC$$
$$+ \delta_2 AA + \delta_3 TM + \delta_4 IRD + \delta_5 MOI + \delta_6 IEIA + \delta_7 S1$$
$$+ \delta_8 S2 + \delta_9 TI1 + \delta_{10} TI2 + \delta_{11} TI3 + \delta_{12} TI4$$

Variables	Description
Open innovation indicators	
BEE	Breadth of external exploration
BES	Breadth of external supply
BC	Breadth of collaboration
BOI	Breadth of open innovation (BEE + BES + BC)
DEE	Depth of external exploration
DES	Depth of external supply
DC1	Depth of collaboration 1
DC2	Depth of collaboration 2
DOI	Depth of open innovation (DEE + DES + DC1 + DC2)
IOI	Intensity of open innovation (BOI + DOI)
Innovative effort indicators	
IRD	Intensity of R&D (expenditure with internal R&D/net sales)
IEIA	Intensity of expenditure on innovation activities (total expenses with innovation activities/net sales)
Performance indicators	
OPI	Operational performance of innovation
DNI	Degree of novelty of the innovation
FP	Financial performance of the company (net sales/number of employees)
Intervening variables	
TM	Target market (National = 0; International = 1)
S	Size (S1 = less than 50 employees; S2 = from 50 up to 249 employees; S3 = 250 or more employees)
SCC	Source of the controlling capital (National = 0; Foreign = 1)
AA	Administrative autonomy (independent = 0; part of a group = 1)
TI	Types of innovation (TI1 = product and process; TI2 = only product; TI3 = only process; TI4 = only abandoned or incomplete projects; TI5 = no innovation)
MOI	Marketing and organizational innovation (No = 0; Yes = 1)

Source: Research data

Table 1.
List of constructs and variables

$$+ \lambda_1 OPI + \lambda_2 DNI + \varepsilon$$

Hypotheses *H1a* and *H1b* were analyzed through multiple linear regression, including intervening variables is as follows:

$$(H1a; H1b)FP = \alpha + \beta_1 BOI + \beta_2 DOI + \delta_1 SCC + \delta_2 AA + \delta_3 TM + \delta_4 IRD$$
$$+ \delta_5 MOI + \delta_6 IEIA + \delta_7 S1 + \delta_8 S2 + \delta_9 TI1 + \delta_{10} TI2$$
$$+ \delta_{11} TI3 + \delta_{12} TI4 + \lambda_1 OPI + \lambda_2 DNI + \varepsilon$$

Amongst the variables related to size (S1, S2 and S3), group S3 (more than 250 employees) was chosen as reference category. Among the variables related to the type of innovation (TI1, TI2, TI3, TI4 and TI5), group TI5 (no innovation) was chosen as the reference category. Subsequently, the results of other categories must be compared to their respective reference category.

IBGE uses sampling weights to better illustrate the reality face by Brazilian companies operating in the service sector. Therefore, all companies (observations) in IBGE's database

have their own weight. The regression analysis of our study used this weight to balance results, considering the number of individuals that each observation represents in the population when estimating proportions, means and regression parameters.

The use of sampling weights creates more robust indicators and enables the correction of heteroscedasticity errors by the method itself. In addition, to this method, we also used the White test to verify heteroscedasticity. Due to its generic approach (Greene, 2002), the White test can detect more general forms of heteroscedasticity than the Breusch-Pagan test. The results of the White test carried out after the regressions confirmed the adjustment provided by the model.

The quality of regressions was assessed through the F-test. If the significance level is low (lower than the alpha significance level), the null hypothesis that all coefficients together are equal can be rejected and the results of the regression can be considered robust. We also analyzed R^2 (R-squared), which indicates the proportion of the variance in the dependent variables that is predictable from the independent variables.

Subsequently, we analyzed the signs of the coefficients (positive or negative effect on the dependent variable) and the t-test. If the result of the t-test is low (lower than the alpha significance level), the null hypothesis (i.e. values of the independent variable do not affect changes in the values of the dependent variable) can be rejected; in other words, the independent variable is effectively related to the dependent variable.

We also checked for the existence of multi-collinearity (association among variables) by calculating the variance inflation factor (VIF) is as follows: if the result is lower to or equals 1, there is no multi-collinearity. If the result is between 1 and 10, multi-collinearity is at an acceptable margin. However, if the result is higher than 10, then multi-collinearity is high and must be corrected.

Our analyzes aimed to find out if the intensity of open innovation, innovative effort and innovative performance have a relevant impact on financial performance, and if there are differences in the effects of breadth and depth of open innovation in the service sector. We also tried to verify, which intervening variables affected the relationships and to identify distinct behaviors among groups based on these variables.

4. Analysis of the results

In this section, we will present the quantitative data of our study, which were obtained because of the access to Pintec's microdata.

4.1 Characterization of database, internal consistency and elaboration of indicators

The information regarding the characteristics of the companies in the database are detailed in Table 2.

Table 3 presents the means of the main constructs of the database according to each group pertaining to the type of innovation (TI).

Despite being composed of around 50% of BOI (breadth of open innovation) and 50% of DOI (depth of open innovation), we realized – through the average indicators in the innovation database – that construct IOI (intensity of open innovation) is represented by approximately 2/3 of BOI. When considering companies' data, it indicates that the interaction practices related to the breadth of open innovation (diversity in sources of information, partners, etc.) are actually more frequent than the practices related to the depth of relationships and collaboration among companies. Laursen and Salter (2006) also state that breadth is preponderant in relation to depth because, on average, UK companies use around seven sources of knowledge in innovative activities, but only one in the depth.

Variables	Total	(%)
Source of the controlling capital (SCC)		
National	1,818	88
Foreign	238	12
Administrative autonomy (AA)		
Independent	1,687	82
Part of a group	369	18
Target market (TM)		
National	2,009	98
International	47	2
Marketing and organizational innovation (MOI)		
Not implemented	588	29
Implemented	1,468	71
Size (S)		
Small	738	36
Medium	930	45
Marge	388	19
Type of innovation (TI)		
Product and process	503	24.5
Only product	153	7.4
Only process	253	12.3
Aband./incomplete	51	2.5
No innovation	1,096	53.3

Source: Research data

Variables	Type of innovation (TI)					
	1	2	3	4	5	Total
IOI	24.7	16.3	19.4	14.2	0.0	7.2
BOI	17.0	12.0	13.2	10.4	0.0	5.0
DOI	7.7	4.3	6.1	3.8	0.0	2.2
OPI	21.8	14.4	18.0	0.0	0.0	6.3
DNI	7.3	3.9	3.5	0.0	0.0	1.8
FP	160.9	212.1	108.2	170.8	161.9	157.8
IRD	0.08	0.06	0.02	0.017	0.0	0.018
IEIA	0.18	0.14	0.39	0.05	0.0	0.08
Quantity	503	153	253	51	1,096	2,056

Source: Research data

4.2 Analysis of the relationship among constructs

Table 4 expresses the result of the regressions, indicating the variables that presented significant results (*p*-value less than 0.10). Amongst the intervenient variables, TM, SCC and AA were significant in all regressions, with positive coefficients and similar magnitudes. Variable TM (target market) presented the highest magnitude. Considering that TM is a

Table 4.
Result of the
regression with
dependent variable
FP

Independent variables	H1; H2 coefficients	H1a; H1b coefficients
TM	271.3854***	271.3221***
SCC	241.4416***	241.3868***
AA	74.7802***	74.4914***
TI1	−156.8783***	−153.3957***
TI3	−110.2171***	−109.0131***
IEIA	−21.9834***	−22.7398***
OPI	−3.7363**	−3.4952**
DNI	30.7401***	29.9431***
IOI	1.6414**	
BOI		2.2164*
Constant	161.3956***	161.345***
R^2	0.0923***	0.0919***
Root MSE	261.72	261.76
p-value White test	0.8511	0.6463
Mean VIF	3.90	4.00

Notes: $*p < 0.10$; $**p < 0.05$; $***p < 0.01$
Source: Research data

dummy variable, it means that for companies whose target market is national (=0), the predicted score of FP would be 271 units lower than that of companies whose target market is international (=1), holding all other variables constant.

The variable SCC (source of the controlling capital) was the second most relevant. Considering that SCC is a dummy variable, for national companies (=0) the predicted score of FP would be 241 units lower than that of foreign companies (=1), keeping all variables constant. Variable AA (administrative autonomy) was the third most relevant, with positive coefficients. As AA is a dummy variable, for independent companies (=0) the predicted score of FP would be approximately 74 units lower than that of companies pertaining to a corporate group (=1), *ceteris paribus*.

The intervening variables that presented negative coefficients and similar magnitudes in all regressions were TI1 and TI3. The independent variable TI1 (companies that innovate in product and process) appeared in the regressions with negative coefficients and high magnitude (approximately –155), indicating that jointly investing in product and process innovation has a negative impact on the results of the company when compared to the reference group of this regression (TI5 – no innovation). The same way, the independent variable TI3 (companies that innovate only in process) appeared in the regressions with negative coefficients and high magnitude (approximately – 110), which indicates that investing only in process innovation has a negative impact on the results of the company when compared to the reference group of this regression (TI5 – no innovation).

The variable IEIA (intensity of expenditure on innovation activities) presented a negative coefficient. It means that, for each unit increased in IEIA, a reduction of about 22 units in FP is predicted, all other variables held constant. The fact that many times investments in innovation do not yield results in the same year they are made explains the negative association found.

Regarding the variables related to innovative performance (OPI – and DNI), the results were quite the opposite. The OPI presented a negative coefficient with low magnitude. It means that for each unit increased in OPI, a reduction of about 3.5 units in FP is predicted,

ceteris paribus. On the other hand, the DNI presented a positive coefficient with high magnitude. For each unit increased in BNI, an increase of approximately 30 units in FP is predicted, considering that all other variables are held constant.

Among all open innovation indicators (IOI, BOI and DOI), the variables IOI (intensity of open innovation) and BOI (breadth of open innovation) were the ones that presented a significant impact, with the same coefficient signal and similar magnitudes. DOI (depth of open innovation) did not present a significant impact. IOI presented a positive coefficient, which means that for each unit increased in IOI, a raise of around 1.6 units in FP is predicted, all other variables held constant. As BOI also presented a positive coefficient, it is expected that for each unit increased in BOI, a raise of approximately 2.2 units in FP is predicted, *ceteris paribus*.

The outcomes of the White test confirmed the absence of heteroscedasticity because the null hypothesis of constant variance could not be rejected (*p*-value higher than the alpha significance level: 0.05). The VIF calculated in each regression indicated values less than 10, which demonstrates an acceptable level of multi-collinearity.

5. Final remarks
Among the priorities of research recommendations in the field of service innovation indicated by Ostrom et al. (2015), one can find is as follows: the encouragement of service innovation through open innovation with the collaboration of customers and partners in the process of developing innovative services; the analysis of the development of service networks and ecosystems; and the measurement of the performance and the impact of services with the creation of metrics that links innovation to the financial results of the company.

When jointly analyzed, the results herein contribute to literature in the above-mentioned themes, suggest a few understandings and provide the answers to the research aim, initially outlined. The main conclusions referring to the analysis of the service sector were as follows:

- In the service sector, operating in international market, having foreign controlling capital and being part of a corporate group indicate a superior financial performance. This finding is in accordance with the bibliographic review carried out by Becheikh et al. (2006), who indicate that exports and internationalization have a significantly positive impact on innovation, and also in line with Laursen and Salter (2006), who affirm that the scope of the market (local, regional, national or international) is consistently positive and significant to explain the commercial performance of innovations. Considering that in our study financial performance is measured by net sales per employee, the results are consistent.

- In addition, the intensity of open innovation is positively related to the performance of organizations in the service sector, considering that companies with stronger open innovation orientation present better financial performance in terms of net sales per employee, which confirms hypothesis *H1* (financial performance is positively related to the intensity of open innovation). More specifically, the breadth of open innovation is responsible for generating the positive effects, despite its low magnitude, which also confirms hypothesis *H1a* (financial performance is positively related to the breadth of open innovation). Hypothesis *H1b* (financial performance is positively related to the depth of open innovation) had no empirical support. This finding is also in line with the results of Laursen and Salter (2006) and Ebersberger et al. (2012), who concluded that the breadth of open innovation is the element responsible for the positive boost in innovation. The authors also affirmed that a broader and more comprehensive approach for open

innovation can be more successful than a deep focus on a single aspect (Ebersberger et al., 2012).

- Among the intervening variables, we verified that size and marketing and organizational innovation do not affect the financial performance indicator in service companies.

- Hypothesis *H2* was not confirmed. In fact, the results indicate that investing in innovation activities negatively affects the financial performance in the short-term. We consider relevant to emphasize herein that the data on investments in innovation provided by Pintec refers only to the past year of the three-year term of the survey, and investments in innovation are unlikely to give results in the same year they were made. Sometimes it takes from two to three years before the company starts to reap the results stemming from innovation. According to Ferraz and Santos (2016), the impacts of service innovation in performance are not normally seen at a given time, but their influence can be perceived over a longer period.

- Companies that develop only product innovation presented a better financial result than companies that innovated in product and process or only in process. Considering that in our study the financial performance of companies is measured by net sales per employee, the results suggest that product innovation interferes directly in this latter indicator, which does not occur with process innovation. Another explanation for the phenomenon is that companies that operate in more competitive markets – with a consequent reduction in financial performance – are undertaking process innovation to reduce costs and survive. As process innovation is usually related to automation, the efforts to implement it and adapt employees may present benefits only in subsequent years.

- The results regarding hypothesis *H3* (financial performance is positively related to innovative performance) were heterogeneous. The indicator OPI had a significant negative impact, despite its low magnitude, on financial performance, which provides no empirical support for *H3*. As the OPI is strongly associated with improvements in processes, our result is in line with the findings related to this type of innovation. On the other hand, the DNI affects the financial performance of the company, which supports *H3*. The results indicate that the launch of new products has a direct impact on the commercial performance of the company, especially with regard to net sales.

The generation of value in services almost always involves a network of actors such as suppliers, customers, institutions and other market agents, in a broader ecosystem. The integration between technologies and abilities and the transfer of knowledge in these ecosystems are essential for the development of service innovation, especially in emerging economies, which deal with more adverse conditions and scarcity of resources (Barrett et al., 2015). In environments with limited resources, the access to external resources and the ability to mobilize and collaborate with external partners are important elements to better deal with restrictions, allowing for a reduction of time and resources, resolution of problems and more agile commercialization of innovations (Witell et al., 2017). On the other hand, the authors emphasize that this networking ability does not necessarily ensure better results in service innovation, and they recommend studies in different types of services and resource limitations.

Regarding the management of innovation, our study aimed at contributing to managerial practices by providing empirical data on the importance of open innovation to improve the performance of organizations, especially the breadth of open innovation. Being Brazil an

emerging economy, it is important for companies to analyze the strategies that may help to overcome adversities and resource limitations. The analyzes herein indicate that companies that develop open innovation practices achieve superior results; they also indicate that a greater degree of novelty in innovations has a positive effect on the financial performance of service companies. It means that companies do not need to necessarily develop all innovative processes internally. In fact, learning practices and the search for external information, as well as the collaboration and creation of partnerships with other organizations, are beneficial for companies to obtain positive impacts in their results. Even though the depth of open innovation has not presented a statistically significant impact in our study, it is necessary to consider that the depth and intensity of collaborative relations are also important and must be adopted by service companies pursuing innovation.

As recommendations for future studies, we suggest the reapplication of our analysis in different sectors of the economy and in other emerging countries to liken our research to other diverse realities.

A few limitations were found throughout our investigation. By choosing to use the database provided by Pintec, we had – on the one hand – the opportunity to deal with a large sample of companies and detailed data on innovation in Brazil. On the other hand, we were restricted to the use of a questionnaire that was not aimed specifically for open innovation. Another limitation is that the financial data obtained from Pintec (revenues and expenditures) refer only to the past year of the survey's three-year term. Therefore, it was not possible to evaluate the results of recent investments in innovation. Either way, the use of this data facilitates the comparison to similar research carried out in different countries that make use of questionnaires with the same methodology.

6. Final observation
The data used herein stem from the Pintec Survey 2014, carried out by IBGE. Data were obtained through authorized access to the institution's restricted data room. The authors are solely responsible for the results, analyzes and interpretations presented; we do not represent IBGE's position and do not present official statistics.

Note
1. Classification elaborated by the National Classification of Economic Activities (abbreviated in Portuguese as the CNAE).

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