Emerging technologies and new business models: a review on disruptive business models

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Abstract
Purpose – This paper aims to conduct a review on disruptive business models. Considering that competition among companies will not only happen through new products, services or technologies but also through innovative business models, the disruptive business models arise to replace the existing business models, adapting the organizational structures to the products and services offered and emphasizing the proposition of unique value.

Design/methodology/approach – The literature on this topic was revised, allowing the obtaining of the state of the art and the construction of a research agenda. The analyzed literature was obtained from systematic searches by the term disruptive business model in some databases. For the analysis of the data, the content analysis strategy was used through categorizations in the material exploration phase, and, later, for the processing of the results, the authors made use of inference and interpretation regarding the content analyzed.

Findings – The collected literature made it possible to obtain a set of data formed by different views of authors on disruptive business models, which was analyzed and categorized to make new inferences and interpretations.

Originality/value – Considering that the literature on the disruptive process of business models is emerging and addressing an important phenomenon in the market that lacks the theoretical basis to sustain it, this paper contributes by presenting a consolidated examination on this subject, thus deepening the theoretical analyzes on this topic and reducing this lack in the literature. This study also presents a research agenda, which clarifies the disruptive business model gap and reveals some opportunities for future empirical researches.

Keywords Innovation, Business models, Emerging technologies, Disruptive business models

Paper type Literature review

1. Introduction
Organizations, regardless of the sectors in which they operate, face a variety of new technologies, which, at the same time, generate business opportunities and challenges for companies (Tongur and Engwall, 2014). Thus, organizations’ focus on emerging technologies provides the steady supply of new products, services and processes, influencing business and market structures (Sainio, 2004; Bueno and Balestrin, 2012). In this sense, several studies point out that the changes provided by the new technologies reflect positively on the performance of the companies, allowing competitive advantage through
innovation and, consequently, their distinctiveness in relation to their competitors (Hamel and Prahalad, 1994; Kassicieh et al., 2002; Hwang and Christensen, 2008; Lui et al., 2016).

Then, it is identified that organizational transformations have benefited from the agility of new technologies, providing the development of new ways of creating value for the market through an innovation process, which expands the boundaries of organizations and contributes to the generation of new business models (Zott et al., 2010). Nevertheless, in addition to the possibility to innovate in the offering of products and services, companies need to be concerned with the adequacy of their business models in relation to the new technologies (Pacheco et al., 2016). This is because recognizing the possibilities or threats of new technologies introduced in the market for the business model allows the company to react by realigning its products or services, processes, skills, logical forms of profit and value network relationships (Sainio, 2004), as the essence of a business model is in defining the manner by which the enterprise is organized to deliver value to customers (Teece, 2010).

However, several companies do not understand this need to adapt their existing business models to the new technologies arising (Markides and Oyon, 2010). In this sense, Gassmann et al. (2013) point out that competition among companies in business ecosystems will not only happen through new products, services or technologies but also through innovative business models, as business model innovation is one type of innovations that have the potential to strongly impact the market and the competitors (Zhang et al., 2018) and may help to establish a differentiable competitive advantage (Teece, 2010). In this context, the disruptive business models arise at a stage in which emerging technologies and innovations become critical, requiring new organizational structures to the products and services offered, which emphasize the proposition of a unique value to the market and replace the existing business models (Hwang and Christensen, 2008; Markides, 2006; Mitchell and Coles, 2004; Moore, 2004; Osiyevskyy and Dewald, 2015; Santos et al., 2009; Wu et al., 2010).

Considering the relevance of the subject addressed, this article aims to conduct a review on disruptive business models, using articles from scientific journals as basis. To this end, the literature on disruptive business models was collected and revised to obtain the state of the art and construct a research agenda related to this theme, also considering, for this purpose, an analysis related to business models and new technologies, which represent the key concepts and segmentation of the main theme of this review about disruptive business models.

Despite the relevance of this topic, there is still little research that seeks to present the theoretical aspects related to disruptive business models (Foss and Saebi, 2017), considering its importance in the creation new business models or the reconfiguration of an organization’s existing business model, with the objective of creating new business structures to an innovative market, in which new products, services or processes will be offered, through the redefinition of what exists in the market, aiming at proposing a unique value to the customer (Markides, 2006; Santos et al., 2009; Habtay, 2012; Amshoff et al., 2015). Besides that, their exact meaning and conceptual boundary, in relation to the aspects of the disruptive and innovation process to business models, are still imprecise in the literature (Wu et al., 2010; Foss and Saebi, 2017).

Therefore, considering that the literature on the disruptive process of business models is emerging and addressing an important phenomenon in the market that lacks the theoretical basis to sustain it, this article contributes, through a review, to the mapping of the literature on disruptive business models, thus deepening the theoretical analyzes on this topic and reducing this lack in the literature. Although there is this conceptual lack in the literature, most of the research on disruptive business models are still theoretical and report superficially a few practical examples of disruptive business models. Thus, the research
agenda of this article contributes to clarifying the disruptive business model gap and revealing some opportunities for future researches in an empirical way.

This research is structured to present the methodological procedures used in the mapping of the review in the section below. Subsequently, in the third section, the results obtained from the analysis of literature on disruptive business models are discussed. Finally, in the fourth section of this article, the main aspects related to the state of the art are discussed, afterwards, the research agenda is presented in the final considerations.

2. Methodology

To contribute to the existing literature on disruptive business models, this research, essentially qualitative and descriptive, proposes the construction of a review on this subject under debate, presenting its state of the art and suggesting a research agenda. A review, as well as other types of review studies, is a form of bibliographic research that uses published material on a given subject as a source of data (Webster and Watson, 2002). Therefore, the scope of the review consists of the identification and analysis of articles from scientific magazines and journals, which serve as relevant sources for the investigation of the subject in question.

The articles selected for the review deal specifically with disruptive business models, both in theoretical research and in empirical research. This set of articles – that constitute the analysis units of the review – was obtained from searches conducted in databases. To carry out these searches, the following scientific databases were chosen: CAPES Journal Portal, EBSCO, SCOPUS and Web of Science. This selection is justified by the influence of these bases in the academic area, considering the number of accesses to several journals and magazines of all areas of knowledge, such as those related to business management, which focus their studies on disruptive business models.

After choosing the scientific databases, a search term was defined to obtain the set of articles to be explored. Four searches were performed, one in each database, by the term disruptive business model (without quotes) only in peer-reviewed titles of scientific articles with no period limitation (search filters), to obtain researches that discuss this subject both specifically and in-depth. The searches in the databases were performed at the beginning of the second semester of 2016 (July). Excluding duplicate articles in the same database, as well as excluding repeated articles from one database to another, a total of 19 articles has been obtained for analysis. No other exclusion criteria for the articles has been used.

Initially, each of the articles resulting from the searches was thoroughly verified, with the purpose of ensuring its relevance for this research, as well as confirming that the topic about disruptive business model was being explored in-depth. To do this, each one of the 19 articles was read by one of the authors, seeking to analyze the relevance of the article and how the topic of disruptive business models was approached. No article was excluded in that stage, being all articles considered important for a more detailed analysis. This is because, in a preliminary reading, it was observed that the articles contained important elements about disruptive business models, which were exposed, especially, in the articles theoretical background and the results.

With these 19 references, the articles data were organized in electronic spreadsheets with the purpose of subsequently carrying out the reviews and analyzes intended in this research. Therefore, all the elements of the selected articles (problem question, objectives, justification, theoretical reference, methods, fields of application, results, final considerations, contributions and other aspects that might be featured in the studies) were catalogued in an Excel worksheet, with the purpose of establishing a consistent review on disruptive business models, which points to the motivations of research on this topic, explain the
contributions of existing literature, describe key concepts, guide future research and present implications for managers and academics (Webster and Watson, 2002).

To do so, for the data analysis, we opted for the content analysis strategy (Bardin, 2011), through categorizations (initial, intermediate and final) in the material exploration phase; and, later, for the processing of results, we used inference and interpretation of the content analyzed. The categorization can be classified as hybrid (Bardin, 2011), as it used criteria defined prior to the collection of data for the initial categorization (in this case, the analysis of the definition of business model, the emerging technologies and innovation processes and the conceptualization of disruptive business models) and criteria defined after the collection for the intermediate and final categorizations, based on the contents of the research data. The categorizations are present in the Table I.

The initial categories are presented in the ‘Analysis’ subsections, considering the importance and the amplitude of this subjects for the review construction of disruptive

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<th>Initial</th>
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<td>Business model</td>
<td>Elements for the elaboration of the concept of business models</td>
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<td>Strategy, value chain, value network, cost structure, target market segment and value proposition</td>
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<td>Strategy, resources and capabilities, revenue model, value network and value proposition</td>
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<td>Emerging technologies and innovation processes</td>
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<td>Simpler, more convenient and more affordable products and services</td>
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<td>Forms of business organization to explore technologies and innovations properly</td>
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<td>Emerging technologies and innovation processes</td>
<td>Emerging technologies and innovation processes cause changes in business models</td>
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Table I. Categorizations (initial, intermediate and final)
business model. The intermediate and final categories are found in the columns of the Tables (subsections 3.1 and 3.2) and the figure (subsection 3.3) that systematize the results in the following subsections of this article. The “processing of results inference and interpretation” phase is represented in the inferences made prominently close to it each systematization and resulting interpretive analyzes, which emerged from the analysis of the documents.

3. Analysis

In this section, the analysis of the 19 articles selected for the review is presented. The complete references of the 19 articles analyzed are present in the Appendix. A first noteworthy finding, referring to the literature reviews presented in the articles analyzed, are the elucidations related to the concepts of emerging technologies and business models, which serve as a basis for the elaboration of explanations about the disruptive business models. As a result, the description of key concepts was defined based on the analysis of three initial categories: business models, emerging technologies and disruptive business models.

The analyzes of each of these initial categories are shown afterwards, based on the results verified and supported by the examination of intermediate categories. Furthermore, in the discussion of disruptive business models, inferences are made about research motivations, the contributions of current literature and the implications for managers and academics, thus constructing a review for the state of the art on this theme.

3.1 Business models

Despite the use of features of business models even when society engaged in exchange markets, this term was only explicitly highlighted in the mid-1990s with the advent of the Internet (McGrath, 2010; Teece, 2010; Zott et al., 2011; Fielt, 2014). During this period, the process of globalization and the insertion of new information and communication technologies in the market pressured the corporate ecosystems in such a way that many organizations, to meet these demands, focused on their business models, so as to find ways to adapt their structures to this growing online marketplace (Kinder, 2002).

Later, other studies indicated the use of the concept of business models in different types of trades, sectors and companies, whether or not they were acting on the Internet (Mahadevan, 2000; Magretta, 2002; Zott et al., 2010). In this sense, although the expansion of business models in the management process of several companies has been observed, the explanations about this theme remain diffuse in scientific research and are being discussed under different perspectives (Shafer et al., 2005). In this perspective, Gordijn et al. (2005) point out that the researches related to the business models present five different phases:

1. the definition and classification of business models;
2. the complementation and proposition of the components of business models;
3. the detailed description of the components;
4. the component modeling, culminating in ontologies of business models; and
5. the application of these models in management and information systems environments (up to mid-2000s).

Taking these phases into account, it is possible to notice that, in the articles analyzed for this review, many authors, when describing business models, focus initially on their definition and, then, on the proposition and description of their components. Given the various approaches to presenting concepts related to business models in literature, Morris et al. (2005)
analyzed different definitions to present a general concept for the subject. According to them, a business model represents an integrated set of decision variables in the strategic, operational and economic areas, and it is directed to generate sustainable competitive advantage in defined markets.

Thus, considering this effort to consolidate different concepts and investigate the literature reviews pointed out in the analyzed articles, in general, it is verified that the elements most present in the definition of business models are related to the strategy of the companies in the *articulation of their activities and structures* aimed at *proposing value* to customers. Table II illustrates those elements and brings the references found in the review of literature of the explored articles.

After this conceptualization, the authors start with the proposition and description of the components of the business models. Wu *et al.* (2010) point out that a business model, as a conceptual tool, is constituted by a set of elements, which are related, allowing to express the business logic of a company. In light of this, several authors point to different sets of components and relations of a business model. Reviewing the collected articles, we found six different sets of business models’ components, as shown in Table III.

Looking at these six sets of components, there is a relative similarity in the composition of the elements of a business model and, consequently, in the functions performed. In general, these elements are proposed and articulated with a focus on following the *central strategy* of the organization, which in turn seeks the *value proposition* to customers through the definition and relationship of *resources, processes, chain and value network*, as well as the *profit and cost formula*.

Another finding in the review of the researched articles revolves around the initial theorization about business models, which characterizes them as a way of shaping business practices in the face of an analysis of the environment (Simmons *et al.*, 2013). This is because

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<td>Hamel (2000)</td>
<td>Central strategy, resources, value network and client interface</td>
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<td>Strategy, value chain, value network, cost structure, target market segment and value proposition</td>
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<td>Value context (market opportunities), value creation and value capture</td>
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<td>DaSilva <em>et al.</em> (2013)</td>
<td>Strategy, resources and capabilities, revenue model, value network and value proposition</td>
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several authors discuss the importance of business models in assessing the opportunities and challenges present in the environment (such as those presented by the introduction of new technologies, for example), which allows the structuring of the business to comply with the requirements of the environment (Sainio, 2004; Downing, 2005; Cohen and Winn, 2007; Franke et al., 2008; Sabatier et al., 2010; George and Bock, 2011). In this sense, it is possible to perceive the influence of the constant changes of the market and the demands of the clients regarding business models, which cause continuous alterations in the organizational structures (Sabatier et al., 2010).

This final finding is related to a new phase, which was pointed out by Taran et al. (2016) and has been discussed and based on business models. This new phase refers to the innovation of business models and other aspects of this innovation process. Regarding this phase, a subject that is being discussed deals with the disruptive business models, which will be analyzed and discussed later in another subsection.

3.2 Emerging technologies and innovation processes

The organization of business structures for the generation of innovation, aiming at the launch of new products or services and the development of new processes or new organizational configurations, has become a constant concern of managers in recent years (Bueno and Balestrin, 2012). This is because, in the midst of continuous market changes, business strategies focused on innovation management are key factors for gaining competitive advantage and distinction in the business environment (Pereira et al., 2015; Gavião et al., 2016). At this stage, emerging technologies play an important role in business models (Bashir et al., 2016), as they create business opportunities and, at the same time, challenges for companies (Sainio, 2004).

In this context, recognizing the possibilities or threats of new technologies introduced in the market for the business model allows the company to react by realigning its products or services, processes, skills, logical forms of profit and value network relationships (Sainio, 2004). This early reaction enables the company to be ready to seize opportunities and to guard itself against the imminent dangers of constant market changes. Considering this scenario, it is possible to see, throughout the literature reviews of the articles analyzed, the insertion of concepts related to disruptive technologies and innovation, which affect the existing business models of the organizations and create new business models for the exploration of these aspects.

This disruptive impact focuses on the discontinuation of the normal course of a process and on the interruption of established performance trajectories, thus causing a strong market shock and the reconfiguration of business structures. This is explained by the fact that disruptive technologies and innovations bring a very different value proposition to the market, especially when it is compared to the options previously available, in view of the result of the new products and services offered. These perform poorly in terms of simplicity; however, in relation to other indicators, they bring superior benefits for the target market segment, such as convenience, accessibility and lower costs. These characteristics were highlighted in literature reviews from the perspective of different authors, as shown in Table IV.

Another aspect highlighted in the literature reviews concerns the influence that disruptive technologies and innovations end up having on the business environment, as this disruptive process does not only impact the business models of the companies that propose to be disruptive but also the competitors. This is because disruptive products and services have peculiar characteristics, as discussed above, and those are targeted at a specific segment of the market (usually that of non-consumers or less attractive customers), thus
creating new markets. This situation generates a great competitive advantage for the companies adopting the technologies and disruptive innovations as well as the failure of the dominant companies of the market. Table V illustrates this discussion pointed out by some authors in the literature reviews analyzed.

Finally, there is also a discussion about the development of new entrepreneurial skills, leading to the breakdown of established trajectories related to the development, production, management and commercialization of disruptive products and services (Day and Schoemaker, 2000). As verified in the review of the articles (Table VI), it is necessary to make changes in partner networks, develop new competencies related to strategic issues to structure the business in the face of the disruptive potential, as well as mature skills for the production of new disruptive products and services.

Despite the authors’ emphasis on the relevance of disruptive technologies and innovations to the market, attention must be paid to business models. This is because disruptive technologies and innovations are only well used when they are combined
with the *restructuring of the existing business model* (Christensen and Raynor, 2003; Johnson *et al.*, 2008), thus provoking a conflict between the business model that is already established for the existing technology and the one that *should be structured for* the disruptive technology or innovation (Christensen and Raynor, 2003). In this sense, new business models are needed to comply with the *changes in business logic* (Christensen *et al.*, 2009).

Considering this contextualization, which appoints for the influence of the emerging technologies and innovation in the disruption process of business models, the analyzed articles point out the promotion of discussions about disruptive business models, which will be examined in the following subsection.

### 3.3 Disruptive business models

Finally, by addressing the inherent aspects of disruptive business models in this analysis, a review on this theme is presented, focusing on the presentation of key concepts, research motivations, contributions of existing literature and implications for academics and managers. Initially, it is worth examining the concepts brought by several authors to the theme, found in the review of the analyzed literature, which characterize this type of model and contextualize it in the organizational environment.

The initial studies on disruptions in the market focused on the analysis of the previously highlighted technologies and discontinuous innovations (Christensen and Bower, 1996; Christensen, 1997). These initial analyzes were extended to the concept of disruptive business models, thus linking business models to technological and innovation ruptures (Christensen and Raynor, 2003). In this sense, the disruption of business models arises at a time when emerging technologies and innovations become critical through an existing business model (Moore, 2004). This is because the commercialization of a new technology or an innovation process requires companies to understand the cognitive role of business models, especially when the opportunities presented by them do not fit into existing business models (Chesbrough and Rosenbloom, 2002).

On that subject, Hwang and Christensen (2008) highlight the fact that many companies fail to be able to unite disruptive technologies and innovations to new business models. In this way, it is understood that disruptive business models arise to replace existing business models, either by their restructuring or by the creation of new models, aiming at a unique value proposition to the market (Mitchell and Coles, 2004; Hwang and Christensen, 2008; Wu *et al.*, 2010). In this line, it should be noted that innovations in business models are not enough to discover new products or services but simply to redefine what an existing product or service is and how it is delivered to customers (Markides, 2006). In this way, in the context of the innovation of business models, it is possible to notice that the attention is focused on the customer (Magretta, 2002), in search for new ways of creating value for consumers, rather than the pure delivery of a new product, service or process (Bashir *et al.*, 2016).

In view of this context where the concept of disruptive business models is found, it is possible to notice, through the review, that one of the motivations of the researches, both theoretical and practical, is to explain some tensions caused by the innovation process of business models. One of the basis of this tension is the conflict between the maintenance of existing business models (for companies that had an established business model but want to exploit the new opportunities brought by disruptive technologies and innovations) and the creation of new business models needed to exploit disruptive technologies and innovations, a completely new business opportunity (Christensen, 1997; Amit and Zott, 2001; Christensen and Raynor, 2003; Chesbrough, 2010). In this line, another motivation found in researches on this theme is the presentation of studies that show the dominant logic of maintaining
existing business models, which seriously limit innovation potentials, ignore new technologies because they do not fit into the current business model and cause business to fail. (Christensen, 1997; Gilbert, 2005; Chesbrough, 2010). A final motivation lies in the market transformation opportunity that disruptive business models offer (Bashir et al., 2016).

The construction and dissemination of research motivated by different aspects about disruptive business models end up having relevant implications for managers and academics. Bashir et al. (2016) argue, for example, that managers can use the innovation of business models not only as a source of value proposition to the market but also as a way to gain competitive advantage, causing improvements in the financial performance of the company. In this sense, it can be understood that the introduction of new business models by managers is an effective way to disrupt market leaders by making existing business models obsolete (Johnson et al., 2008; Yovanof and Hazapis, 2008; Gassmann et al., 2014; Osiyevskyy and Dewald, 2015).

Thus, managers must assume an entrepreneurial behavior and analyze the business beyond their traditional perspectives, looking for new ways of creating and capturing value through new business models (Chesbrough and Rosenbloom, 2002; Bashir et al., 2016). About this, Tripsas and Gavetti (2000) warn that disruptive business models can go against managerial beliefs about success factors in the industry, resulting in strong opposition to business model innovation. Another important implication highlighted by the review is that managers are aware that it is not enough to incorporate emerging technologies and innovation processes into existing business models. In these cases, it is necessary to evaluate and re-adapt business models (Dasilva and Trkman, 2014).

The presentation of these implications revolving around disruptive business models to managers and academics becomes crucial with the purpose of contributing to the field and theory, because when it comes to designing new business models for disruptive technologies and innovations, there is generally, a lack of knowledge about these issues (Amshoff et al., 2015). Therefore, the dissemination of discussions and theoretical and practical studies contribute to illustrate the different situations in the context of disruptive business models, which underpin the decisions of managers and allow different forms of reaction and innovation processes into existing business models. In these cases, it is necessary to evaluate and re-adapt business models (Dasilva and Trkman, 2014).

Figure 1 illustrates the review, presenting a systematization of the relationship of business models, new technologies and innovation processes with disruptive business models. In this sense, it is possible to see the breadth of the concept of disruptive business models, which encompasses aspects related to the influence of emerging technologies and innovations on the organization’s existing business models.

This is because this theme focuses on replacing business models, either by reconfiguring existing models or by creating new models, when the exploration of emerging technologies and innovation processes is not adequately leveraged in today’s models, requiring new forms of business organization. Thus, the delivery of differentiated value to consumers, competitive advantage, the opening of new markets and the obsolescence of existing business models are characteristics observed with disruptive business models in the business environment.

3.4 Research agenda

Through our comprehensive review of the disruptive business model literature, we developed a future research agenda, based on the reviews carried out around the research investigated and on the findings described in the analysis of results. As already described, although there is a conceptual lack in the business model disruptive literature, most of the research on disruptive business models are still theoretical and report superficially a few
practical examples of disruptive business models. Thus, this research agenda reveals some opportunities for future researches, predominating the possibilities of empirical research on this subject under review.

The first opportunity for future research concerns the development of empirical research in areas that have not yet been studied in relation to disruptive business models (Murty and Kumar, 2015; Pereira et al., 2015). Discussions about the implementation of disruptive business models have been registered in different areas of knowledge, such as the aviation sector (Pereira et al., 2015), the taxi service industry (Bashir et al., 2016), the newspaper industry (Karimi and Walter, 2016) and the health sector (Hwang and Christensen, 2008; Sabatier et al., 2012). Consequently, the accomplishment of studies that go deeper in the analyzes related to the organizations that are innovating in their business models and to the specific scenario of other segments allow the expansion of this theme through research applied to the field, allowing to identify similarities and differences between the cases of different sectors.

Another possible future research that has been identified is the construction of empirical researches that investigate the development of corporate behavior for the adoption of innovations of business models. In the literature, it is pointed out the importance of the figure of managers to identify the need for reconfiguration or innovation of business models (Chesbrough and Rosenbloom, 2002; Bashir et al., 2016). However, in some cases there is strong resistance on the part of managers to these changes (Markides and Oyon, 2010). Therefore, research that investigates the motives that facilitate the adoption of corporate behavior for the implementation of innovations of business models can help to modify the hostile behavior of some managers in relation to changes (Karimi and Walter, 2016).

From another point of view, a possible future study is the elaboration of empirical researches featuring the social motives related to the innovation of business models. Analyzing the market and what the customer wants and needs becomes essential to develop business models that meet these requirements through a unique value proposition to the customer (Magretta, 2002; Bashir et al., 2016). Therefore, understanding how companies
carry out these investigations and how they develop new business models from these findings will contribute to the expansion of the topic under discussion through studies that fill this gap (Habtay, 2012).

Finally, another future research is the development of empirical research that shows the relationship between the dominant logic of maintaining business models versus the innovation of business models in the face of disruptive technologies or innovations. As presented in this research, this subject is often discussed by several authors, who point to the consequences of not adopting new business models in the face of new technologies or another process of innovation in theory (Markides and Oyon, 2010). Therefore, research that reports in practice this relationship between maintaining existing models and adopting new models will be excellent examples to be consulted by other managers in similar situations with their companies (Christensen, 1997; Gilbert, 2005; Johnson et al., 2008; Chesbrough, 2010; Markides and Oyon, 2010).

The next section will retrieve the main points of the constructed research agenda, indicating some implications for literature and practice.

4. Final considerations

Business models have traditionally been considered a management tool that enables the organization of business structures, ensuring the flow of business (Simmons et al., 2013). Nevertheless, the maintenance of an original business model in the face of the commercialization of a disruptive technology or innovation causes several limitations in the conduction of business (Christensen, 1997). In this sense, the new business structures or the reconfiguration of existing structures provide new ways of managing the value attributes offered, focusing on meeting the new demands made by customers (Rodrigues et al., 2013). Thus, with the constant changes in the market, it is clear that innovation in business models has become a key factor to be considered in the strategies of companies (Pereira et al., 2015).

In view of this context, this article sought to review the literature on disruptive business models, with the purpose of constructing a review that portrays the state-of-the-art and presenting a research agenda related to this theme; despite its relevance, there is still little research that seeks to present the theoretical aspects related to disruptive business models (Foss and Saebi, 2017). In this sense, starting from the content analysis of the collected material, we analyzed theoretical and practical researches that pointed to discussions of concepts related to business models, new technologies and disruptive business models. Also, the research motivations, the contributions of the existing literature and the implications for managers and academics about disruptive business models were evidenced.

Thus, the review made in this article summarizes the state of the art of the research about disruptive business models, from the perspective of the conceptualization and contextualization of this theme. This fact contributes to the theory by mapping the literature on disruptive business models, deepening the theoretical analyzes of this subject and reducing the conceptual lack in the literature, considering that the literature on the disruptive process of business models is emergent that lacks the theoretical basis to sustain it.

In addition, the presentation of research opportunities, through the identification of research gaps in this theme, becomes useful for academics interested in the exploration of studies on disruptive business models. This is because, although the literature on disruptive business models is increasing in the past years, there is a relative lack of attention to the empirical researches on this subject. To present a better understanding of disruptive business model in practice, future studies should draw on these different opportunities for research, presented in the research agenda in this article.
Thus, this article contributes to clarifying the disruptive business model gap and to reveal some opportunities for future empirical researches, although it should be noted, in this regard, some limitations in the research by the depth of data collection because of the databases used.

References


Review on disruptive business models


### Appendix

<table>
<thead>
<tr>
<th>Year</th>
<th>Author</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>Sainio, L. M.</td>
<td>A framework for analysing the effects of new, potentially disruptive technology on a business model case – Bluetooth</td>
</tr>
<tr>
<td>2007</td>
<td>Smith, G. G.</td>
<td>Disruptive business models and the small or rural radiology practice</td>
</tr>
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<td>2008</td>
<td>Hwang, J. and Christensen, C. M.</td>
<td>Disruptive innovation in health care delivery: a framework for business model innovation</td>
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<td>2008</td>
<td>Yovanof, G. S. and Hazapis, G. N.</td>
<td>Disruptive technologies, services, or business models?</td>
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<td>2010</td>
<td>Markides, C. and Oyon, D.</td>
<td>What to do against disruptive business models (when and how to play two games at once)</td>
</tr>
<tr>
<td>2011</td>
<td>Klick, A.</td>
<td>Managing through disruption: banks confronted by disruptive forces are reshaping operations to better serve their customers</td>
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<td>2012</td>
<td>Habtay, S. R.</td>
<td>A firm-level analysis on the relative difference between technology-driven and market-driven disruptive business model innovations</td>
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<td>2012</td>
<td>Sabatier, V., Craig-Kennard, A. and Mangematin, V.</td>
<td>When technological discontinuities and disruptive business models challenge dominant industry logics: insights from the drugs industry</td>
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<td>2013</td>
<td>Simmons, G., Palmer, M. and Truong, Y.</td>
<td>Inscribing value on business model innovations: insights from industrial projects commercializing disruptive digital innovations</td>
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<td>2014</td>
<td>Ángel, M. A. V. D., Rodriguez, M. M. and Tirado, Q. L.</td>
<td>Disruptive models of business of two Latin American companies that emerge from the network of value of bovine meat</td>
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<td>2014</td>
<td>DaSilva, C.M. and Tkman, P.</td>
<td>Business model: what it is and what it is not</td>
</tr>
<tr>
<td>2014</td>
<td>Habtay, S. R. and Holmén, M.</td>
<td>Incumbents responses to disruptive business model innovation: the moderating role of technology vs. market-driven innovation</td>
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<td>2015</td>
<td>Amshoff, B., Dulme, C., Echterfeld, J. and Gausemeier, J.</td>
<td>Business model patterns for disruptive technologies</td>
</tr>
</tbody>
</table>

**Table AI.** Complete references of the 19 articles analyzed

(continued)
### Table AI.

<table>
<thead>
<tr>
<th>Year</th>
<th>Author</th>
<th>Title</th>
<th>Journal</th>
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<tr>
<td>2015</td>
<td>Murty, D. N. and Kumar, B. V.</td>
<td>Internet of things (IoT): is IoT a disruptive technology or a disruptive business model?</td>
<td><em>Indian Journal of Marketing</em></td>
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<td>2015</td>
<td>Osiyevskyy, O. and Dewald, J.</td>
<td>Explorative versus exploitative business model change: the cognitive antecedents of firm-level responses to disruptive innovation</td>
<td><em>Strategic Entrepreneurship Journal</em></td>
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<td>2016</td>
<td>Bashir, M., Yousaf, A. and Verma, R.</td>
<td>Disruptive business model innovation: how a tech firm is changing the traditional taxi service industry</td>
<td><em>Indian Journal of Marketing</em></td>
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<td>2016</td>
<td>Karimi, J. and Walter, Z.</td>
<td>Corporate entrepreneurship, disruptive business model innovation adoption, and its performance: the case of the newspaper industry</td>
<td><em>Long Range Planning</em></td>
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The effect of creative corporate culture and intangibility on the performance of foreign firms traded on the NYSE

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Abstract
Purpose – Following the tenets of resource-based view, the present study aims to investigate the effect of creative corporate culture according to the competing values framework model at the level of corporate intangibility and its respective repercussions on performance.

Design/methodology/approach – The sample included 117 non-USA foreign firms traded on the New York Stock Exchange (NYSE), which issued annual financial reports between 2009 and 2014 using the 20-F form. To meet the study objectives, in addition to the descriptive and comparative analyses, the authors performed regression analyses with panel data, estimating generalized least-squares, two-stage least-squares and ordinary least-squares.

Findings – Creative culture had a negative effect on the level of intangibility and corporate performance, while the level of intangibility did not appear to influence corporate performance. When combined, creative culture and intangibility had a potentially negative effect on corporate results. In conclusion, creative corporate culture had a negative effect on performance, even in firms with higher levels of intangibility, characterized by elements like experimentation and innovation.

Originality/value – Although the study hypotheses were eventually rejected, the analyses are relevant to both the academic setting and the market because of the organizational and institutional aspects evaluated, especially in relation to intangibility and creative culture and in view of the unique cross-cultural approach adopted. Within the corporate setting, the study provides a spectrum of stakeholders with tools to identify the profile of foreign firms traded on the NYSE.

Keywords Resource-based view, Intangible assets, Competing values framework, Creative corporate culture

Paper type Research paper
1. Introduction
Compaínes have invested much effort in an attempt to survive on today’s competitive markets (Fekete and Böcskei, 2011), thereby undergoing changes in several organizational aspects, including their culture, responsible for influencing the creation of competitive advantage, in view of the fact that culture can determine the degree of success of a firm (Han, 2012).

Scholars are giving increasing attention to the topic because of the great importance of corporate culture and its implications for firms (Barney, 1986; Han, 2012; Zheng et al., 2010). Based on the competing values framework (CVF), initially proposed by Quinn and Rohrbaugh (1983) and more recently by Cameron et al. (2006), corporate culture may be segregated into four types: collaborative (“clan”), creative (“adhocracy”), competitive (“market”) and controlling (“hierarchy”) (Cameron and Quinn, 1999). The CVF model is centered on corporate values perceived as predominant in the firm’s conduct and as translating a given cultural trait which guides the firm’s actions.

Cameron et al. (2006) also defend the existence of two dimensions to explain the corporate culture profiles: focus (internal and external) and structure (organic and mechanistic). Internal focus is the combination of collaborative and control culture, while external focus is the combination of creative and competitive culture (Cameron et al., 2006). Organic or flexible structure is the combination of collaborative and creative culture, whereas mechanistic or stable structure is the combination of competitive and control culture (Cameron et al., 2006). Corporate culture is not defined by a single aspect but is a combination of cultural traits in which, in general, one culture prevails over the others (Wu et al., 2011), with the need to preserve a balance between the different cultures (Cameron and Quinn, 2006).

For the purposes of this study, the discussion centers on the creative (innovative) culture type, or adhocracy; thus, external focus and organic structure, according to the dimensions proposed by Cameron et al. (2006). Firms with creative cultural potential present traits of entrepreneurship, flexibility and creativity (Acar and Acar, 2014; Cameron and Quinn, 2006; Tseng, 2010). Such characteristics are expected to promote innovation (Denison and Spreitzer, 1991). In this context, it is assumed that the set of elements which make up creative culture raises the firm’s level intangibility. Indeed, empirical evidence shows a positive association between innovation and intangible assets in Brazilian firms (Miranda et al., 2013; Santos et al., 2012).

A strategic resource controlled by the firm, corporate culture, is a potential source of sustainable competitive advantage (Barney, 1986; Flamholtz and Randle, 2012). In light of the tenets of resource-based view (RBV), the success of a firm depends on the resources it has at its disposal and its ability to control such resources, including intangible assets (Galbreath, 2005).

Thus, based on RBV, corporate culture may be considered a sustainable strategic resource controlled by the firm, with specific characteristics which can determine the success or failure of a business, which, in turn, increases organizational efficacy in a culture-specific manner, leading to better performance (Barney, 1986; Cameron et al., 2006; Fekete and Böcskei, 2011; Flamholtz and Randle, 2012; Han, 2012; Helfat and Peteraf, 2003).

Likewise, a study by Carvalho et al. (2010) presented empirical data on the association between intangibility and increased (superior and persistent) corporate performance. According to RBV, this evidence supports the notion that intangible assets, because of their nature, potentialize the effects on corporate performance.
The present study was therefore aimed at investigating the effect of creative culture on the level of intangibility and its effects, individual and combined, on the performance of foreign firms traded on the New York Stock Exchange (NYSE). Based on the studies of Fekete and Böcskei (2011), Han (2012) and Kim et al. (2004), we hypothesized that creative culture has a positive influence on the level of intangibility of firms and that both constructs, individually or combined, have a positive impact on corporate performance, with the combined effect expected to be greater than the individual effect.

Studies on corporate culture are gaining followers in the academic world because of the expansion of the view of organizational objectives to include behavioral, social and environmental aspects. Recently, some authors have evidenced a positive association between creative corporate culture and corporate performance (Acar and Acar, 2014; Fekete and Böcskei, 2011; Han, 2012; Tseng, 2010), but little has been published on creative corporate culture, intangibility and the effect of these two on performance.

The theoretical justification of the study lies in the possibility of clarifying the interaction between creative culture, intangibility and performance. Our analysis has broadened the scope by including firms from around the world which invest in intangible assets as a means to remain competitive on the market.

2. Review of the literature and hypotheses

2.1 Creative corporate culture, intangibility and performance

Corporate culture may be defined as a set of central organizational values which inform corporate decisions and behaviors and which may influence the beliefs and actions of stakeholders (Flamholtz and Randle, 2012). According to Cameron and Quinn (1999), corporate culture is a set of elements – basic values, approaches, assumptions, interpretations, etc. – which characterizes a given firm; thus, each culture profile may have a different impact on corporate success, also taking into account the firm’s strategic orientation and the needs of the external environment.

Several authors have proposed to classify corporate culture into dimensions or types. One such classification, the CVF, first proposed by Quinn and Rohrbaugh (1983), defines the differences between the values characterizing different models of corporate efficacy and was later used by Cameron and Quinn (2006) to explain culture profiles in different organizational models.

The proposed model centers on competitive values and includes the following culture types: collaborative (clan), creative (adhocracy), competitive (market) and control (hierarchy) (Cameron and Quinn, 1999).

To Cameron et al. (2006), each culture profile has distinct elements represented by beliefs, values and artifacts which direct the firm toward specific results in terms of organizational efficacy. Many scholars believe that corporate culture oriented towards success increases organizational efficacy (Cameron et al., 2006; Hartnell et al., 2011; Quinn and Rohrbaugh, 1983) represented by certain elements relative to the specific profiles of each culture, such as satisfaction and commitment among staff (collaborative culture), innovation of products and services (creative culture), participation in the market, earnings, product quality, productivity (competitive culture) and efficiency and good internal performance (control culture) (Cameron and Quinn, 1999).

As highlighted by RBV, corporate culture is considered a strategic resource controlled by the firm in the sense that it provides a potential source of sustainable competitive advantage (Barney, 1986; Flamholtz and Randle, 2012).
As for sustainable competitive advantage, the literature shows that what makes corporate culture a sustainable strategic resource is the fact that, if well managed, it is transmitted to generations of staff through the firm, thereby perpetuating the source of competitive advantage (Flamholtz and Randle, 2012, p. 83). Thus, among the assets associated with organizational efficacy, corporate culture is one of the most extensively investigated (Zheng et al., 2010).

RBV proposes that a firm’s unique traits, based on its assets, have an impact on performance and the creation of sustainable competitive advantage, defined mainly as “rare, valuable, inimitable and non-substitutable” resources and capacities and by the degree of heterogeneity of the resources created and controlled by the firm (Barney, 1991; Helfat and Peteraf, 2003). One such resource is corporate culture.

The characteristics of creative culture give firms an external orientation, with better developed knowledge conversion and corporate performance (Tseng, 2010). Thus, creative corporate culture, based on the criterion of adaptation to the environment, has the potential to positively affect corporate performance (Fekete and Böcskei, 2011; Han, 2012; Kim et al., 2004).

In view of the above, Figure 1 shows the model proposed in this study, which describes the relationship between creative corporate culture, intangibility and corporate performance.

In short, creative corporate culture is in light of RBV regarded as a sustainable strategic resource (Barney, 1986; Flamholtz and Randle, 2012) characterized by the firm’s commitment to investments in innovation and experimentation (Cameron and Quinn, 2006). This profile has direct implications on the firm’s level of intangibility. In addition, many researchers have pointed out that creative corporate culture and the level of intangibility can have different effects on corporate performance depending on the sampling context (Carvalho et al., 2010; Fekete and Böcskei, 2011; Flamholtz and Randle, 2012; Han, 2012).

Note: $a$, $b$, $c$ and $c'$ represent analyses to verify the direct relationship between creative corporate culture and corporate performance ($c$) and the relationship mediated by intangibility ($a$, $b$, $c$, $c'$), as suggested by Baron and Kenny (1986).

Source: The authors
2.2 Hypotheses

Creative corporate culture (adhocracy) is characterized by strong dynamism and focus on the external environment (Cameron et al., 2006) and is closely associated with risk taking, innovation and change (Quinn and Spreitzer, 1991). The literature shows that firms with potential creative culture have a profile of entrepreneurship, flexibility and creativity (Acar and Acar, 2014; Cameron and Quinn, 2006; Tseng, 2010). These traits are expected to promote innovation (Denison and Spreitzer, 1991) and therefore lead to higher levels of intangibility Santos et al. (2012).

According to the CVF model, innovative firms seek to gain an edge over the competition by introducing new products, services and/or processes (Cameron and Quinn, 2006). The basic premise in creative culture is that change favors the creation and/or mobilization of resources.

The firm’s focus on innovation and consequent adoption, implementation and development of routines aimed at the informatization of the environment for new technological developments makes it possible to increase the firm’s ability to create products faster and cheaper Naor et al. (2014). The set of elements which make up creative corporate culture cause the level of intangibility to rise. Based on the above, we formulated the following study hypothesis:

*H1*. Creative corporate culture has a positive influence on the level of intangibility of foreign firms traded on the NYSE.

The characteristics of creative corporate culture (commitment to experimentation and innovation, introduction of new products and services, entrepreneurial and risk-taking management, among others) (Cameron and Quinn, 2006; Naor et al., 2014) have an impact on a firm’s performance and outcome.

Tseng (2010) states that the characteristics of creative corporate culture are oriented towards the external environment and imply a potential for developed knowledge conversion and improved corporate performance. In this respect, considering the aspect of adaptation to the environment, creative corporate culture can affect corporate performance (Kim et al., 2004).

The literature shows that, in fact, creative corporate culture has a positive influence on corporate performance (Acar and Acar, 2014; Fekete and Böcskei, 2011; Han, 2012). Moreover, Tseng (2010) found empirical evidence that allowed to affirm that creative corporate culture enables firms to convert knowledge more easily than their competitors and that performance benefits more from this culture type than from other types. Based on these arguments, the second study hypothesis was formulated thus:

*H2*. Creative corporate culture has a positive influence on the performance of foreign firms traded on the NYSE.

Internal corporate resources may be classified as tangible (machines, equipment, real estate) or intangible (competences, efficient processes, brands, etc.) (Barney, 1991). From the accounting perspective, directive CPC 04 (R1), issued by the Brazilian Committee of Accounting Directives (CPC), defines intangible assets as “identifiable non-monetary assets without physical substance” (CPC, 2010, p. 6) and establishes criteria for recognizing and quantifying such assets. To be recognized as intangible, an asset must be identifiable, controlled by the firm and capable of generating future economic benefits. Intangible assets that do not meet these legal criteria are not included in mandatory financial reports.
According to Carvalho et al. (2010), the potential of intangible assets to create value depends on certain attributes, most of which are not marketable and require internal development, thereby becoming important factors of differentiation. In this perspective, and by virtue of their attributes, intangible assets are among the resources that support superior performance and the creation of competitive advantage (Basso et al., 2015; Decker et al., 2013; Jordão and Almeida, 2017; Perez and Famá, 2006). Thus, a third study hypothesis was formulated:

H3. Intangibility has a positive influence on the corporate performance of foreign firms traded on the NYSE.

In view of the precepts of RBV, corporate culture and intangible assets are sustainable strategic resources capable of determining corporate success or failure, with implications for the improvement of performance (Barney, 1986).

In view of the above, it may be assumed that firms with strong creative culture have high levels of efficacy with regard to the characteristics that promote innovation, improve productive processes and expand R&D. Such attributes, in turn, lead to growth of the firm’s intangible structure, hence, of its level of intangibility. The higher level of intangibility may in turn have significant effects on performance, depending on the nature of the intangible resources (Basso et al., 2015; Decker et al., 2013; Perez and Famá, 2006).

Thus, conceivably, the combination of a strong creative corporate culture and a substantial intangible asset structure would potentiate the individual effects of these factors on corporate performance. To test this possibility, a fourth hypothesis was formulated:

H4. Creative corporate culture combined with high levels of intangibility has a potential positive influence on the corporate performance of foreign firms traded on the NYSE.

Unlike previous studies, we used secondary data to identify creative corporate culture (Fiordelisi and Ricci, 2014). In addition, we performed a cross-cultural descriptive and comparative analysis of creative corporate culture and intangibility in firms headquartered in different regions and analyzed, in separate and in combination, the relationship between creative corporate culture, the level of intangibility and corporate performance.

3. Methodology

The study sample included firms traded on the NYSE but headquartered outside the USA. The choice was justified by the representative number of the US firms traded on the NYSE, the inclusion of which would substantially raise the tradeoff of the study. Initially we considered all 520 foreign firms traded on the NYSE on 31 July 2015. Subsequently, firms were excluded which did not use the 20-F form (n = 201), which belonged to the financial sector (n = 45), whose fiscal year was different from the calendar year (n = 31), which had not issued annual reports throughout the period covered by the study (n = 103), whose information was incomplete (n = 17), which were headquartered in Africa (n = 2) (because of the insufficient number of firms to represent the continent), or which were identified as outliers (n = 4). Thus, the final sample consisted of 117 firms (702 observations).

The study was based entirely on secondary data: annual reports (20-F) issued by the firms and available on the website of the US Securities and Exchange Commission (SEC). The purpose of the 20-F form, which is mandatory for all foreign firms with stock
traded on the NYSE, is to make information disclosed by such firms comparable to information disclosed by USA firms. Among other things, 20-F reports contain information on key operational activities, market risks, internal controls, codes of ethics and conduct, corporate governance, financial results and audits.

The financial information used to calculate the indicators of intangibility and performance, regardless of the currency used in the reports, was expressed in millions of USA dollars.

To quantify corporate culture, many researchers have used instruments for the collection of primary data, scoring organizational culture on a scale (Acar and Acar, 2014; Tseng, 2010). In contrast, we used secondary data through text analysis which consists of objectively and systematically scanning texts for key words or ideas (Stone et al., 1966).

The approach is based on the assumption that the words and expressions chosen by members of a firm reflect the predominant culture developed by the firm over time (Levinson, 2003). In other words, the distinctive traits of a firm are believed to be reflected in its documents. Text analysis is essential to measure the semantic content of official documents made available by firms, as explained by Fiordelisi and Ricci (2014). With this technique, the indicators used to proxy corporate culture are less prone to the subjectivity of the researchers interpreting the data (Fiordelisi and Ricci, 2014).

The level of creative culture was determined with the technique proposed by Fiordelisi and Ricci (2014). The authors identified a representative number of synonyms for each culture type defined by the CVF based on the argument of Carretta et al. (2011) that the use of synonyms minimizes the problem of subjectivity in the selection of the words. Thus, the authors identified a number of word roots related to each culture type and organized them in “bags or words”. The bags for collaborative, creative, competitive and control culture contain, respectively, 34, 30, 41 and 35 word roots (Fiordelisi and Ricci, 2014). In this study, we focused on the 30 word roots associated with creative culture (Table I).

Creative corporate culture (CC) was estimated for each foreign firm traded on the NYSE between 2009 and 2014 as the percentage corresponding to the ratio between the number of times creative culture-specific word roots occurred in the company’s reports and the number of times word roots from all four culture types occurred. For example, if a report contained 500 word roots from all four cultures, 160 of which were creative culture-specific, the creative culture percentage of that document would be 32 per cent (160/500).

The level of intangibility (INT) of each firm was measured based on the amount of investments in intangible assets and expressed as the ratio between intangible assets and all assets (Santos et al., 2012).

<table>
<thead>
<tr>
<th>Culture type</th>
<th>Bag of words (n = 30)</th>
</tr>
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<tbody>
<tr>
<td>Creative culture (CC)</td>
<td>Adapt, begin, chang, creat, discontin, dream, elabor, entrepre, envis, experim, fantas, freedom, futur, idea, init, innovat, intellec, learn, new, origin, pioneer, predict, radic, risk, start, thought, trend, unafra, ventur, vision</td>
</tr>
</tbody>
</table>

Source: Fiordelisi and Ricci (2014)
To measure corporate performance \((PER)\) we used return on equity, defined as the ratio between net earnings and equity as used by Azeez (2015) and Miranda et al. (2013) to measure performance. The parameter allows to evaluate the return on shareholders’ investments.

The findings were submitted to multiple linear regression with panel data and robust errors. \(INT\) was used as dependent and independent variable, while \(CC\) was used as independent variable only, as shown in the equations below:

\[
INT_{it} = \beta_0 + \beta_1 CC_{it} + \sum \beta_{2-9}[CON]_{it} + \epsilon_{it}
\]

\(PER_{it} = \beta_0 + \beta_1 CC_{it} + \sum \beta_{2-9}[CON]_{it} + \epsilon_{it} \) \(\text{(2)}\)

\(PER_{it} = \beta_0 + \beta_1 INT_{it} + \sum \beta_{2-9}[CON]_{it} + \epsilon_{it} \) \(\text{(3)}\)

\(PER_{it} = \beta_0 + \beta_1 INT_{it} + \beta_2 CC_{it} + \sum \beta_{3-11}[CON]_{it} + \epsilon_{it} \) \(\text{(4)}\)

where \(CC\) is creative corporate culture, \(INT\) represents investments in intangible assets, \(PER\) is performance expressed as return on equity, \(it\) represents the subscripted firm and year, respectively, and \(\beta\) represents the coefficients of the model. Among the control variables \((CON)\), \(SIZ\) is company size expressed as the \(\ln\) of its assets; \(LEV\) is leverage expressed as the ratio between liabilities and assets, \(REG\) is regional location, \(EFCR\) is the firm-crisis effect, \(GDP\) represents the country’s economic situation, \(LEG\) is the country’s legal system, \(ECO\) is the country’s level of economic development, and \(INP\) is a dummy variable representing innovative potential, with “1” assigned to potentially innovative firms (IT, telecommunications, automobiles, pharmaceutics, aerospace and defense, biotechnology and food), according to the Global Innovation Management Institute (www.giminstitute.org), and “0” otherwise.

To analyze the role of intangibility as mediator between creative corporate culture and corporate performance, we adopted the procedures proposed by Baron and Kenny (1986) according to which four conditions are required for mediation. Considering the model presented in Figure 1, initially the relations \(c\), \(a\) and \(b\) must be significant, and \(c' < c\) (partial mediation) or \(c = 0\) (complete mediation).

The organizational variables \(SIZ\) and \(LEV\) are factors which can affect performance. The inclusion of these variables was based on studies like Azeez, (2015), Fiordelisi and Ricci (2014), and Naranjo-Valencia et al. (2015). As for the institutional variables, \(REG\) (West or East) is used to control for the influence of region on culture (Gray, 1988) because, as shown by Naor et al. (2014), cultural differences between West and East may have an impact on corporate efficacy. The classification of countries into West and East was based on the prime meridian (Greenwich).

It is important to consider the effect of financial crises on corporate performance. To do so, we used a metric similar to that proposed by Fiordelisi and Ricci (2014): firms with decreasing profitability (expressed as return on assets) over three consecutive years were assigned the value “1”, and “0” otherwise. We also considered the effect of country crises by introducing the variable per capita \(GDP\), as informed by the World Bank Group (https://data.worldbank.org/).

\(REG\) was determined based on world map analysis, \(LEG\) was assigned according to Juriglobe (www.juriglobe.ca/eng/), and \(ECO\) was retrieved from the website of the
International Monetary Fund (www.imf.org/external/index.htm). All three are dummy variables.

Regression analysis with panel data were performed for firms headquartered in Latin America, Asia and Europe, and the sensitivity of the results was verified. To make the results more robust, the models were estimated with generalized least-squares (GLS), two-stage least-squares (2SLS) and ordinary least-squares (OLS). These techniques allow to correct correlation effects between the residues and between the residues and the independent variables and to control for problems of endogeneity.

4. Results

4.1 Analysis and discussion

Table II shows mean percentages of creative corporate culture, levels of intangibility and corporate performance in the sample according to continent (Latin America, Asia and Europe).

The three continents accounted for 32.5 per cent (Latin America), 33.3 per cent (Asia) and 34.2 per cent (Europe) of the sampled firms. Asia and Europe displayed the greatest heterogeneity in relation to the number of countries and firms. The mean percentage of

<table>
<thead>
<tr>
<th>Continent</th>
<th>Countries</th>
<th>Firms</th>
<th>Obs. (%)</th>
<th>CC</th>
<th>INT</th>
<th>PER</th>
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<tr>
<td>Latin America</td>
<td>8</td>
<td>38</td>
<td>228</td>
<td>0.141</td>
<td>0.398</td>
<td>0.119</td>
</tr>
<tr>
<td>Asia</td>
<td>10</td>
<td>39</td>
<td>234</td>
<td>0.138</td>
<td>0.292</td>
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<td>Europa</td>
<td>13</td>
<td>40</td>
<td>240</td>
<td>0.144</td>
<td>0.846</td>
<td>0.172</td>
</tr>
<tr>
<td>Total</td>
<td>31</td>
<td>117</td>
<td>702</td>
<td>0.141</td>
<td>0.516</td>
<td>0.113</td>
</tr>
</tbody>
</table>

Notes: CC = creative corporate culture; INT = level of intangibility; PER = corporate performance. Results expressed as mean values

Source: The authors

Table III.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Categories</th>
<th>Firms</th>
<th>CC (t/F)</th>
<th>INT (t/F)</th>
<th>CCxINT (t/F)</th>
<th>PER (t/F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>REG</td>
<td>West</td>
<td>77</td>
<td>0.143</td>
<td>0.01**</td>
<td>0.630***</td>
<td>0.089***</td>
</tr>
<tr>
<td></td>
<td>East</td>
<td>42</td>
<td>0.1380</td>
<td>0.289</td>
<td>0.038</td>
<td>0.041</td>
</tr>
<tr>
<td>LEC</td>
<td>Common</td>
<td>15</td>
<td>0.138</td>
<td>0.05**</td>
<td>0.243***</td>
<td>0.119***</td>
</tr>
<tr>
<td></td>
<td>Civil</td>
<td>66</td>
<td>0.144</td>
<td>0.228</td>
<td>0.082</td>
<td>0.113</td>
</tr>
<tr>
<td></td>
<td>Mixed</td>
<td>38</td>
<td>0.140</td>
<td>0.089</td>
<td>0.032</td>
<td>0.040</td>
</tr>
<tr>
<td>ECO</td>
<td>Emerging</td>
<td>67</td>
<td>0.141</td>
<td>0.07*</td>
<td>0.315***</td>
<td>0.044***</td>
</tr>
<tr>
<td></td>
<td>Advanced</td>
<td>52</td>
<td>0.143</td>
<td>0.767</td>
<td>0.106</td>
<td>0.145</td>
</tr>
<tr>
<td>EFCR</td>
<td>Yes</td>
<td>34</td>
<td>0.140</td>
<td>0.547</td>
<td>0.53</td>
<td>0.075</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>85</td>
<td>0.142</td>
<td>0.503</td>
<td>0.070</td>
<td>0.147</td>
</tr>
<tr>
<td>INP</td>
<td>Yes</td>
<td>45</td>
<td>0.138</td>
<td>0.00***</td>
<td>0.703***</td>
<td>0.097***</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>72</td>
<td>0.143</td>
<td>0.398</td>
<td>0.056</td>
<td>0.107</td>
</tr>
</tbody>
</table>

Notes: REG = regional location; LEC = legal system; ECO = economic development; EFCR = effect of firm crisis; INP = innovative potential; (a) variables submitted to Student’s t test for comparison of means; (b) variable submitted to analysis of variance. *, ** and *** correspond to the 10%, 5% and 1% level of significance, respectively

Source: The authors
creative corporate culture was highest in Europe (14.4 per cent) and lowest in Asia (13.8 per cent).

The lowest mean level of investment in intangible assets was observed for Asian firms (29.2 per cent of total assets). Mean levels were considerably higher for firms in Latin America (39.8 per cent) and Europe (84.6 per cent).

Mean corporate performance was highest in Europe (17.2 per cent). In fact, Europe surpassed the other two continents with regard to all three study variables.

Table III displays the results of the descriptive and comparative analyses of mean creative corporate culture, intangibility, corporate performance and $CC \times INT$, according to regionality, legal system, economic development and effect of crisis.

As shown by the results, the percentage participation of creative culture was similar for firms in Western and Eastern countries. The other variables were higher for Western countries (Latin America and Europe). This seems to indicate that firms in Western countries invest more in intangible assets and are more profitable.

Firms headquartered in common law countries such as the USA and the UK (where norms are based on jurisprudence) might be expected to have higher levels of intangibility and performance because of the more flexible environment, but our findings show the opposite to be true: firms in civil law countries displayed higher levels of creative culture, characterized by innovation, creativity and flexibility (Acar and Acar, 2014; Cameron and Quinn, 2006; Tseng, 2010).

Our results also show that corporate intangibility and performance were 2.5 times and 1.8 times greater, respectively, in countries with advanced economies than in countries with emerging economies. However, the difference in creative culture was not significant.

The existence of a financial crisis within the firm affected performance only, as expected. The fact that no other variable differed suggests that cultural differences are associated with institutional rather than organizational aspects. Interestingly, firms in the innovative sector displayed higher levels of intangibility despite lower levels of creative culture. Performance did not vary between innovative and non-innovative firms.

After characterizing the sample, we conducted descriptive analyses and data correlation analyses to verify the data distribution. Table IV shows the descriptive statistics.

On average, 14.2 per cent of the word roots identified in the reports issued by the sampled firms were in the creative culture word bag. The firms displayed little heterogeneity with regard to creative culture, as shown by the small standard deviation (2.3 per cent). In contrast, the mean percentage of intangible assets in relation to equity was 50.9 per cent,

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>1</th>
<th>2</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 CC</td>
<td>0.141</td>
<td>0.024</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 INT</td>
<td>0.516</td>
<td>0.869</td>
<td>-0.05</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 PER</td>
<td>0.112</td>
<td>0.354</td>
<td>-0.07**</td>
<td>0.09**</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 SIZ</td>
<td>9.530</td>
<td>1.659</td>
<td>0.21***</td>
<td>0.11***</td>
<td>0.03</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 LEV</td>
<td>0.561</td>
<td>0.185</td>
<td>0.10***</td>
<td>0.24***</td>
<td>0.06</td>
<td>0.11***</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>6 INP</td>
<td>0.385</td>
<td>0.487</td>
<td>-0.11***</td>
<td>0.17***</td>
<td>0.02</td>
<td>0.27***</td>
<td>-0.10***</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Notes: CC = creative corporate culture; INT = intangibility; PER = corporate performance; SIZ = company size; LEV = leverage; INP = innovative potential. *, ** and *** correspond to the 10%, 5% and 1% level of significance, respectively.

Source: The authors.

Table IV. Descriptive statistics and correlation matrix.
with considerable variability. The most variable parameter (354.0), however, was corporate performance, with an average return of 11 per cent for shareholders.

The correlation analysis showed that \( CC \) was correlated with \( INT, PER, SIZ \) and \( LEV \), though only weakly. On the other hand, \( INT \) was correlated with all the continuous study variables. The correlation coefficients were in the range from \(-0.07 \) to \( 0.24 \).

The existence of correlations between the study variables is suggestive of multicollinearity. To minimize these effects, we performed regression analyses with panel data and robust errors. Table \( V \) shows the results of the econometric models.

As shown in Table \( V \), all the statistical models were significant at the 1 per cent level. The models differed with regard to explanatory power \( (R^2) \), with the best result being observed for model 4 (19.6 per cent). In model 1, \( CC \) was negative and significant, suggesting it is a determinant for the level of intangibility.

In Model 2, in which \( PER \) is a dependent variable, a significant and negative association was observed between \( CC \) and \( PER \). According to RBV, culture is a resource capable of creating a competitive advantage reflected in corporate performance. In the present sample, \( PER \) was indeed affected, but in the opposite direction. This disagrees with earlier empirical studies in which the association between creative culture and performance was positive (Fekete and Bocskei, 2011; Han, 2012).

Model 3 shows no significant association in any estimation, indicating that the efficiency of the management of shareholders’ investments (i.e. returns) was not affected by positive or negative changes in the level of intangibility. This finding contradicts Decker et al. (2013) and Miranda et al. (2013).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Models (OLS)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td>( CC )</td>
<td>-0.240** (0.048)</td>
</tr>
<tr>
<td>( INT )</td>
<td>0.015 (0.870)</td>
</tr>
<tr>
<td>( SIZ )</td>
<td>0.065 (0.513)</td>
</tr>
<tr>
<td>( LEV )</td>
<td>0.015 (0.870)</td>
</tr>
<tr>
<td>( REG )</td>
<td>0.075 (0.716)</td>
</tr>
<tr>
<td>( EFCR )</td>
<td>-0.123*** (0.000)</td>
</tr>
<tr>
<td>( GDP )</td>
<td>-5.07e-06*** (0.000)</td>
</tr>
<tr>
<td>( LEG_{com} )</td>
<td>0.135 (0.515)</td>
</tr>
<tr>
<td>( LEG_{ec} )</td>
<td>0.002 (0.991)</td>
</tr>
<tr>
<td>( ECO )</td>
<td>0.018 (0.513)</td>
</tr>
<tr>
<td>( INP )</td>
<td>0.031*** (0.043)</td>
</tr>
<tr>
<td>Intercept</td>
<td>0.013 (0.832)</td>
</tr>
<tr>
<td>( N )</td>
<td>702</td>
</tr>
<tr>
<td>( F )</td>
<td>12.23***</td>
</tr>
<tr>
<td>( p-value )</td>
<td>0.000</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.189</td>
</tr>
</tbody>
</table>

**Table V.** Regression (OLS) of creative culture, intangibility and corporate performance

**Notes:** \( CC \)=creative corporate culture; \( INT \)=investments in intangible assets; \( PER \)=corporate performance expressed as return on equity; \( SIZ \)=company size estimated by the \( \ln \) of assets; \( LEV \)=leverage expressed as the ratio between liabilities and assets; \( REG \)=regional location; \( EFCR \)=effect of crisis; \( GDP \)=effect of country crisis; \( LEG_{com} \)=common law country; \( LEG_{ec} \)=civil law country; \( ECO \)=country’s level of economic development; \( INP \)=dummy variable for innovative potential. Estimated coefficients and standard errors robust to heteroscedasticity (in parentheses). *, ** e *** *, ** and *** correspond to the 10%, 5% and 1% level of significance, respectively.

**Source:** The authors
Decker et al. (2013) evaluated the influence of intangible assets on profitability and found that return on equity was higher for tangible asset-intensive than intangible asset-intensive firms. Miranda et al. (2013) also observed a negative association between intangible assets and return on equity in medium-high technology-intensive firms. This, in turn, disagrees with Perez and Famá (2006) who reported better performance for intangible asset-intensive firms and a positive association between intangibility and persistent performance.

Testing the relationship between creative corporate culture, intangibility and performance, Model 4 indicates that PER was influenced negatively by CC and positively by INT. The results negate a mediating role for INT between CC and PER as the mediator variable had no effect on performance (Model 3) and therefore does not meet the criteria reproduced in Figure 1.

It should be pointed out that in our sample, EFCR had no effect on creative corporate culture (Model 1), a finding supported by the literature, according to which crises and financial restrictions at the organizational level have a positive impact on creativity as firms resort to innovation in the hope of turning business around (Yang and Hung, 2015).

Thus, the results of our study, considering the sample and time frame adopted, did not confirm the tenets of RBV which defines creative corporate culture and intangible assets as sustainable strategic resources capable of directly impacting corporate performance (Carvalho et al., 2010; Fekete and Böcskei, 2011; Flamholtz and Randle, 2012; Han, 2012). In other words, the empirical evidence gathered here is insufficient to confirm the study hypotheses.

4.2 Sensitivity analysis

We performed regression analyses estimated with GLS and 2SLS to correct correlation effects between the residues and between the residues and the independent variables (GLS) and to control for problems of endogeneity (2SLS). The results of the regression in the different estimations, with and without control variables, are shown in Table VI.

In general, the regression analyses of all the proposed study models with control variables, estimated with GLS and 2SLS, yielded results similar to the models estimated with OLS (Table V). The differences are mainly with regard to the level of significance of the tests

<table>
<thead>
<tr>
<th>Models</th>
<th>Without control variables</th>
<th>With control variables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coef.</td>
<td>z</td>
</tr>
<tr>
<td>PANEL A (generalized least squares – GLS)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CC → INT</td>
<td>−2.07</td>
<td>−1.47</td>
</tr>
<tr>
<td>CC → PER</td>
<td>−1.08</td>
<td>−1.78*</td>
</tr>
<tr>
<td>INT → PER</td>
<td>0.04</td>
<td>2.36**</td>
</tr>
<tr>
<td>CC+INT → PER</td>
<td>−0.95</td>
<td>−1.65*</td>
</tr>
<tr>
<td>PANEL B (two-stage least squares – 2SLS)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CC → INT</td>
<td>−2.10</td>
<td>0.038**</td>
</tr>
<tr>
<td>CC → PER</td>
<td>−1.06</td>
<td>0.034**</td>
</tr>
<tr>
<td>INT → PER</td>
<td>0.03</td>
<td>0.645</td>
</tr>
<tr>
<td>CC+INT → PER</td>
<td>−0.98</td>
<td>0.013**</td>
</tr>
</tbody>
</table>

Notes: CC = creative corporate culture; INT = investments in intangible assets; CC → INT = dynamic variable between CC and INT; PER = performance expressed as return on equity. The control variables included SIZ, LEV, REG, EFCR, GDP, LEG_com, LEG_civ, ECO and INP. Estimated coefficients and standard errors robust to heteroscedasticity. *, ** and *** correspond to the 10%, 5% and 1% level of significance, respectively.

Source: The authors
related to the coefficients and to the models. Creative culture could only explain 0.4 per cent of the level of intangibility and 0.6 per cent of corporate performance, but the explanatory power \( R^2 \) rose to 7.75 per cent when \( CC \) and \( INT \) were analyzed in combination. This is evidence that creative corporate culture and intangibility account for only a small part of corporate performance, as reported by Fekete and Böcskei (2011) and Han (2012).

To verify the robustness of our results, we performed a regression analysis of the study variables according to continent (Latin America, Europe, Asia). Table VII shows the results of the analysis.

The results show a significant and negative effect of creative corporate culture on performance in firms from Asia and Europe (especially the latter). The effect of intangibility on performance was only significant for European firms. The dynamic variable \( CC \times INT \) yielded similar results for Asia and Europe.

Our evidence suggests that creative culture has a negative impact on the level of intangibility and corporate performance, the level of intangibility is not significantly reflected in corporate performance and the effect of the combination of creative culture and intangibility on corporate performance is significantly greater than the effect of each factor.

It should be pointed out that, in European firms, intangibility met the criteria of Baron and Kenny (1986) and may therefore be considered a mediator between creative corporate culture and corporate performance. In other words, the relationships between \( c, a \) and \( b \) (Figure 1) were significant at the level of “complete mediation” \( (c = 0) \), as demonstrated by the fact that \( CC \) was non-significant in Model 4. Thus, the total effect of creative culture on corporate performance was \(-1.92 (c' = c + ab)\), whereas the direct effect of creative culture on corporate performance was \(-1.01 (c' = c - ab)\). This is an indication that higher levels of intangibility tend to reduce performance in European firms.

### Table VII.
Regression of creative culture, intangibility and corporate performance by continent

<table>
<thead>
<tr>
<th>Models</th>
<th>Without control variables</th>
<th>With control variables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coef.</td>
<td>p-value</td>
</tr>
<tr>
<td><strong>PANEL A – Latin America (228 observations)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( CC \rightarrow INT )</td>
<td>−0.332</td>
<td>0.858</td>
</tr>
<tr>
<td>( CC \rightarrow PER )</td>
<td>0.352</td>
<td>0.629</td>
</tr>
<tr>
<td>( INT \rightarrow PER )</td>
<td>−0.229</td>
<td>0.115</td>
</tr>
<tr>
<td>( CC+INT \rightarrow PER )</td>
<td>0.276</td>
<td>0.638</td>
</tr>
<tr>
<td><strong>PANEL B – Asia (234 observations)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( CC \rightarrow INT )</td>
<td>−3.317</td>
<td>0.031**</td>
</tr>
<tr>
<td>( CC \rightarrow PER )</td>
<td>−2.012</td>
<td>0.008***</td>
</tr>
<tr>
<td>( INT \rightarrow PER )</td>
<td>−0.202</td>
<td>0.162</td>
</tr>
<tr>
<td>( CC+INT \rightarrow PER )</td>
<td>−2.720</td>
<td>0.003***</td>
</tr>
<tr>
<td><strong>PANEL C – Europe (240 observations)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( CC \rightarrow INT )</td>
<td>−5.878</td>
<td>0.002***</td>
</tr>
<tr>
<td>( CC \rightarrow PER )</td>
<td>−2.302</td>
<td>0.063*</td>
</tr>
<tr>
<td>( INT \rightarrow PER )</td>
<td>0.202</td>
<td>0.017**</td>
</tr>
<tr>
<td>( CC+INT \rightarrow PER )</td>
<td>−1.133</td>
<td>0.117</td>
</tr>
</tbody>
</table>

**Notes:** \( CC \) = creative corporate culture; \( INT \) = investments in intangible assets; \( CC \rightarrow INT \) = dynamic variable between \( CC \) and \( INT \); \( PER \) = performance expressed as return on equity. The control variables included SIZ, LEV, REG, EFCR, GDP, LEG_com, LEG_civ, ECO and INP. Estimated coefficients and standard errors robust to heteroscedasticity. *, ** and *** correspond to the 10%, 5% and 1% level of significance, respectively.

**Source:** The authors
5. Conclusions
In this study, we investigated the relationship between creative corporate culture, intangibility and corporate performance in 117 foreign firms traded on the NYSE between 2009 and 2014. All the firms in the sample issued annual financial reports using the 20-F form.

Initially, we conducted an analysis of the levels of creative culture, intangibility and corporate performance in the sampled firms in light of institutional aspects. On the average, all three variables were higher in European firms than in Latin American or Asian firms. The descriptive analysis revealed great variability among the firms, especially with regard to creative culture. On the average, in over half of the firms (51.6 per cent), the equity disclosed in company reports was intangible.

Our results show that creative culture was negatively associated with intangibility (i.e. investments in intangible assets). Based on this finding, $H1$ was rejected. However, it is worth highlighting that firms in countries with advanced economies made greater investments in intangible assets. $H2$ was significant, but in the opposite direction to our expectations, and so was rejected as well. In addition, we found no evidence of a relationship between the levels of intangibility and corporate performance, making it necessary to reject $H3$. Finally, when creative culture and intangibility were combined into a dynamic variable, corporate performance was found to be negatively affected. $H4$ was therefore rejected.

The sensitivity analysis confirmed the robustness of the findings. When analyzed according to continent, the negative effect of creative culture on intangibility and performance was particularly strong in European firms, although intangibility as a mediator attenuated the negative effect of creative culture on performance.

In the perspective of RBV, corporate culture is a strategic intangible resource which may be converted into a potential competitive advantage. Thus, firms with a strong creative culture would tend to invest in innovation, improvement of productive processes and expansion in R&D, which, in turn, would lead to a greater intangible asset structure and, consequently, higher levels of intangibility and performance.

However, the findings of the present study did not confirm our expectations for a positive association between creative culture, intangibility and corporate performance. Simply put, in the sampled firms (foreign firms traded on NYSE), and in the period covered by our data (2009-2014), creative culture did not promote intangibility or improve corporate performance.

The negative effect of creative culture on performance may be explained by the constant culture adaptations required by the dynamism of the market; indeed, the NYSE is one of the most competitive markets in the world.

The fact that our hypotheses were rejected does not detract the relevance of the study. As shown by many authors, “negative” findings represent as important contribution to the discussion of the theory as “positive” findings (Bettis, 2012; Meyer et al., 2017). Our results suggest, among other things, that the relationship between creative culture, intangibility and corporate performance may be mediated by variables not evaluated in this study ($R^2$) and, considering the significant influence of national culture on corporate culture, that future studies may need to focus on specific markets (Cameron et al., 2006).

Although the study hypotheses were eventually rejected, our analyses are relevant to both the academic setting and the market because of the organizational and institutional aspects evaluated, especially in relation to intangibility and creative culture, and in view of the unique cross-cultural approach adopted. Within the corporate setting, the study provides a spectrum of stakeholders with tools to identify the profile of foreign firms traded on the NYSE.
Despite the methodological rigor and the importance of the findings of this study, our results cannot be extrapolated to other groups of firms. Rather, further studies with different sampling strategies and/or focus on specific markets/firms are necessary. Likewise, different metrics for intangibility and performance (operational, market, non-financial, etc.) might be tested, as suggested by the finding of different results for different subsets of firms. Moreover, it might be interesting to clarify why intangibility was only a mediator between creative culture and corporate performance among European firms. Finally, the existence of practices of isomorphism in financial reporting may be worth investigating, considering the small variation in creative culture word roots observed in the sampled company reports.

References


Further reading


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Misty consensus, messy dissensus: paradoxes of the Brazilian innovation policies

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Instituto Brasiliense de Direito Público, Brazil

Abstract

Purpose – The purpose of this paper is to show that the wide acknowledgement of the association between innovation and economic and social development and of the importance of innovation policies has formed a kind of “misty consensus” hardly contested in Brazil. However, the innovation policies adopted in the country lack an institutional framework to support their implementation, marking what is called in this paper a “messy dissensus”.

Design/methodology/approach – It is argued that the reasons why the science, technology and innovation (ST&I) policies have failed to contribute more effectively increasing Brazilian technological efforts have less to do with the policies themselves and more to do with their detachment from the institutional framework used to implement them.

Findings – It is shown that this institutional framework: (i) is barely adherent to the perception of the systemic nature of the innovation process; (ii) does not create enough incentives for bureaucrats in public institutions to allocate resources in the industrial sector; (iii) encourages the pulverization of resources and the consequent loss of focus, which may reduce the efficiency of the adopted policies; (iv) encourages the replication of models and priorities usually adopted in contexts that fail to match the Brazilian reality.

Originality/value – In this paper, the focus is on the obstacles that undermine the potential of ST&I policies to contribute more effectively to the improvement of the Brazilian innovation indicators. It is argued that these obstacles have less to do with the innovation policies themselves and more to do with their detachment from the institutional framework used to implement them. This institutional framework includes not only the formal and legal rules but also informal social norms that govern individual behavior and structure social interactions.

Keyword Innovation policies

Paper type Research paper

1. Introduction

The wide acknowledgement of the association between innovation and economic and social development has been motivating a growing presence of this subject in the public policies worldwide agenda during recent decades. Unlike the macroeconomic prescriptions – which are frequently subject to irreconcilable divergences – innovation policies form a kind of “misty consensus”, as antagonists to their adoption are hardly found. In fact, innovation policies have been considered very important not only by politicians and bureaucrats but
also by society as a whole, including, obviously, academic communities and business associations. Furthermore, conflicts usually observed between employers and employees are hardly observed in this case.

In Brazil, since the 1990s, the recurrent comparisons between the local economy and the fast growing Asian ones—especially South Korea—led to the crystallization of the perception that it would be necessary to provide more incentives for innovation in the industrial sector. That kind of perception relied on the fact that Brazil had managed to catch up in scientific production but failed to increase its technological production significantly. This essentially consensual perception led to the adoption, since the 1990s, of innovation policies explicitly focused on the industrial sector.[1]

The spread of innovation policies focused on the industrial sector and the relatively high rates of growth of the gross domestic product (GDP) in the period before 2014 contributed to create an expectation that a leap in the innovation indicators would show up in the results of the last edition of the Brazilian Innovation Survey (PINTEC).[2] Issued by the Brazilian Institute of Geography and Statistics (IBGE) according to the Organization for Economic Co-operation and Development (OECD, 2005) guidelines, the last edition of the survey covers the period between 2012 and 2014. However, as shown in Section 2 of this work, in spite of some advances, results somehow frustrated the expectations. When compared to a set of selected countries used as reference, the relatively poor results obtained in Brazil suggest some kind of “red queen race”, which refers to a quotation extracted from Lewis Carroll’s *Through the Looking-Glass*.[3] Obviously, public policies are not the only factor that explains the behavior of innovation indicators. In the Brazilian case, in addition to the policies, there is evidence that the relatively low technological efforts of the industrial sector are associated to the following structural and systemic factors:

- The local industrial structure, which is relatively less concentrated in high tech sectors than the ones in more developed countries. Feldmann (2009, p. 136) shows that “even the big Latin American companies do not belong, in general, to high technology sectors”[4].
- The higher share of multinational firms in high tech industries in Brazil, as these firms tend to concentrate their technological efforts in their countries of origin (De Negri, 2012).
- The high levels of capital cost in Brazil, which makes innovation investments less attractive to the industrial sector when their risks are taken into account[5].
- The relatively low exposure of the Brazilian firms to international competition[6].

Given their structural and systemic nature, these factors do not change abruptly. However, the spread of the innovation policies focused on the industrial sector and the positive economic environment created the expectation of an improvement in the indicators which in fact did not happen. In this work, however, the focus is on the obstacles that undermine the potential of science, technology and innovation (ST&I) policies to contribute more effectively to the improvement of the Brazilian innovation indicators[7]. It is argued that these obstacles have less to do with the innovation policies themselves and more to do with their detachment from the institutional framework used to implement them. This institutional framework includes not only the formal and legal rules but also informal social norms that govern individual behavior and structure social interactions. The basic argument of this work—which is detailed in Section 3—is that a “messy dissensus” creates institutional obstacles to the full effectiveness of consensual innovation policies[8]. To support this proposition, a set of data and arguments are systematized in this paper.
2. Background: innovation policies and innovation indicators in Brazil

Since the 1990s, Brazil adopted a set of innovation policies explicitly focused on the industrial sector. The adoption of those policies was concurrent with the emergence of the national innovation system concept in the theoretical field. The concept originally proposed by Freeman (1987) and Lundvall (1988) includes, in its broad perspective, several subsystems which are interconnected and influenced by the geopolitical, cultural, social, political, economic and local contexts. Thus, as stressed by Cassiolato and Lastres (2008), a more complete view of the national innovation system is not limited to a narrow perspective which would associate it only to the production/innovation and the capacity-building, research and technological services subsystems. In fact, the national innovation systems have increasingly recognized typically institutional aspects which involve, for example, rules, norms and incentives. This perception explains why this work adopts a broad perspective of the national innovation systems. Cassiolato and Lastres (2008) argue that since the early 1990s, the concept of national innovation system “has been used as an analytical tool and as a framework for policy analysis in both developed and underdeveloped countries”. That is essentially the context in which the so-called systemic model of innovation – which adopts a more broad and complex conception of the innovation phenomenon – spread among policy-makers.

As it considers the simultaneous influence of organizational, institutional and economic factors on the processes of generation, diffusion and adoption of ST&I, the systemic model is broader than the linear one, which, according to its stylized description, assumes that innovation results from sequential steps from basic research to applied research and then to development, production and marketing. The policy implication of the linear model is, then, to create a public research infrastructure, as the firms would in a more or less spontaneous way benefit from the results of the activities performed in universities and research centers. A systemic approach, on the other hand, emphasizes interactions as a key condition to promote innovation in individual companies. As stressed by Johannessen (2009), the policy implication of the interactive model is that the emphasis on research must turn more towards relations among elements generating innovation systems at various system levels.

Given the complex nature of the innovation process, a systemic approach seems to be more realistic than a stylized model like the linear one. However, while the linear model is, at the same time, analytical (because it proposes a model that permits an interpretation of the reality) and prescriptive (because policy implications emerge from it immediately), the systemic model is predominantly analytical and less prescriptive. The less prescriptive nature of the systemic model explains why it is harder to extract concrete innovation policy instruments from it. Lundvall and Borrás (2005, p. 615), for instance, propose a framework where they report, in sequence, policy instruments aimed at science, at technology and at innovation. Those instruments form a kind of sequence of layers, as the technology policies include the science policies and the innovation policies include the technology policies. However, in the case of the innovation policies, the reported instruments seem more related to a “wish list” than to concrete actions which could be immediately implemented. This is the case, for example, of actions like improving the access to the information society or improving the social capital for regional development. On the other hand, the instruments associated to the science and technology policies – such as public funding of research activities, creation of public research centers or public procurement – seem much more directly applicable.

In Brazil, the spreading of the systemic model since the 1990s was concurrent with the adoption of several innovation policies focused on the industrial sector. Thus, in 1993, Law
n. 8.661/1993 was enacted to establish the conditions for the concession of fiscal incentives for the technological capacitation of the agricultural and industrial sectors. In spite of the reduced number of firms that benefited from that law (largely because of the rigid and bureaucratic procedures to access the fiscal incentives), it might be considered a turning point in the Brazilian ST&I policies as it explicitly focuses on the industrial sector. In the late 1990s, the so-called Brazilian science and technology sector-specific funds were established aiming at providing more stable financial resources to ST&I activities and at increasing the total amount directed to R&D activities in the industrial sector. Those funds aimed at creating an institutional environment that was more favorable to the deepening of the cooperation between public agents and the industrial sector (Morais, 2009, p. 67). The enactment of the so-called Innovation Law in 2004 (Law n. 10.973/2004) aimed to create instruments to regulate the relationship between universities and research centers, on one hand, and the industrial sector, on the other hand. Besides, the Innovation Law created the legal background for the allocation, by the Brazilian Innovation Agency (FINEP) of grants to business enterprises, which were, until then, forbidden (or at least controversial) in Brazil. The following year, the legal framework to provide fiscal incentives to R&D activities in Brazil was improved, as those incentives were included in the third chapter of the so-called “Lei do Bem” (Law n. 11.196/2005). Since the mid-2000s, the FINEP launched several public programs and calls to support business enterprises and, in the late 2000s, Law n. 12.349/2010 created the legal framework for the use of public procurement as an instrument for supporting innovation efforts made by business enterprises. Finally, the Constitutional Amendment n. 85/2015 altered several constitutional provisions to improve the articulation between the state and the public and private research institutions and to broaden the set of institutions eligible for public support for research. Given all those movements, the Brazilian innovation policies may be considered modern and similar to the ones adopted in more developed countries. Besides, there is considerable evidence that those instruments have positive and significant impacts on the technological efforts firms make. Araújo et al. (2012), for example, used sophisticated statistical methods to control for the selection bias typically observed in the analysis of innovation policies and concluded that the access to the sector-specific funds has positive and significant impacts on the firms’ R&D expenditures.

However, the advances observed in the legal framework were not fully reflected in the increasing of the technological efforts of the industrial sector in the country. In fact, between 2000 and 2015, and in spite of the peak in the mid 2010s, business enterprise R&D expenditures (taken as a proxy of the technological efforts of the industrial sector) in Brazil remained fairly stable, as shown in Figure 1. The data used to plot Figure 1 were calculated on the basis of the Brazilian innovation surveys, which are performed every three years. For the remaining years, the Ministry of Science, Technology, Innovation and Communications (MCTIC is the acronym in Portuguese) and the former Ministry of Science, Technology and Innovation (MCTI is the acronym in Portuguese) either interpolated the business enterprise R&D expenditures or extrapolated them for the years after the last available one[11]. Even when those caveats are considered, the fact is that no significant increase of the ratio between the business enterprise R&D expenditures and the GDP was observed in Brazil during the period shown in the figure. In particular, when the period between 2005 and 2013 is considered (as a reference to comparisons with other countries shown in Table I), there was a small decrease in the ratio (from 0.52 to 0.51 per cent or 0.01 percentage point).

The Brazilian numbers strongly contrast with the increase of the business enterprise R&D investments in the set of selected countries shown in Table I.
As shown above, there was a generalized growth of the ratio between business enterprise R&D expenditures and GDP, as all the countries or groups of countries in Table I (except for Brazil) had positive variations in that indicator. In the case of the USA (a large country with relatively high business enterprise R&D expenditures and a diversified economy), there was an increase of almost 0.20 percentage points. A similar variation can be observed in the case of the European Union, where R&D investments are smaller than the ones in the USA. Countries traditionally marked by lower business enterprise R&D expenditures and where institutions are more similar to the ones in Brazil (Portugal and Spain) also increased their indicators between 2005 and 2013. In the case of South Korea, the higher level of business enterprise R&D expenditures in 2005 did not prevent an increase of 1.24 percentage points. The numbers regarding the USA, the European Union and South Korea show that even countries located on the technological frontier managed to increase their ratio between business enterprise R&D expenditures and GDP. Finally, in the case of China, a clear catch up process took place, as the aggregation of modern sectors to the local economy has been contributing to a significant increase in the local business enterprise R&D expenditures. In short, Table I clearly confirms the “red queen race” mentioned in the introduction of this paper.

Table I.
<table>
<thead>
<tr>
<th>Country</th>
<th>2005 (per cent)</th>
<th>2013 (per cent)</th>
<th>Variation (p.p.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>0.52</td>
<td>0.51</td>
<td>−0.01</td>
</tr>
<tr>
<td>United States</td>
<td>1.73</td>
<td>1.92</td>
<td>0.19</td>
</tr>
<tr>
<td>European Union (19 countries)</td>
<td>1.12</td>
<td>1.34</td>
<td>0.22</td>
</tr>
<tr>
<td>European Union (28 countries)</td>
<td>1.10</td>
<td>1.29</td>
<td>0.19</td>
</tr>
<tr>
<td>Portugal</td>
<td>0.29</td>
<td>0.63</td>
<td>0.34</td>
</tr>
<tr>
<td>Spain</td>
<td>0.59</td>
<td>0.67</td>
<td>0.08</td>
</tr>
<tr>
<td>South Korea</td>
<td>2.02</td>
<td>3.26</td>
<td>1.24</td>
</tr>
<tr>
<td>China</td>
<td>0.90</td>
<td>1.54</td>
<td>0.64</td>
</tr>
</tbody>
</table>

Source: Elaborated by the author based on Eurostat data available at: https://goo.gl/HoiQNW
3. The dissensus: the institutional obstacles

As shown in the previous section, the slow evolution of the Brazilian innovation indicators in a context marked by the spreading of innovation policies focused on the industrial sector and by reasonably high GDP growth rates (before 2014) suggests the existence of some kind of paradox, especially if the Brazilian data are confronted with the ones of other countries in the same period. Although innovation policies are far from being capable of explaining by themselves the path followed by the national ST&I indicators, this section discusses the obstacles that limit the potential of those policies to contribute more effectively to the improvement of the Brazilian innovation indicators. The basic underlying hypothesis is that these obstacles have less to do with the innovation policies themselves and more to do with their detachment from the institutional framework used to implement them. This detachment becomes more evident in the four aspects discussed in the subsections below.

3.1 Difficulties in implementing the systemic model

The first aspect of the detachment of the innovation policies from the institutional framework used to implement them has to do with the conceptual basis on which those policies rely. Although formulated according to a systemic model of the innovation process, the policies strongly rely on instruments that have much more to do with the linear model. As shown in Section 2, the linear model is more prescriptive than the systemic one, as the focus of the policies is placed on the scientific production, which would spin off to the industrial sector. Obviously, this kind of prescription is barely applicable to policies formulated considering the systemic model of innovation (Cavalcante, 2009). In spite of that, the instruments used in the “systemic policies” are essentially the same as those used in the “linear policies”. That is the case, for example, of the grants directed to researchers, which remain strongly based on the scientific production (papers published) and only marginally consider the technological production (patents, for example) of the candidate.

This kind of incentive obviously helps to explain the divergence of the Brazilian scientific and technological indicators. In fact, the Brazilian share in the number of scientific papers indexed by the Scopus – which may be considered a proxy for the scientific production – grew from 1.18 per cent, in 2000 to 2.57 per cent in 2015 (Figure 2).

Although the share in 2015 was still low as compared to countries like the USA (22.26 per cent) and even some BRICS countries (Russian Federation, 2.59 per cent; India, 5.11 per cent; China, 17.83 per cent; South Africa, 0.72 per cent), it is quite clear that there has been a significant increase in the Brazilian scientific production over the past 15 years.

On the other hand, the country’s share in the world patents granted by the US Patent and Trademark Office (USPTO) – which, in spite of its traditional methodological limitations may be considered a proxy for the technological production – was restricted to around 0.1 per cent in the mid-2010s (Figure 3).

There seems to have been an increase since 2011 (from 0.06 to 0.11 per cent). However, in 2015, the number of patents granted to Brazilian residents reached 323, while some BRIC countries reached thousands (Russian Federation, 4,40; India, 3,355; China, 8,116; South Africa, 166). A look at USPTO data shows that Brazil has never gone beyond 400 patents per year.

The difficulties to put action into effect under the systemic view of the innovation process are confirmed by anecdotal, thought recurrent and hardly deniable, evidence. De Negri et al. (2009), for instance, show that only 1,831 (13.6 per cent) out of 13,433 projects supported by the sector-specific funds involve firms. Although those cooperative projects represent around 35 per cent of the total resources, the concentration of the resources in universities is quite evident. Accordingly, Kubota et al. (2012) show that the so-called CT-Info
(a sector-specific fund aimed at the information and telecommunication technologies) supported only 99 firms in the period between 2002 and 2007. This kind of result led the authors to suggest that the fund had been captured by what they call “the academy complex”. All the data reinforces the perception that the industrial sector still has only limited access to public resources for ST&I in Brazil. These difficulties are also explained by the proportionally larger emphasis the Brazilian support agencies put on scientific production as compared to technological production. In fact, the criteria the agencies such as

Source: Elaborated by the author based on MCTIC data available at: https://goo.gl/vWhse2

Figure 2. Brazilian share in the number of scientific papers indexed by Scopus, 2000-2015

Source: Elaborated by the author based on USPTO data available at: https://goo.gl/vWhse2

Figure 3. Brazilian share in the world patents granted by the United States Patent and Trademark Office (USPTO)
the National Council for Scientific and Technological Development (CNPq) and the Coordination for the Improvement of Higher Level Personnel (CAPES) use to select projects create incentives to publish papers, but not to deposit patents, for example (De Negri and Cavalcante, 2013).

In spite of this more general framework, there are some successful cases marked by high interaction levels between universities, research centers and firms. The successful cases of aircraft technologies, agriculture innovation and offshore oil extraction observed in Brazil seem to reinforce this perception. In fact, the research networks around Embraer, Embrapa and Petrobras have been achieving significant outputs. Formerly a public company, Embraer has become one of the world’s two leading producers of regional jet passenger aircraft. The Brazilian Agricultural Research Corporation (Embrapa) is a public company which provides solutions for the development of Brazilian agribusiness through technology generation and transfer. Finally, Petrobras, one of the largest oil companies in the world, is controlled by the Brazilian federal government and is a world leader in offshore oil exploitation technology. All those cases are path dependent and have been marked by a long-term involvement of both government and industry and some sort of institutional network. As a result, they are not easily replicable in other contexts.

3.2 Low incentives to direct resources to the industrial sector
In spite of the misty consensus about the necessity of directing resources to R&D activities in the industrial sector in Brazil, it is much more socially accepted that the government should direct its resources to universities and public research centers. In fact, before the enactment of the “Innovation Law”, it was forbidden – or, at least, legally controversial – to direct grants to R&D projects carried out by firms. In general, bureaucrats responsible for the allocation of this kind of resource are afraid of being accused of favoring firms in exchange for any kind of benefit. As their salaries and their possibilities of getting a promotion are not directly associated to the effectiveness of the innovation policies focused on the industrial sector, bureaucrats would rather direct resources to more socially accepted projects in nonprofit organizations. This seems to be valid even when there are good projects and firms are capable of implementing them.

This is Viotti’s (2008, p. 161, translated by the author) point of view, to whom:

Be it because of their own nature, be it because of the traditional and institutionalized practices, public agencies may find it easier to deal with and support universities and research centers, but they find it very hard to do something similar when firms are involved. This difficulty has especially to do with the efforts to implement the new instruments of the policies which are aimed at innovation, as in the case of grants and of public procurement of new products and processes.

Accordingly, public development banks, which for decades provided credit to the industrial sector in Brazil, have difficulties in allocating resources to innovation activities, as it is harder to estimate future cash flows and these projects usually have less collateral than more traditional ones. As a result, development banks have fewer incentives to direct their resources to innovation projects. Even in the case of the Brazilian Innovation Agency (FINEP), which focuses on innovation projects, there might be cases where credit operations are troubled by the projects higher risk levels.

Although this aspect lacks objective evidence (bureaucrats would hardly explicitly recognize that their decisions may not be the best for their institutions), there seems to be a rationale for it. Risk aversion of bureaucrats – whose wages and possibilities of getting a promotion are not related to their focus on innovation – seems to be the underlying reason for this behavior.
Another aspect of the detachment of the innovation policies from the institutional framework used to implement them are the obstacles to establishing priorities for these policies. In general, bureaucrats responsible for the allocation of resources to financing innovation activities have more incentives to pulverize the resources over a large number of small projects than to concentrate them in a smaller, but more coherent, number of projects. That is essentially a consequence of the way the bureaucrats are legitimized. As bureaucrats rely on the approval of the “scientific community”, they prefer to contemplate each researcher with a small amount of resources instead of allocating them to a smaller number of larger projects. In short, they prefer to have “twenty little friends” and not “nineteen little enemies and one big friend”. As a result, innovation policies tend to be shaped by the demand and not by the focus on strategic areas and the projects tend to lack scale and continuity.

According to data presented by De Negri et al. (2009), the average value of the projects financed by the sector-specific funds between 2000 and 2008 was US$140 thousand. Although it might be considered relatively high in some more traditional sectors marked by incremental innovations, it is unlikely that this amount is enough to carry out competitive projects in areas like biotechnology and nanotechnology, which tend to require large scale laboratories. Table II, built upon data presented by De Negri et al. (2009), shows the average project value for each sector-specific fund in the period 2000-2008.

As shown in the table, the average project value ranges from US$52 thousand, in the case of the water resources fund, to US$2 million, in the case of the telecommunications fund.

### Table II.
Number of projects, total and average value, sector funds, 2000-2008

<table>
<thead>
<tr>
<th>Sector Fund</th>
<th>No. of projects</th>
<th>Total value (R$ thousand)</th>
<th>Average value (R$ thousand)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aeronautics</td>
<td>47</td>
<td>40,975</td>
<td>872</td>
</tr>
<tr>
<td>Agribusiness</td>
<td>683</td>
<td>37,112</td>
<td>54</td>
</tr>
<tr>
<td>Amazônia</td>
<td>78</td>
<td>19,077</td>
<td>245</td>
</tr>
<tr>
<td>Waterborne transport</td>
<td>57</td>
<td>12,149</td>
<td>213</td>
</tr>
<tr>
<td>Biotechnology</td>
<td>189</td>
<td>22,904</td>
<td>121</td>
</tr>
<tr>
<td>Energy</td>
<td>640</td>
<td>81,605</td>
<td>127</td>
</tr>
<tr>
<td>Space technology</td>
<td>6</td>
<td>1,812</td>
<td>302</td>
</tr>
<tr>
<td>Water resources</td>
<td>786</td>
<td>41,237</td>
<td>52</td>
</tr>
<tr>
<td>Informatics</td>
<td>524</td>
<td>35,356</td>
<td>67</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>811</td>
<td>354,264</td>
<td>437</td>
</tr>
<tr>
<td>Mineral resources</td>
<td>161</td>
<td>12,356</td>
<td>77</td>
</tr>
<tr>
<td>Oil</td>
<td>1,228</td>
<td>112,272</td>
<td>91</td>
</tr>
<tr>
<td>Health</td>
<td>424</td>
<td>27,638</td>
<td>65</td>
</tr>
<tr>
<td>Transport</td>
<td>9</td>
<td>1,678</td>
<td>186</td>
</tr>
<tr>
<td>Transversal projects</td>
<td>5,854</td>
<td>494,891</td>
<td>85</td>
</tr>
<tr>
<td>Telecommunications</td>
<td>54</td>
<td>108,218</td>
<td>2,004</td>
</tr>
<tr>
<td>FNDCT</td>
<td>707</td>
<td>79,288</td>
<td>112</td>
</tr>
<tr>
<td>Other sources</td>
<td>242</td>
<td>48,824</td>
<td>202</td>
</tr>
<tr>
<td>Grants</td>
<td>330</td>
<td>281,025</td>
<td>852</td>
</tr>
<tr>
<td>“Horizontal fund” (&quot;green and yellow&quot;)</td>
<td>603</td>
<td>70,725</td>
<td>117</td>
</tr>
<tr>
<td>Total</td>
<td>13,433</td>
<td>1,883,406</td>
<td>140</td>
</tr>
</tbody>
</table>

**Note:** Values originally in Brazilian Reals (BRL) converted to US$ using the average exchange rate of the period 2000-2008

**Source:** Elaborated by the author based on data by De Negri et al. (2009)
3.4 Isomorphic innovation policies

Even if it was possible to avoid the pulverization of resources, the priorities established for the innovation policies would tend to be generic and to reproduce the priorities of other countries marked by different economic and social realities, leading to a kind of “isomorphism” analogous to the concept originally proposed by Meyer and Rowan (1977). According to those authors, organizations tend to keep their structures isomorphic aiming at legitimacy. This perception is similar to Keynes’s (1937, p. 214) proposition that “knowing that our own individual judgment is worthless, we endeavor to fall back on the judgment of the rest of the world which is perhaps better informed”.

In the specific case of the innovation policies, the bounded rationality, the bureaucrat’s need of legitimacy and the high levels of uncertainty are the reasons why policy-makers tend to replicate models and priorities shaped in other contexts. As bureaucrats responsible for the allocation of resources need to legitimize themselves in the eyes of the politicians, it is reasonable to assume that their decisions are oriented, to some degree, by their desire for acknowledgment. Evidences for this argument may be found in cross-country comparisons of ST&I priorities in OECD countries (OECD, 2010, p. 89 apud IEDI, 2011). The OECD segments those priorities into groups like “environment, climate change and oceans”, “health and life sciences” or “natural resources and energy”. Some countries declared more than ten ST&I priorities, and on several occasions, those priorities seem detached from local conditions or endowments. As a result, priorities established for Turkey, for example, do not seem much different from the ones established for Germany.

In Brazil, explicit industrial and ST&I policies usually present generic challenges (such as “to promote innovation and technological development”) or mention several of the topics used by the OECD to compare ST&I priorities. For example, the so-called “Plano Brasil Maior” issued in 2011 mentions national security (“complexo industrial da defesa”), sustainability, renewable energy sources, health, social challenges (“social inclusion”), engineering, nanotechnology, biotechnology, information and communication technologies and cultural diversity. In short, almost all priorities used by the OECD are somehow mentioned in the industrial and ST&I policy issued in 2011 (Brasil, n.d). In a country where the resources allocated to ST&I activities are proportionally lower than the resources allocated by OECD countries, the absence of clear priorities adherent to the local conditions might seriously harm the possible outcomes of the actions undertaken.

4. Concluding remarks

In this work, it has been argued that the wide acknowledgement of the association between innovation, economic and social development and the importance of innovation policies have formed a kind of “misty consensus” hardly contested in Brazil. However, the innovation policies adopted in the country lack an institutional framework to support their implementation, marking what was called a “messy dissensus”. Thus, the reasons why the ST&I policies failed to contribute more effectively to the increase of the Brazilian technological efforts have less to do with the policies themselves and more to do with their detachment from the institutional framework used to implement them, as the “messy dissensus” emerges at the moment these policies are put in march. To support that argument, it was shown that:
The institutional framework is barely adherent to the perception of a systemic nature of the innovation process. Although formulated according to a systemic model of the innovation process, the policies strongly rely on instruments which have much more to do with the linear model.

There are not enough incentives for bureaucrats in public institutions to allocate resources to the industrial sector because it is much more socially acceptable that the government should direct its resources to universities and public research centers.

The institutional framework encourages the pulverization of resources and the consequent loss of focus, which may reduce the efficiency of the adopted policies. As bureaucrats rely on the approval of the “scientific community”, they prefer to contemplate each researcher with a small amount of resources than to focus on a few strategic projects. As a result, innovation policies tend to be shaped by the demand and not by the focus on strategic areas and the projects tend to lack scale and continuity.

In practice, bureaucrats tend to adopt models and priorities established for contexts which are different from the Brazilian reality. Bounded rationality, bureaucrats’ need of legitimacy and high levels of uncertainty are the reasons why policy-makers tend to replicate models and priorities shaped in other contexts.

The update of the institutional framework used to implement the innovation policies in Brazil is, therefore, required to make these policies contribute more effectively to the increase of the country’s technological efforts. This update involves the creation of new incentives for bureaucrats and public institutions to allocate resources to the industrial sector. These incentives may include lighter and less bureaucratic procedures to direct resources to firms along with the creation of severe punishments in cases of misuse of resources. Policy evaluation should also be enhanced to allow the institutional framework to be calibrated. Finally, to avoid the pulverization of resources and foster the establishment of priorities more adherent to the local reality, transparency and accountability procedures could be applied to the innovation policies adopted in the country.

Notes
1. The main features of those policies are described in Section 2 of this work.
2. Between 2001 and 2010, average GDP growth rate reached 3.68 per cent, higher than the averages of the previous decades (2.61 per cent in the 1990s and 1.57 per cent in the 1980s). Between 2011 and 2013, growth rates reached 2.96 per cent (relatively high for Brazilian standards in the past decades). However, in 2014, 2015 and 2016 growth rates were only 0.5, –3.77 and –3.59 per cent.
3. “[…] it takes all the running you can do, to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that!”
4. Cavalcante and De Negri (2011) and Cavalcante (2014) analyze the relation between business enterprise R&D expenditures and industrial structure in Brazil and compare it to the more developed countries.
5. Treasury bills interest rates in Brazil at the end of 2015, 2016 and 2017 reached 14.25, 13.75 and 7.00 per cent, respectively. Even considering their downward trend and adjusting for inflation, those rates are very high, particularly when compared to the interest rates in several developed countries, which remained close to zero in the same period. Rates of return of innovation project require a spread over the risk-free capital costs. As a result, on several occasions, these projects are simply unfeasible in Brazil.
6. The ratio exports plus imports as a per cent of GDP, which is a usual measure of trade openness, is very low in Brazil (below 27 per cent according to the World Bank Data). Despite the limitations of this indicator – especially in the case of larger economies – it reinforces the perception that Brazilian firms are not exposed to international competition very much.

7. Authors like Pinto and Feldmann (2016, p. 66) argue that “the governments do not foster a proper institutional environment for the emergence of innovation”, but those authors do not focus on the institutional framework used to implement the innovation policies.

8. According to the Merriam-Webster’s dictionary, the first known use of the word “dissensus” in English dates back to 1962. We decided to use it (instead of the more commonly used “dissent”) to establish a contrast between the “misty consensus” and the “messy dissensus”.


10. Authors like Balconi, Brusoni and Orsenigo (2010), however, complain about the caricaturizing of the linear model, which is frequently presented in papers that discuss the systemic model. In additions, Mazzoleni and Nelson (2005) claim that the importance of the knowledge produced in universities and research institutes in the economic development process of a country has become increasingly higher.

11. In Brazil, in order to follow the Frascati Manual (OECD, 2002), the former MCTI calculated the business enterprise R&D expenditures as the sum of (i) private and state enterprises expenditures; (ii) other federal state enterprises expenditures; (iii) R&D expenditures in graduate programs in private institutions.

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Further reading


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Process philosophy’s potential contributions to innovation process research within organization studies

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Abstract

Purpose – The purpose of this paper is to discuss process philosophy’s potential contributions to understanding and investigation of innovation processes associated with organizational contexts.

Design/methodology/approach – The paper is a theoretical piece that examines the concept of process philosophy by relating it to the relevant literature and use of examples.

Findings – In particular, the authors develop some ideas and encourage future discussion around two aspects: process philosophy-oriented conceptualizations of innovation processes and process philosophy-oriented methods of investigation about innovation processes. The authors conclude that more process philosophy-oriented research of innovation processes must be conceptually multidimensional and methodologically performative.

Originality/value – There is a recent claim about a “process turn” within organization studies, which is partly represented by attempts to develop and apply a deeper meaning of process. The presentation of the concept is novel, and does add to the literature. These aspects provide clarification regarding implications of thinking and enquiring procedurally into innovation processes.

Keyword Research

Paper type Conceptual paper

Introduction

There is a recent claim about a “process turn” within organization studies (OS), which is partly represented by attempts to develop and apply a deeper meaning of process. (Van de Ven, 2007; Langley et al., 2013; Hernes, 2014). According to Hernes (2008, p. 10), “ideas are brought forward from early philosophical works and later sociological works, the aim being to explore the ontological and epistemological implications of taking different process views.” As a result of these debates, the organization is characterized by its processual

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Conflicts of interest: The authors declare no conflicts of interest.
nature, which is a view contrary to the traditional notion of the organization as a context where activities give rise to processes. Therefore, this new perspective affects the way in which an organization as a phenomenon of study shall be conceptualized, interpreted and analyzed and how the actors produce new rules, routines or practices at the same time while performing their activities (Hussenot and Missonier, 2016). Further, viewing an organization as a process implicates a review of concepts, theories and methods traditionally used on OS.

Helin et al. (2014, p. 3) define process philosophy as an umbrella under which there are process philosophers interested:

In understanding and showing how the world is a world of organizing, how things swell, how life – including human lives - never reaches the settlement we presume or hope it might.

According to a strong view, things are processes. In other words, the world is made of processes instead of things or stable-fixed substances. What we perceive as things are collections or constellations of dynamic and interactive processes. On the other side, according to a weak view, things are subordinated to processes in the sense that things depend on processes to be what they are. As pointed out by Olsen (2011), modern process philosophers tend to adhere to the weak view in the sense that a substance is not denied even though there is prioritizing of the process over the substance.

As a way to investigate organizational life, process philosophy suggests going-along-with-things “rather than an attempting to capture, to fix, or to measure things.” (Helin et al., 2014, p. 10). Method, in this sense, means to follow a (unique, own) way. It also means making use of language as a way to affect the world we experience. Moreover, more importantly, doing research under a process view signifies taking action in the sense of being actively related to the becoming of life. As such, it demands the development of a very special capacity for understanding and describing the richness of (the empirical) life-in-process through actions and interactions carefully suited to different contexts of research.

Our aim with this theoretical essay is to discuss process philosophy’s potential contributions to an understanding and investigation of innovation processes associated with organizational contexts. Particularly, we develop some ideas and encourage future discussion around two main aspects:

1. process philosophy-oriented conceptualizations of innovation processes; and
2. process philosophy-oriented methods of investigation into innovation processes.

As such, these complementary aspects provide clarification regarding implications of thinking and enquiring procedurally into innovation processes.

The work was organized as follows: besides the introduction, the next section described ontological and epistemological principles derived from process philosophy. Following that, we develop two propositions about what we consider to be more process philosophy-oriented research of innovation processes. We also illustrate how these two specific ideas have been put in practice – according to our analysis – in theoretical–empirical studies of innovation processes. Finally, we conclude by stressing the potentiality and limitations of process philosophy-oriented research within OS and innovation studies.

“Process is what process does”: ontological and epistemological dimensions applicable to innovation process studies
The title of this section was borrowed from the work of Helin et al. (2014). By analyzing the thoughts of many important process philosophers, they have recognized five aspects in common: temporality, wholeness, openness, force and potentiality.
In summary, temporality allows us to understand the constant process of becoming that reveals a forever-emergent present. This notion of temporality as perishability of the world also gives us a new lens to understand the emergent nature of innovation-oriented events and practices within organizational settings. We may use the notion of temporality to define and understand innovation processes from the distinction between moments of becoming and being. While the becoming reveals transformation and creation, the being allows the perception of the duration of things. For example, by observing innovation processes, we may identify and differentiate actions of creation, which characterize the appearance of new ideas, process and so on, from actions of maintenance, which allow the conservation of practices or elements related to the surge of innovations. The notion of temporality may also permit new ways of perceiving the process of becoming and may amplify the capacity to understand the relations and interactions between past, present and future in the innovation processes.

Alternatively, the idea of wholeness offers insights into the way in which events and practices develop into widespread phenomena and vice versa. It is also important in the conceptualization of innovation processes because it focuses on the interconnected nature of reality and draws attention to the mutual influence between potentially influential elements and the creation of things through processes. Also, assuming an analytical distinction between the “parts” and the “whole” allows a better understanding of dynamics between interactional elements of processes and the results of these mutual and complex influences.

Openness, as opposed to a closed and finished view of the world, provides an essential feature for comprehension of the continuous process of self-accomplishment and social accomplishment. It also reveals the inherent messiness, ambiguity and inconclusiveness of the world and any attempt to create finalized accounts of the world. We may apply the idea of openness to characterize different innovation processes from levels of permeability (or sensibility to external information) on and between individuals, groups, organizations and material elements involved in the creative process of economic-focused innovation to transform a novel idea into an implemented reality. At the same time, the notion of openness allows the categorization of innovation processes based on the capacity of many human and non-human agents to create new patterns or orders from new and often non-aggregated data or information, translating them into innovation.

Force, in turn, exposes the creative energy of process and enables us to understand the innovation process within organizational context beyond traditional categories, such as position and structure. Accordingly, from a process-oriented view, dominant and dominated forces are the shapers of limits, possibilities and activities. The notion of force may also be applied as a way to define and differentiate types of innovation processes on the basis of dynamic and mutual influential forces (active or reactive; negatives or positives), which, at the same time, constitute and boost processes in many directions. For example, we may have an improved understanding of innovation process dynamics by observing conflicts between agents involved in networked interactions, which lead to the creation of alternative paths of action. By observing movements, actions and reactions, we may also visualize tendencies regarding intents and outcomes within innovation processes.

Finally, potentiality qualifies the process as the production of the new. It is a recognition that the being is an abstraction from its becoming in the sense that all life is characterized by a virtual power of becoming. We may define innovation processes by the application of the potentiality notion. This is related to the power of affecting and being affected as a result of the interaction between temporality and force. It is the ongoing inner possibility of becoming in a dynamic world constituted of connections. Creation, according to this point of view, is the realization (or actualization) of the virtual by making itself perceptible. Real and virtual
are not distinct substances but different conditions of being. Here is the ontogenesis of innovation because the notion of potentiality, as noted by Helin et al. (2014), shows the potential to imagine, to strive, to open up and to move to accompany the evolution of being. In defining and studying innovation processes, potentiality implicates the sensibility of the researcher to the non-visible. It also demands the ability to see the intrinsic relation between virtual and real as complementary faces of reality.

Regarding the operationalization of constructs in the context of organizational research, according to a process philosophy-oriented perspective, Helin et al. (2014) synthesize the main aspects related to the “way of doing Process Research” under three labels or subsections: belonging to and becoming with the world, the particular and performativity.

Belonging to and becoming with the world demands the development of a very special capacity to understand and to describe the richness of (the empirical) life-in-process through actions and interactions carefully suited to different contexts of research. Langley et al. (2013) help us to understand some practical implications of this process-oriented positioning in organizational research by highlighting the necessary use of varied sources of longitudinal data and mixed methods as a way to observe how processes unfold over time. They also mention the notion of “interactional expertise” (as proposed by Collins, 2004, p. 6) as a “kind of knowledge required for one to communicate about a domain without necessarily being able to practice in that domain.”

The particular is a notion derived from the idea that “each thing is a multiplicity of ‘becomings’ relative to the connections it makes (and is potentially capable of)” (Helin et al., 2014, p. 13). By developing an increased ability to, at the same time, perceive this multiplicity and focus on particular aspects relevant to the study, the researcher may be able to see more, listen more and understand better. The “particular,” in this sense, is that aspect capable of significantly altering the perception of the whole: “One aspect in your field study story, when focused on, alters ‘the whole’ that the story is about” (Helin et al., 2014, p. 13). The particular generates connections which reveal “beings” and “becomings” in a mutual relation with the context.

Finally, performativity means doing research of a nonrepresentational nature. In this sense, the world is not something “out there” to be described, measured or modeled. Research as a performatve activity implies a kind of temporal-rooted productive experimentation through discourse and play. It is the abandonment of theoretical and methodological regulating structures by acknowledging the transformative and creative power of researching similar to many other types of acting. It implicates a more imaginative and realistic type of theorizing. The particular, as mentioned before, becomes what it becomes in relation to connections. Therefore, doing performative research involves a creative and conscious use of experience and thought in dealing, shaping and changing practices. It means “to write the world while participating in it” (Helin et al., 2014, p. 14).

Discussion
In this section, we illustrate how ideas discussed before have been put in practice – according to our analysis – in theoretical–empirical studies of innovation processes. We also develop two propositions about what we consider to be a more process philosophy-oriented research of innovation process.

Based on our purpose, we have chosen two studies. The first was the work of Hoholm and Olsen (2012) about an industrial food product innovation project called “Salma.” The authors structured their analysis – aimed at investigating the evolution of interactive innovation processes over time – into a kind of bipolar process model. One of the processes involved in the networked innovation processes in the study was characterized by relatively
stabilized interacted business networks, which were aimed to reproduce a self-reinforcing cycle. The other networked processes were characterized by their emergence and by a change-oriented network of relations and actions. Between these two types of processes, the concept of friction or controversy was used as a way of explaining the outcomes of the interaction between movement-oriented relationships and stability-oriented structures involved in the innovation project.

The second investigation used as a basis for an illustration of the proposed discussion was the work of Jay (2013) about change and innovation processes in hybrid organizations. The investigation is an in-depth field study of the public–private Cambridge Energy Alliance and investigates the unintended consequences of hybrid organizations’ efforts to generate innovative solutions to complex problems:

P1. Process philosophy-oriented studies of innovation processes imply conceptual multidimensionality by embracing notions such as temporality, wholeness, openness, force and potentiality.

The study of Hoholm and Olsen (2012) illustrates the notion of temporality as an essential element of innovation processes. For example, the necessary interactions within both processes-stability and movement-involved in innovation creation are:

Closely related to past experience, present interaction, and future expectations. Altogether, this resembles a research perspective investigating ‘the social creation of reality through interaction’ over time (Medlin, 2002, p. 4) (in Hoholm and Olsen, 2012, p. 3).

Interactions, we may say, are “beings” focused on the “becoming.” In some sense, they can be considered as evidence of future states intended by actors involved in the interactions. They also allow the apprehension of duration in the context of the innovation processes, as they also expose contents (such as different types of resources) and forms (such as actors involved, frequency and ways of interaction) taken by actions.

Hoholm and Olsen (2012) also illustrate the notion of wholeness by showing how mutual influence between the two types of processes affects the creation of innovation and also demonstrate the interconnected nature of innovation processes by showing how forces affect resources both directly and indirectly: “[…] effects are never merely local; they distribute through friction across interfaces to other resources – transforming them too” (Hoholm and Olsen, 2012, p. 3).

The notion of openness may also be inferred from the study. First, by describing a creative process as a result of friction between two opposite processes, it calls our attention to a highly probable difference in levels of permeability between different contexts of innovation. Presumably, in empirical situations where stability-oriented networks are predominant as a force, the level of sensibility to external information may be expected to be small. On the other side, when movement-oriented networks are predominant as a force, the permeability is expected to be high. Second, by placing innovation processes “between the social and the material, and in the relation/association of events over time,” it draws attention to the process of order emergence through interactional and repetitive interactional practices between heterogeneous human and non-human actors: “This ordering process is about shaping recursive patterns, and when interconnecting multiple such orderings, a complexity emerges […]” (Hoholm and Olsen, 2012, p. 4).

The notion of force emerges in the sense that the study characterizes innovation processes involved in the empirical case by their role as productively interactive and mutually influential forces that constitute and boost the phenomena as a whole. In other
words, the friction or controversy between the aims and the means of both processes makes the innovation outcome possible.

Potentiality is revealed in the study by assuming a principle of actor network theory (ANT), which states that “entities take their form and acquire their attributes as a result of their relations with other entities” (Law, 1999, as cited in Hoholm and Olsen, 2012, p. 4). In this sense, sociality is constituted as a “circulating entity,” which is also characterized by multiple continuously negotiated realities. According to Latour (1988, 1996, as cited by Hoholm and Olsen, 2012, p. 8), networks “should be understood as processes of translation, association, deformation and transformation.”

The interaction between temporality and force, as it is presupposed in the scope of the notion of potentiality also reveals how innovation processes may be simultaneously characterized by intended and unintended transformations. It also demonstrates potentiality as a dimension of innovation processes with ongoing unpredictable possibilities in a dynamic context constituted by connections. They are also a result of constant friction or controversies between inner processes marked by recursive patterns of relations and actions, which permit the actualization of the virtual into the real:

P2. Process philosophy-oriented studies of innovation processes demands that the researcher has the capacity to study contextualized “life-in-process,” to focus on particular aspects relevant to the study and to adopt a performative and investigative attitude.

The study of Jay (2013) illustrates the idea of belonging to and becoming with the world, as proposed within process philosophy in applying an inductive, theory-building, multi- and mixed-method qualitative strategy. The investigation was conducted based on a two-year ethnographic field study combined with elements of action research that were focused on understanding and describing how actors and organizations change over time. Data gathering included participant observation, semi-structured interviews and archival data analyses.

The study also exemplifies the capacity to focus on particular aspects relevant to the study in the sense of an ability to also perceive the multiplicity of elements involved and focus on particular aspects relevant to the study. As described by the researcher:

I noticed [...] that certain meetings were particularly valuable to observe because they consolidate topics from multiple different conversations; they focused on those actions, outcomes, and issues [that] people were most eager to interpret (Jay, 2013, p. 143).

The “particular,” as mentioned before, is also that aspect capable of significantly altering the perception of the whole. For example, when the researcher identified some contradictions between organization members and clients’ points of view about a subject matter, it was possible to identify the implications of these contradictions to the organization’s business model and identity. Alternatively, as another example of “particular,” we may stress the observed reframing in the prevalent institutional logic as a key mechanism in generating organizational structural changes:

They took new actions that produced new outcomes, continuing the iterative process. As people became more reflexive and aware of the paradox, these shifts in organizational identity gradually supported more innovative action. (Jay, 2013, p. 146).

Finally, details from participant observation reveal the performative investigative attitude taken by the researcher. As an engaged organizational historian, he periodically shared his findings with organization members and, by doing this, generated a collaborating and
contributing process of mutual interpretations. The interactive methodology also embraced reflexiveness, transparency, triangulation and self-awareness about the researcher’s own impact on the organizational processes under study. The researcher demonstrated the performative investigative attitude by documenting the moments in which he felt his feedback may have influenced the thinking inside an organization: “Latour (2005) called this the ‘fourth notebook’: the space for documentation of the researcher as actor influencing the system he or she is observing” (Jay, 2013, p. 143).

Conclusions
The inspirational quality of the early twentieth-century process philosophy is not an entire novelty inside organizational and innovation studies. The actor network theory, for example, is rooted in many process metaphysics fundaments. However, recent claims about the process philosophy’s potential contributions to OS raise old and new questions about its value in understanding organizational-related issues, such as innovation processes.

By considering processes of innovation as characterized by complex and dynamic interactions, more radical process-based conceptualizations of the innovation process phenomena may inspire more insightful ideas about the interactional phenomena and on the elements involved in creative relations.

This paper’s objective represents only a small, modest step in the direction of a better understanding of process philosophy’s potential contributions to innovation process research within OS. At the same time, we hope to contribute to showing potential relations between analytical constructs inspired by the process philosophy perspective and the empirical phenomenon of the innovation process. Alternatively, rather, we may talk about innovation processes (in the plural) in that there are multiple possible empirical manifestations of this type of event.

In applying the dimensions proposed by Helin et al. (2014), we also follow previous considerations offered by Olsen (2011, 2013) about limitations and possibilities of a more strongly process view within OS and innovation studies. We particularly recognize – as the author explains – that process philosophy, as a perspective, is not a competing or substitutional paradigm when compared to other scientific paradigms but an alternative and complementary conceptual framework. Moreover, in many senses, process philosophy-oriented research is an alternative to typical social science. The search for a covering-law representation of fixed things is replaced by a way of following things in life. As such, this way of researching may enrich studies of innovation processes. It may also impregnate research with localized and contextualized views of the world represented by researchers actively connected to life-in-process empirical settings. Process research informed by process philosophy involves experiencing the world – including its practices in everyday life – in a performative way. According to this view, process research shapes the world and is more realistic in the sense that things only become within particular contexts and relationships. For this reason, process philosophy may contribute to research on innovation processes because it demands a view of experience and thought “as temporal and partly irreversible processes rooted in transformative action involving sociality and materiality (Charles Sanders Peirce)” (Helin et al., 2014, p. 14).

We finish the discussion proposed in this paper by borrowing the expression “ontological training” used by Koskela and Kagioglou (2006), which represents a demand that we break out of our dominant Western metaphysics way of thinking within management and OS. We believe that a renewed interest in process philosophy is a fruitful way of doing it.
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Profile of academic entrepreneurship in Brazil
Evidence from the evaluation of former holders of undergraduate research, master and PhD scholarships

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Abstract

Purpose – This paper aims to understand, in the state of São Paulo academic environment, the differences between the profiles of academic entrepreneurs, nonacademic entrepreneurs and non-entrepreneurs.

Design/methodology/approach – The authors collected data from a more comprehensive research, whose objective was to evaluate the scholarship programmes of São Paulo Research Foundation (FAPESP). For data collection, the authors used an online questionnaire, pre-filled with information from the Lattes Curriculum of the sample individuals, as well as information obtained from FAPESP and from coordination for the improvement of higher education personnel. The response rate of the questionnaires was 21 per cent. The authors sought to explore the variables regarding entrepreneurial activities carried out by former scholarship holders, by relating them to other key variables identified in the literature review and explained in the hypotheses.

Findings – The results indicate that entrepreneurship rates decrease with the higher academic level of the researcher; in general, academic entrepreneurs come from families with a good financial situation, and applied sciences are the areas of knowledge with more entrepreneurs.

Originality/value – Despite the great number of theoretical and empirical studies found in the literature on entrepreneurship and academic entrepreneurship, there is still a shortage of practical studies on this latter topic in Brazil. This gap is even more evident when the authors consider the significant growth of entrepreneurial activity in the country in the past years. This paper contributes to fill this gap, and it aims to

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understand, in the state of São Paulo academic environment, the differences between the profiles of academic entrepreneurs, nonacademic entrepreneurs and non-entrepreneurs.

**Keywords** University, Spin-offs, Academic entrepreneurship, Entrepreneurial profile, Entrepreneurial activity, Technological entrepreneurship

**Paper type** Research paper

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**1. Introduction**

Entrepreneurial activity is one of the world’s main drivers of economic, technological and social change (Bygrave, 2009; Volkmann *et al.*, 2010). Entrepreneurship positively affects the economy through the development of technological innovations, creation of new companies and markets, generation of new short and long-term employment opportunities and encouragement of firms’ competitiveness (Kritikos, 2014). Several authors have demonstrated the special relevance of small technology-based companies for innovation and job creation (Guerrero *et al.*, 2015; Sánchez and Maldonado, 2015).

Nowadays, entrepreneurship is also one of the main channels for carrying out universities’ socioeconomic support functions – or what is commonly known as their third mission (Costa and Torkomian, 2005). According to Etzkowitz (1998), entrepreneurship in universities and research institutes is not an unprecedented phenomenon. Entrepreneurial initiatives have been growing since the 1970s, when researchers in the biomedical sector began to seek ways to capitalize on their research by founding or associating with private companies, thus characterizing an entrepreneurial branch that Stuart and Ding (2006) called academic entrepreneurship.

Despite the great number of theoretical and empirical studies found in the literature on entrepreneurship and academic entrepreneurship, there is still a shortage of practical studies on this latter topic in Brazil. This gap is even more evident when we consider the significant growth of entrepreneurial activity in the country – from 2002 to 2016 the number of entrepreneurs grew 15 per cent, reaching 36 per cent of the population between 18 and 64 years old [Global Entrepreneurship Monitor (GEM), 2017].

This paper contributes to fill the gap and aims to understand, in the state of São Paulo academic environment, the differences between the profiles of academic entrepreneurs, nonacademic entrepreneurs and non-entrepreneurs. To do this, we compared the profile of the academic entrepreneur found in the study – former scholarship holders of undergraduate, master and PhD research – with the profile described in the literature, through the analysis of factors that affect their decision to start a business.

The research question that guided the paper was:

*RQ.* How personal factors and professional trajectory affect academic entrepreneurship carried out by former undergraduate, master and PhD scholarship holders in the state of São Paulo, Brazil?

The article also contributes with inputs for the elaboration of policies and strategies by the government, universities and research institutes, to encourage academic entrepreneurship, aiming to achieve positive impacts on technological, economic and social development.

To attain its goal, we organized the article in six sections, including this introduction. Section 2 presents the literature review, which highlights the concepts and determinants of academic entrepreneurship to support the hypotheses. Section 3 describes the methodology, considering the broader context where data were collected. Section 4 displays the results, followed by their discussion in Section 5. Section 6 presents some final remarks.
2. Concepts and key factors of academic entrepreneurship

The original concept of entrepreneurship is attributed to economists Cantillon (1755) and Say (1821). Since then, several authors have expanded the discussion on what is entrepreneurship and who is the entrepreneur (Austin et al., 2006; Druilhe and Garnsey, 2004; Gartner, 2008). In general, the authors in this area choose two different streams:

(1) entrepreneurship linked to value creation through innovation, not necessarily involving the creation of companies (Filion, 2004; Hisrich, 1990; Schumpeter, 1934); and

(2) entrepreneurship that takes advantage of business opportunities for creating companies (Cole, 1968; Vesper, 1982; Gartner, 1989; Lumpkin and Dess, 1996; Bygrave, 2009), whether innovative or not. We adopted this second perspective in this article, applied to academic entrepreneurship.

Academic entrepreneurship, in turn, regards entrepreneurial activities carried out by researchers, based on intellectual capital acquired or developed in universities or research institutes, within each researcher’s educational field (Franzoni and Lissoni, 2006).

In addition to the creation of technology-based companies, commonly referred as spin-offs (Smilor et al., 1990; Jones-Evans, 1995; Oakey, 2003; Pirtney et al., 2003; Brennan et al., 2005; Freitas et al., 2011; Cantaragiu, 2012), the concept of academic entrepreneurship can also include knowledge trading activities (Gibbons and Wittrock, 1985; Louis et al., 1989); technology transfer activities, such as patents and licensing (Birley, 2002; Nicolaou and Birley, 2003); and activities of social value creation (not-for-profit actions, such as developments and services to needy communities).

Although we recognize the importance and validity of academic entrepreneurship categories, this research emphasizes the idea of companies’ creation, understood as the practice of transferring to society the knowledge derived from research carried out in universities or research institutes (the parent organizations) by their members or former members, such as teachers, researchers, employees, undergraduate or graduate students (Costa and Torkomian, 2005).

We chose this delimitation because the available data refer to the creation of companies by former students who received scholarships to carry out undergraduate, master and PhD research. We further explain this point in the Methodology section. In addition, this definition facilitates the comparison of findings in different circumstances and countries, since the other categories of academic entrepreneurship may be subject to local definitions and cultural interpretations (Cantaragiu, 2012).

There are many drivers of academic entrepreneurship, as well as many authors who have studied this topic, among them Carayannis et al. (1998), Louis et al. (1989); Moore (1986), Filho Pedrosi (2012); Radosevich (1995), Roberts and Malonet (1996); Shane and Stuart (2002); and Steffensen et al. (2000).

Based on these studies, we divided the determinants of academic entrepreneurial activity into three major groups. These are environmental factors, related to the macro-environment of the researcher’s home institution (Etzkowitz, 1998; Llano, 2010; Louis et al., 1989), organizational factors, related to the features of the researcher’s institution or group (Clark, 1998; Roberts, 1991; Roberts and Malonet, 1996; Kenney, 1988; Mathieu et al., 2008; Lockett and Wright, 2005; Siegel et al., 2007; Louis et al., 1989; Moore, 1986), and personal determinants, related to the attributes of the academic entrepreneur, such as psychological features and professional experience (Clarysse et al., 2011; Haeussler and Colyvas, 2011; Louis et al., 1989; McClelland, 1967).
Among the personal factors, some authors analyze entrepreneurs’ motivational factors or psychological traits that influence the creation of companies (Brockhaus, 1982; Dubini, 1989; Roberts, 1991), such as wish for autonomy (McQueen and Wallmark, 1985; Roberts and Wainer, 1971), creativity (Filion, 2004; Moore, 1986), loss or dissatisfaction with the job (Dubini, 1989; Moore, 1986; Wadhwa et al., 2009), among others. In a research with Brazilian university students, Garcia et al. (2013) and Ferreira et al. (2017) address these points by highlighting the search for income and the possibility of putting their ideas into practice as the more relevant motivational factors, besides self-fulfillment and social reasons.

Others analyze the influence of human and social capital on academic entrepreneurship (Aldridge and Audretsch, 2011; Davidsson and Honig, 2003; De Clerq and Arenius, 2003). There are also those who examine more objective attributes of entrepreneurs, such as age (Van De Ven et al., 1984), gender (Clarysse et al., 2011; Haeussler and Colyvas, 2011), professional experience (Wadhwa et al., 2009), academic education area (Haeussler and Colyvas, 2011) and level of education [Wadhwa et al., 2009, Global Entrepreneurship Monitor (GEM), 2017].

Clarysse et al. (2011), using a panel of university scholars from the UK universities, studied the determinants of spin-offs’ creation by professors and researchers, and concluded that personal determinants, especially previous experience with entrepreneurship, are the most important factors for the creation of such companies. However, Aldridge and Audretsch (2011), through interviews with scientists of the US National Cancer Institute, highlight that social factors (measured by the scientist’s relationship with the private sector) are more relevant than environmental and personal factors in a scientist’s decision to become an entrepreneur.

Although there are theoretical and empirical studies on the determinants of academic entrepreneurship, there is no consensus on what is the specific set of factors that drive a scientist to become an entrepreneur. This paper contributes to this understanding in a particular context, based on objective personal attributes, such as socioeconomic profile (measured by family income), level of education, professional experience, gender and area of study. From a literature review on the influence of these factors on academic and nonacademic entrepreneurship, we developed the guiding hypotheses of the research.

As to family income, Wadhwa et al. (2009) used a sample of 549 American entrepreneurs and observed that the majority came from middle-class (71 per cent) or upper middle-class (22 per cent) families. Some authors do not relate this fact to the financial capital but rather to the opportunity for a higher income to create human and social capital for such individuals (De Clerq and Arenius, 2003; Jayawarna et al., 2014).

This issue is linked to recent conclusions about the motivations for entrepreneurial activities being generally focused on the search for opportunities rather than the satisfaction of needs (GEM, 2017). Although this is a general trend, data from this same study show important differences between countries. In Brazil, for example, there is a balance between the two types of motivations.

It is worth noting that while there are studies about the influence of socioeconomic status on entrepreneurial profile, as mentioned above, we found no references on the relationship between this fact and academic entrepreneurship.

Therefore, the first research hypothesis is based on the general discussion of entrepreneurship:

\[ H1 \] Researchers that come from higher-income families (above nine minimum wages) are more likely to become academic entrepreneurs than those from lower-income families.
Wadhwa et al. (2009) also showed that 75 per cent of the individuals in the entrepreneurs’ sample had previously worked for other companies for more than six years, before creating their own firms. Sieger et al. (2011), who carried out a study with 695 entrepreneurs from 30 countries, also mention the importance of prior participation in the labor market. According to their research, 58 per cent of entrepreneurs had previously worked as employees, and 33 per cent considered a previous employment experience as the main factor of success for the entrepreneurial activity.

Jones-Evans (1992, 1995) identified four types of academic entrepreneurs, based on their previous work experience and highlighted that such experience, either purely academic or purely productive and commercial, strongly affects the participation of individuals in the activities of business creation. Shane and Khurana (2003) also found a positive relationship between professional experience and the likelihood of an invention being commercialized through start-up companies. This study was based on MIT patents filed in the USA between 1980 and 1996. According to the authors, professional experience affects knowledge about the issues that an entrepreneur will face. Another finding of this relationship comes from the paper by Mosey and Wright (2007), which highlights the importance of academic entrepreneurs’ previous experience with their own companies, for building their networks of relationships.

Given the convergent view on the importance of previous work experience for academic entrepreneurship, we suggest the following hypothesis:

**H2.** Researchers who work during their undergraduate studies are more likely to become academic entrepreneurs than those who did not work during this period.

For Sieger et al. (2011), the second factor of success in entrepreneurial activity, after a previous work experience (33 per cent), is higher education (30 per cent). Research by Wadhwa et al. (2009) on the profile of companies’ founders – mainly North American and technology-intensive firms – strengthens this issue, as 95 per cent of the entrepreneurs had at least a college degree, and 47 per cent had graduate studies’ degrees.

These results are distinct from those by De Clerq and Arenius (2003), who conducted a study based on data from the 2002 Global Entrepreneurship Monitor survey with 4,536 individuals that lived in Belgium and Finland. They analyzed the influence of human capital (in terms of educational level) on start-ups, and concluded that the likelihood of becoming an entrepreneur is inversely proportional to the level of qualification (considering formal education). That is, the probability of someone with a university degree creating a company is lower than that of a person with a high-school certificate. However, they found a positive relationship between education and the individual’s perception of his entrepreneurial abilities, which, in turn, positively affects the creation of firms.

Louis et al. (1989) speculate on the existence of a relationship between a researcher’s age and advanced types of academic entrepreneurship. For them, more experienced scholars are likely to engage, for example, in consulting activities due to their reputation and visibility achieved during their academic life, as well as in initiatives to get research funding and patent filing. However, such experience showed a negative relationship with the creation of companies and equity stake.

A more recent study by Abreu and Grinevich (2013) draws similar conclusions, and it found in a large sample of British scholars that senior researchers are more likely to engage in informal commercial activities (such as consulting or research projects) than those with shorter career time, although there is no relationship between seniority and the creation of companies. Goethner et al. (2012), in turn, studied German scientists and went beyond the
level of seniority, by concluding that the achievement of a PhD degree has no influence on their intentions toward academic entrepreneurship.

Haeussler and Colyvas (2011) reached different conclusions in their study with a sample of 4,621 German and British biologist researchers, who published or patented between 2002 and 2005. They concluded that academic experience, revealed, among other facts, by the higher number of publications, positively affects the commitment to industry and the use of entrepreneurial opportunities. Aldridge and Audretsch (2011) arrived at the same conclusion by examining scientists who had received funding from the National Cancer Institute (USA).

Based on the non-consensual findings of the literature, we suggest the following hypothesis:

\[ H3. \] The higher the researchers' level of qualification (understood as formal education – Graduation, Master and PhD), the higher the probability of becoming academic entrepreneurs.

An analysis of the overall profile of entrepreneurs from GEM (2017) data indicates that, globally, women are less prone to become entrepreneurs than men. Nevertheless, there are significant differences between countries and cases in which this ratio, measured by entrepreneurship rates at the initial stage, is equal, as in Brazil and Mexico.

De Clercq and Arenius (2003) also examined the effect of gender on enterprise creation. Although the probability of men engaging in entrepreneurial activities was higher in their sample, the difference in relation to women was not significant.

However, most of the studies point out that, as occurs in general entrepreneurship, male's participation in academic entrepreneurship is more significant than female's. According to Abreu and Grinevich (2013), Clarysse et al. (2011); Haeussler and Colyvas (2011); and Klofsten and Jones-Evans (2000), male researchers are more likely to engage in this type of entrepreneurship when compared to women. Clarysse et al. (2011), through a scholars' panel from the UK universities, concluded that women have 40 to 50 per cent less chance to start a company than their male colleagues.

Haeussler and Colyvas (2011) present similar results as those by Clarysse et al. (2011) but with a less obvious difference. In their study, male researchers have a slightly higher tendency to register patents (8 per cent higher) and create firms (4 per cent higher). However, the study observes that in the case of consulting, women show equal levels of entrepreneurship. This is because this activity requires smaller investments, a lower level of engagement and time availability, suggesting that these variables impose structural restrictions on women.

Rosa and Dawson (2006) also studied gender influence in academic entrepreneurship. They analyzed 20 of the UK's leading universities, concluding that the percentage of female entrepreneurs was low (12 per cent) when compared to male researchers. For them, the small share of women that create companies is related to their under representation in scientific research, as well as to the fact that few women occupy senior positions in research (where the interest for products' commercialization is generally higher). Klofsten and Jones-Evans (2000) also argue that gender difference in academic entrepreneurship may be a reflection of the current structure of academic careers, dominated by men.

Based on this aspect, we suggest the fourth hypothesis of the research:

\[ H4. \] Male researchers are more likely to become academic entrepreneurs than female researchers.

Another determinant of academic entrepreneurship is the knowledge area, as highlighted in the paper by Kenney and Richard Goe (2004). In this regard, Louis et al. (1989) used two
surveys conducted in 1985 with a sample of healthcare scientists and managers from 50 of the most relevant research universities in the USA. They found no evidence that healthcare scholars are more prone to entrepreneurial activities than to other academic activities.

Haeussler and Colyvas (2011) also discuss the influence of the knowledge area on academic entrepreneurship. They stratified the large biological sciences area into four subareas: basic area, clinical area, engineering area and others. The research results suggest that active researchers in the clinical area (clinical medicine, oncology and pharmaceutical sciences) and in engineering (bioinformatics and bioprocess engineering) are more involved in commercial activities than the others, and they are more prone to entrepreneurship.

More comprehensively, the study by Goethner et al. (2012) goes in the same direction, by concluding that scientists involved with applied research are more inclined to entrepreneurship than those that deal with basic research. Abreu and Grinevich (2013) strengthen this aspect by reckoning that scholars in biological sciences, engineering and physics are more prone to licensing and spin-off activities than in other areas. Hence, we propose the fifth and final research hypothesis:

\[ H5. \] Researchers in the areas of biological sciences and engineering are more likely to become academic entrepreneurs as compared to those in other areas.

3. Methodology
We collected data for this study from a more comprehensive research, whose objective was to evaluate the scholarship programs for Undergraduate research (IC), Master (MS) and PhD (DR) of São Paulo Research Foundation (FAPESP). The study was carried out between 2010 and 2012, and it used a quasi-experimental design, where the treatment group was composed by individuals who had requested IC, MS and DR scholarships to FAPESP between 1995 and 2009, had their submissions approved and finished their projects by the end of 2009. On the other hand, the control group gathered individuals who had their applications denied by FAPESP, but they received grants from other funding agencies such as the National Council for Scientific and Technological Development and the Coordination for the Improvement of Higher Education Personnel (CAPES). Hence, the assessment focused on the effect of peer review – the model used by FAPESP – for the selection of fellows, compared to the quota model adopted by the other agencies.

For data collection, we used an online questionnaire, pre-filled with information from the Lattes Curriculum of the sample individuals, as well as information obtained from FAPESP (database with information from applicants and submitted projects and their status – denied, approved in progress or approved completed) and from CAPES (database of graduate students in Brazil). The questionnaire had information on the following: the socioeconomic profile of former scholarship holders; their academic trajectory throughout graduation and, where appropriate, graduate studies; their professional career; and their scientific and technological production, coordination, participation in projects and supervision of dissertations.

The questionnaire was available on the internet from February to March 2012, through a link sent to sample individuals by e-mail. We sent 57,490 e-mails, of which 39,765 successfully reached the recipients. Failure to reach the whole sample was due to outdated electronic addresses in FAPESP and CAPES databases. The response rate of the questionnaires that reached the recipients and were satisfactorily filled out was 21 per cent, that is, 8,682 questionnaires, which is representative of the research universe.
We sought to explore the variables regarding entrepreneurial activities carried out by former scholarship holders, by relating them to other key variables identified in the literature review and explained in the hypotheses.

To identify entrepreneurial activity, we started with a question about the individual being a founding partner of an enterprise or employing organization for which he had declared an employment relationship (whether the link had occurred shortly after graduation or at the moment of data collection). To determine if we could consider such entrepreneurial activity as academic, we used the answer to the question about the creation of the company or organization being related to some stage of his/her academic education. Figure 1 shows the chain that allowed classifying respondents into non-entrepreneurs, academic entrepreneurs (in which there is a relationship between education and entrepreneurship) and nonacademic entrepreneurs (where there is no relationship). The Appendix presents the research tool used to collect data.

The analysis of questionnaires shows that among the 8,682 satisfactorily filled out, there were 3,336 complete answers on the involvement with entrepreneurial activities (based on the question “Were you one of the founding partners of this company/employer organization?”). From this number, 115 individuals gave positive responses. Since three of them did not answer about the relationship between entrepreneurial activity and their academic trajectory, we removed them from the sample of entrepreneurs (see Table I).

Table II, in turn, shows the stages of the academic path to which entrepreneurial activity relates, in the case of academic entrepreneurs. It shows a balanced distribution of academic levels.

Figure 1. Linkage of questions to identify entrepreneurial activities
These are the other variables used in the study: monthly family income at the beginning of the former scholarship holder’s academic career (measured in number of minimum wages), work during graduation (since, as former scholarship holders, respondents should not have employment links during master and PhD studies), maximum level of education (graduation, master or PhD), gender and knowledge area. Sections 4 and 5 present and discuss the relationships between these variables and the categories used in the research.

Statistical analysis comprised crossed tables or graphical representations of these tables, of the “entrepreneurial activity” variable with those that answer the hypotheses, through absolute and percentage frequencies. We used Pearson’s chi-square test to check the association between crossed variables, and we considered \( p \)-value < 5 per cent (0.05) for rejecting the null hypothesis, where there is no association. The low frequency of entrepreneurial activity categories, as shown in Table I, did not enable multivariate analyses or multiple crossings.

4. Results
After completing the sample’s general characterization, this section presents the results from the online questionnaire, organized according to the research hypotheses. All the analyses considered the frequencies for each of the three categories identified: non-entrepreneurs, academic entrepreneurs and nonacademic entrepreneurs.

To test \( H1 \), related to the “income” factor, we analyzed the distribution of monthly family income (in minimum wages – SM) of the researchers, when they began their academic trajectory, that is, at the time they started graduation (Figure 2).

Regarding family income, results show that the profile of academic and nonacademic entrepreneurs and of non-entrepreneurs, prior to entrepreneurial activity, is similar, as in all cases, there are mainly individuals whose monthly family income at the beginning of graduation was higher than nine minimum wages.

Despite the similar pattern and specificity of the sample, there is an important difference when comparing entrepreneurs with non-entrepreneurs and even when comparing academic entrepreneurs with nonacademic (difference of 14 per cent in the latter case), with \( p \)-value = 0.02 (chi-square = 20.9; 6 degrees of freedom). Thus, \( H1 \) was confirmed, since researchers originating from families with higher income were more entrepreneurial than those with lower-income levels.

### Table I.
Sample distribution by entrepreneurship category

<table>
<thead>
<tr>
<th>Entrepreneurship category</th>
<th>Frequency</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-entrepreneur</td>
<td>3,221</td>
<td>96.6</td>
</tr>
<tr>
<td>Academic entrepreneur</td>
<td>82</td>
<td>2.5</td>
</tr>
<tr>
<td>Nonacademic entrepreneur</td>
<td>30</td>
<td>0.9</td>
</tr>
<tr>
<td>Total</td>
<td>3,333</td>
<td>100</td>
</tr>
</tbody>
</table>

### Table II.
Academic stages of the category “academic entrepreneur”

<table>
<thead>
<tr>
<th>Academic stage</th>
<th>Frequency</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC</td>
<td>31</td>
<td>38</td>
</tr>
<tr>
<td>MS</td>
<td>23</td>
<td>28</td>
</tr>
<tr>
<td>DR</td>
<td>28</td>
<td>34</td>
</tr>
<tr>
<td>Total</td>
<td>82</td>
<td>100</td>
</tr>
</tbody>
</table>
To check H2, related to previous work experience, we examined the work history of former scholarship holders during undergraduation (Figure 3). Figure 3 shows a similar pattern between the different profiles of former grantees. This situation contradicts the profile described in the literature, where previous work experience indicates a propensity for entrepreneurship. Thus, from the sample data H2 was rejected ($p = 0.9; \chi^2 = 0.21; 2$ degrees of freedom).

To test H3, on the influence of the level of academic education, we checked the maximum level achieved by former scholarship holders (Table III). Table III shows that the rate of academic entrepreneurship is higher at the graduation level, and PhDs are less entrepreneurial ($p$-value = 0.07; $\chi^2 = 14.2; 4$ degrees of freedom).

<table>
<thead>
<tr>
<th></th>
<th>Up to 1 SM</th>
<th>Between 1 and 9 SM</th>
<th>Between 9 and 18 SM</th>
<th>More than 18 SM</th>
</tr>
</thead>
<tbody>
<tr>
<td>NON-ENTREPRENEUR</td>
<td>27</td>
<td>1066</td>
<td>918</td>
<td>622</td>
</tr>
<tr>
<td>NON-ACADEMIC ENTREPRENEUR</td>
<td>0</td>
<td>8</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>ACADEMIC ENTREPRENEUR</td>
<td>0</td>
<td>13</td>
<td>24</td>
<td>30</td>
</tr>
</tbody>
</table>

**Note:** $p$-value < 0.05

To check $H2$, related to previous work experience, we examined the work history of former scholarship holders during undergraduation (Figure 3).

Figure 3 shows a similar pattern between the different profiles of former grantees. This situation contradicts the profile described in the literature, where previous work experience indicates a propensity for entrepreneurship. Thus, from the sample data $H2$ was rejected ($p = 0.9; \chi^2 = 0.21; 2$ degrees of freedom).

To test $H3$, on the influence of the level of academic education, we checked the maximum level achieved by former scholarship holders (Table III).

Table III shows that the rate of academic entrepreneurship is higher at the graduation level, and PhDs are less entrepreneurial ($p$-value = 0.07; $\chi^2 = 14.2; 4$ degrees of freedom).

**Note:** $p$-value = 0.9
freedom). Hence, \( H3 \) was rejected. However, when considering entrepreneurship in general, there is an increase in entrepreneurial activity according to the level of education.

Table IV displays the sample profile for the variable “gender” to test \( H4 \).

Regarding the sample’s general profile, 56 per cent of the former grantees are females. This same percentage applies to non-entrepreneurs, while for nonacademic entrepreneurs the proportion is 77 per cent. However, for academic entrepreneurs, the relationship reverses, with 48 per cent of former female grantees and 52 per cent of men, showing a higher balance. With \( p\)-value = 0.02 (chi-square = 7.6; 2 degrees of freedom), \( H4 \) can be accepted.

To test \( H5 \), we used data from the knowledge area of the former beneficiaries for each entrepreneur category. Table V shows education areas in which entrepreneurship rates are higher: Biological Sciences (21 per cent of academic entrepreneurs and 18 per cent of nonacademic entrepreneurs) and Engineering (19 per cent of academic entrepreneurs and 5 per cent of nonacademic). Together, they represent 40 per cent of academic entrepreneurs. An aggregate analysis shows that Applied Sciences (including Engineering, Applied Social Sciences, Agricultural Sciences and Health Sciences) represent a majority (54 per cent) among academic entrepreneurs.

From these data, we can confirm the final hypothesis. It is worth mentioning that the profile of nonacademic entrepreneurs is quite different when we consider the distribution by knowledge areas, since the highlights in this case are former scholarship holders from the areas of Biological Sciences and Human Sciences. The \( p\)-value for this table was less than 0.0001, but should be interpreted with care, given the large dimension of the table (chi-square = 952.6; 27 degrees of freedom).

5. Discussion
This research had the purpose of studying personal determinants that affect academic entrepreneurship. We carried out bibliographical and documentary research and an online

<table>
<thead>
<tr>
<th>Academic education</th>
<th>Academic entrepreneur</th>
<th>Nonacademic entrepreneur</th>
<th>Non-entrepreneur</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Freq. (%)</td>
<td>Freq. (%)</td>
<td>Freq. (%)</td>
<td>Freq. (%)</td>
</tr>
<tr>
<td>Graduation</td>
<td>24 4.56</td>
<td>4 0.76</td>
<td>498 94.68</td>
<td>526 100</td>
</tr>
<tr>
<td>Master</td>
<td>25 2.51</td>
<td>12 1.20</td>
<td>959 96.29</td>
<td>996 100</td>
</tr>
<tr>
<td>PhD</td>
<td>33 1.82</td>
<td>14 0.77</td>
<td>1,762 97.40</td>
<td>1,809 100</td>
</tr>
</tbody>
</table>

Note: \( p = 0.07 \)

<table>
<thead>
<tr>
<th>Gender</th>
<th>Academic entrepreneur</th>
<th>Nonacademic entrepreneur</th>
<th>Non-entrepreneur</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Freq. (%)</td>
<td>Freq. (%)</td>
<td>Freq. (%)</td>
<td>Freq. (%)</td>
</tr>
<tr>
<td>Women</td>
<td>39 48</td>
<td>23 77</td>
<td>1,812 56</td>
<td>1,874 56</td>
</tr>
<tr>
<td>Men</td>
<td>43 52</td>
<td>7 23</td>
<td>1,412 44</td>
<td>1,462 44</td>
</tr>
</tbody>
</table>

Note: \( p < 0.05 \)
survey with former scholarship holders for undergraduate, master and PhD research who requested support from FAPESP.

The first result to highlight (Table I) is the small number of entrepreneurs among former scholarship holders (3.4 per cent), which shows a lack of connection between researchers’ qualification and the creation of companies. The majority of Brazilian researchers – especially PhDs have links with teaching and research institutions and a little involvement with companies, which reflects the low intensity of research and development activity in these organizations in the country, according to the Center for Management and Strategic Studies in Science, Technology and Innovation [Centro de Gestão e Estudos Estratégicos (CGEE), 2016]. As explained in the final section, this finding should be the focus of attention of Brazilian public policies.

Regarding the attributes examined, Table VI shows the behavior of the three profiles of former scholarship holders, and a fourth profile that does not distinguish between academic and nonacademic entrepreneurs. They are quite similar in all features, with differences for academic entrepreneurs in terms of gender and area of study.

The explanation for the profiles’ similarity relates to the research universe itself. Mostly composed by former students from public research universities, it regards a part of the population that is financially privileged. Because of the low number of vacancies in public

<table>
<thead>
<tr>
<th>Education area</th>
<th>Academic Entrepreneur</th>
<th>Nonacademic entrepreneur</th>
<th>Non-entrepreneur</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biological Sciences</td>
<td>15 21</td>
<td>4 18</td>
<td>374 17</td>
<td>393</td>
</tr>
<tr>
<td>Engineering</td>
<td>14 19</td>
<td>1 5</td>
<td>255 11</td>
<td>270</td>
</tr>
<tr>
<td>Applied Social Sciences</td>
<td>9 12</td>
<td>0 0</td>
<td>154 7</td>
<td>163</td>
</tr>
<tr>
<td>Agricultural Sciences</td>
<td>9 12</td>
<td>2 9</td>
<td>224 10</td>
<td>235</td>
</tr>
<tr>
<td>Exact and Earth Sciences</td>
<td>8 11</td>
<td>1 5</td>
<td>342 15</td>
<td>351</td>
</tr>
<tr>
<td>Health Sciences</td>
<td>8 11</td>
<td>2 9</td>
<td>321 14</td>
<td>331</td>
</tr>
<tr>
<td>Human Sciences</td>
<td>4 5</td>
<td>3 14</td>
<td>345 15</td>
<td>352</td>
</tr>
<tr>
<td>Linguistics, Literature and Arts</td>
<td>4 5</td>
<td>2 9</td>
<td>147 7</td>
<td>153</td>
</tr>
<tr>
<td>Multidisciplinary</td>
<td>2 3</td>
<td>2 9</td>
<td>54 2</td>
<td>58</td>
</tr>
<tr>
<td>Information unavailable</td>
<td>0 0</td>
<td>5 23</td>
<td>11 0</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>73 100</td>
<td>22 100</td>
<td>2,227 100</td>
<td>2,322</td>
</tr>
</tbody>
</table>

Table V. Education areas by category

<table>
<thead>
<tr>
<th>Attributes of former scholarship holders</th>
<th>Academic entrepreneur</th>
<th>Nonacademic entrepreneur</th>
<th>Academic and nonacademic entrepreneur</th>
<th>Non-Entrepreneur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most researchers come from families with higher income</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Most researchers worked during graduation</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Most researchers are PhDs</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Most researchers are of the male gender</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Most researchers come from the Applied Sciences area</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Table VI. Analysis of the determinants for each profile of former scholarship holders
institutions, the country’s income concentration and the approval system for entering Brazilian universities, higher education in the country is elitist (Pinto, 2004). According to IBGE data (Góes and Duque, 2016), 46 per cent of the students in Brazilian public universities in 2013 came from families with an average monthly income above seven minimum wages.

As shown by Cardoso and Sampaio (1994), in a study with a sample of 2,226 students from higher education institutions in the state of São Paulo, there is a mismatch regarding the factor “labor”, when comparing public and private universities, since 33.3 per cent of the students in public universities work, against 63.7 per cent of those in private universities. The explanation for this heterogeneity is the difference in profile of students of private and public higher education institutions in Brazil, according to the previous argument.

Therefore, we worked with a universe and a sample that comprised individuals from families of middle and upper classes, for whom the need to work during undergraduation was not significant.

There is also a prevalence of PhDs in the sample, much more related to methodological procedures than to the nature of the research universe. The response rate of the questionnaires was strongly influenced by the ease of access to former scholarship holders and by their interest in taking part in a FAPESP evaluation study. Considering the higher involvement of PhDs in the academic environment, this was the group most interested in answering the survey, and whose access channels were updated.

Table VII summarizes the information on the personal determinants of entrepreneurship described in the literature, compared to our findings and based on the hypotheses tests.

As discussed earlier, literature in the field is rather fragmented, because it deals with different personal determinants of academic entrepreneurship in cases or small groups of individuals, focusing, for example, on specific countries or regions or even on particular institutions. This prevents the creation of a single set of determinants and the generalization of results. This fact may be related to entrepreneur’s own multifaceted attribute: there is no single type of entrepreneur (Fillion, 2004), and by analogy, there would not be a single type of academic entrepreneur. It is worth mentioning that there are still relevant gaps in the studies on academic entrepreneurship, especially the influence of family income. This article tries to assist this debate, although in a specific context of former scholarship holders of undergraduate, master and PhD research in the state of São Paulo, Brazil. We must consider that the environmental attributes of entrepreneurship, namely, the structures of Brazilian higher education system (marked by elitization) and Brazilian innovation system (low R&D activity in companies) affect the results.

With regard to family income, study results are compatible with the literature, which indicates that this factor positively affects the propensity for entrepreneurship. However, we must consider, according to previous discussion, that the whole sample of former beneficiaries has a similar income profile.

However, although a higher level of academic entrepreneurship of former grantees with higher family incomes may relate to greater access to family’s financial resources, some authors observe that the main benefit associated with family income is the social capital. That is, the access to a network of partners, potential customers and business investors (Edelman et al., 2016).

In the discussion about previous work experience, once again, the similar income profile of former grantees helps to explain why few of them worked during graduation. However, since it is not a significant element for our sample, it has little effect on the propensity for entrepreneurship.
<table>
<thead>
<tr>
<th>Determinants</th>
<th>Literature</th>
<th>Hypothesis</th>
<th>Field research</th>
<th>Test result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family income</td>
<td>In general, entrepreneurs come from middle- or upper middle-class families</td>
<td><strong>H1</strong> – Researchers from higher-income families are more prone to become academic entrepreneurs than those from lower-income families</td>
<td>Academic and nonacademic entrepreneurs come from middle or upper classes</td>
<td>Confirmed</td>
</tr>
<tr>
<td>Professional experience during college</td>
<td>Work experience is one of the factors that explain the involvement with entrepreneurial activity</td>
<td><strong>H2</strong> – Researchers who work during their undergraduate studies are more likely to become academic entrepreneurs than those who did not work during this period</td>
<td>It is not possible to state that professional experience during college has affected entrepreneurial activity</td>
<td>Rejected</td>
</tr>
<tr>
<td>Academic education</td>
<td>Higher education is a determining factor of entrepreneurial activity, but in the case of academic entrepreneurship, there is no consensus in the literature. More experienced scholars have a higher tendency to become involved with entrepreneurial activities but not necessarily with the creation of firms</td>
<td><strong>H3</strong> – The higher the researchers’ level of qualification, the higher the probability of becoming academic entrepreneurs</td>
<td>Academic entrepreneurship is higher at undergraduate level, and PhDs are little entrepreneurial</td>
<td>Rejected</td>
</tr>
<tr>
<td>Gender</td>
<td>There is a higher participation of men, both in general entrepreneurship and in academic entrepreneurship</td>
<td><strong>H4</strong> – Male researchers are more likely to become academic entrepreneurs than female researchers</td>
<td>The difference between male and female participation in academic entrepreneurship is small, with a slight advantage for men</td>
<td>Confirmed</td>
</tr>
<tr>
<td>Area of study</td>
<td>There is evidence that researchers in applied areas, such as Engineering, are more prone to entrepreneurship</td>
<td><strong>H5</strong> – Researchers from Biological sciences and Engineering are more prone to become academic entrepreneurs than researchers from other areas</td>
<td>The majority of academic entrepreneurs are former scholarship holders in Applied Sciences</td>
<td>Confirmed</td>
</tr>
</tbody>
</table>
With regard to the level of education, we observed that the rate of academic entrepreneurship is higher at the undergraduate level, and PhDs are less entrepreneurial. This finding confirms the proposition by Louis et al. (1989) that the entrepreneurial initiative of creating companies has a negative relationship with academic activity, measured by the number of publications.

One possible explanation for this behavior is the global trend for PhDs to seek professional positions in their own universities, based on teaching and research (Bin et al., 2015). This situation is not only the reflection of a tradition in PhDs’ education – largely centered on the self-reproduction of the academic model – but the lack of opportunities to work in sectors other than education, especially in developing countries and the lack of encouragement for entrepreneurship (both in terms of public policies and the way PhD education takes place). In Brazil, a recent report by CGEE (2016) on PhDs’ trajectory proves this model.

However, when we consider entrepreneurship in general, the situation is a bit different. University graduates and PhDs are similarly involved in entrepreneurial activities but with less emphasis than masters.

Regarding gender, our findings partially confirm the literature, because in the case of academic entrepreneurship, men have a slight advantage, but among nonacademic entrepreneurs the number of women is higher (77 per cent). We must also consider the contextual element, since among research scholarship grants in Brazil, especially for graduate studies, men are the largest beneficiaries (Artes, 2013).

One factor that may have influenced these numbers concerns the greater difficulty of women to follow an academic career because of time and effort devoted to the family (Jacobs and Winslow, 2004; Probert, 2005; Winslow, 2010). Faced with difficulties at the university and with professional placement, some of these women may be starting their own businesses, whether or not related to the research they developed. This hypothesis should be explored in future studies.

Finally, data on entrepreneurial activity and knowledge areas confirm the literature, with the Applied Sciences area standing out in both academic and general entrepreneurship. This is an important result, considering that former scholarship holders have a fairly equal distribution among knowledge areas, except for Applied Social Sciences and Linguistics, Literature and Arts, where numbers are lower.

6. Final remarks
The purpose of this article was to contribute to the understanding of the profile of entrepreneurial researchers in the Brazilian academic context, with focus on the state of São Paulo. It contributes to the development of the topic of academic entrepreneurship in the country, both from the conceptual and empirical points of view, based on the presentation and discussion of data on the entrepreneurial activity of a sample of former scholarship holders of undergraduate, master and PhD research.

From research results, we can conclude that the researcher’s family income, level of education, gender and knowledge area are factors associated (to a greater or lesser degree) with academic entrepreneurship. That is, higher family income, lower levels of education, male gender and more applied areas of knowledge shape the profile of the academic entrepreneur. On the other hand, a previous work experience during graduation does not have a direct relationship with entrepreneurial activity.

These conclusions find support in the literature on academic entrepreneurship, as well as in the profile of undergraduate and graduate students of public universities in the state of São Paulo, who comprise the majority of those that apply for FAPESP undergraduate,
master and PhD scholarships. As already mentioned, there is evidence that public higher education in Brazil is elitist; the upper social class drives its resources to careers of higher economic returns, and research scholarships’ grantees are mostly men.

In addition, results also find support in the configuration of the National Innovation System in Brazil, especially marked by higher R&D investments from the public sector – mainly in universities and research institutes – compared to private investments. The low level of entrepreneurship (academic and nonacademic) of the research sample is surely a reflection of this configuration.

It is worth mentioning some limitations of the study. The first and most evident is the sample cutting, as data refer to the group of individuals who requested a scholarship to FAPESP under the categories undergraduate, master and PhD, which was granted or denied. It is a group with special attributes, mostly made up of students from public universities in the state of São Paulo, with academic performance and supervisors’ profile compatible with the Foundation’s criteria.

The second important limitation concerns the set of explored variables, since, as discussed in the literature review, the determinants of academic entrepreneurship are often classified into three groups (environmental, organizational and personal determinants). By the nature of the research that originated this article, we favored more objective personal determinants.

The third limitation concerns the concept of academic entrepreneurship used in the study. Although the focus was the creation of start-up firms, literature describes a much broader scope for the concept – although there is no convergence on such boundaries yet.

Hence, although the paper brings important conclusions, we expect that future studies related to entrepreneurial activities of former undergraduate, master and PhD students will be conducted with a wider universe of individuals, addressing other determinants and including new types of academic entrepreneurship to get a broader understanding of this phenomenon.

On the paper developments in terms of policies and strategies, we can highlight three points. The first concerns the need for greater encouragement to academic entrepreneurship in Brazil, especially for masters and PhDs, whose main recipient today is the education sector. This reflects the lack of opportunities in other economic sectors because of limited investments in research, development and innovation in the country but also to PhD education, focused on self-reproduction. This means that in Brazil masters and PhDs have few employment opportunities outside the academy, and that graduate courses do little toward an entrepreneurial qualification that supports these students, so that they can identify business opportunities from the results of their research. Therefore, it is urgent to rethink master and PhD education, as has been discussed globally (Gould, 2015; Thiry et al., 2015) and also locally (Schwartzman and Balbachevsky, 2014), with emphasis on new possibilities of action, including the entrepreneurial activity.

FAPESP’s own experience with the Small Business Innovative Research Program (PIPE) is a path in this direction, as it stimulates the association between academic researchers and companies for the development of research projects, aiming at technological innovation (Salles-Filho et al., 2011). Initiatives for the creation of an industrial academic PhD, still recent in Brazil, also strengthen such changes.

The second issue, still less explored, refers to the creation of incentives for entrepreneurship in Basic sciences. Although we expect more entrepreneurial activity from former students of Applied sciences, it is necessary to rethink how to create alternative paths and careers for graduates from other areas.
We can highlight a third implication of the research, although of a more comprehensive nature than the others, and with an indirect relationship with the discussion developed in the article. This is the problem of the elitization of access to higher education in Brazil, which is naturally reflected in the profile of the local academic entrepreneur. We understand that the incentives previously mentioned and associated with the democratization of access to higher education may not only expand academic entrepreneurship in Brazil but also make family income less determinant for this type of activity.

Such political orientations could contribute to the dissemination of results from research developed in Brazil, so as not being restricted to the scientific community but also used by society and local industry. In addition, such guidelines can assist in establishing new possibilities of professional trajectories – including entrepreneurship – for graduates of higher education in Brazil. Therefore, we could expect positive impacts on the country’s indicators of technological, economic and social development.

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Appendix
As presented in the methodology section, data used in this paper came from a more extensive research. This appendix shows part of the questionnaire used in that research, emphasizing the relevant questions for the discussion on entrepreneurship.

Topic 1 – stages of academic education

- First, write your name.
- Indicate how many undergraduate courses you have concluded in your academic path and/or if you are currently attending an undergraduate course.
- Indicate how many undergraduate researches you have concluded during the undergraduate course previously mentioned. Consider as indication of conclusion the delivery and approval of the final report of the undergraduate research. Undergraduate researches that were renewed to continue the initial research project must count only once.
- Identify the big area and the prevalent knowledge area of your undergraduate research.
• Indicate how many academic masters, PhDs and direct PhDs you have concluded in your academic trajectory. Consider as indication of conclusion the presentation and approval of the dissertation or thesis.
• Identify the big area and the prevalent knowledge area of your Master, PhD and direct PhD research.

Topic 2 – socioeconomic profile
• Write your gender.
• At the beginning of your academic trajectory, what was the monthly family income? Consider as family income the sum of your income with the income of the people who lived with you. Consider as the beginning of your academic trajectory the moment immediately before you begin to attend an undergraduate course.
• Did you work (or do you work) during undergraduation? Consider as a work situation the one in which you had (or have) a formal link with the company/employer organization and salary, including internships of different kinds.

Topic 3 – professional trajectory
• Did you have any occupation/employment link after the conclusion of your undergraduate course? Do not consider post-doctoral as occupation/employment link; only consider occupations/employment links where you stayed for at least one year; do not restrain yourself to links related to your academic and research path that you eventually developed afterwards.
• For the first and final occupation/employment links after the conclusion of your undergraduate course, mention the work regime or relationship (Civil servant; employee with signed work permit; employee without signed work permit; serviceman at the Army, Navy, Air Force, Military Police or Fire Department; self-employed/autonomous/consultant (private individual); employer/businessman; volunteer)
• Were you one of the founding partners of this firm/employer organization?
• To what stage of your academic education is the creation of this company/organization mainly related?

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Technological cooperation network in biotechnology

Analysis of patents with Brazil as the priority country

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Abstract

Purpose – The establishment of partnerships between companies, government and universities aims to enhance innovation and the technological development of institutions. The biotechnology sector has grown in recent years mainly driven by its cooperative business model. Compared to other countries, this sector is slowly advancing in Brazil, with delays in science, technology and innovation, especially in the private sector. This paper aims to examine, through social network analysis, the collaborative networks between institutions that filed patents in biotechnology – medicinal preparations from plants – whose inventions had Brazil as the priority country.

Design/methodology/approach – The study of technological cooperation using patent documents is a reliable approach as they serve as good indicators of the interactions between organizations that focus on innovation and development of new product. Social network analysis of cooperation networks helps to understand the connections between patent assignees, and how they establish relationships.

Findings – Results show that public universities are the institutions that most deposit patents, as well as those that co-operate the most, especially Universidade of Campinas. The study also reveals the critical role of Research Support Agencies in stimulating research and technological development, which result in new technologies.

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1. Introduction
According to the Organization for Economic Cooperation and Development (OECD, 2008), innovative potential depends on how knowledge progresses and on the structure of connections of each country’s National Innovation System (NIS). In this regard, the importance of establishing partnerships between companies, government and universities, aiming to enhance technological innovation, has been discussed and emphasized over the years in studies that address NIS (Freeman, 1995; Nelson and Rosenberg, 1993; Lundvall, 1992), open innovation (OI; Chesbrough, 2003) and, more recently, the joint-product orientation (Foray and Lissoni, 2010).

In an NIS, the innovative process occurs through the flow of technology and information between the actors of this system, who can be individuals, companies, universities, governments and research institutes, among others. Regarding the same issue, the triple helix innovation model is based on the relationship between government, industry and university. The latter is the driver of connections with the production sector of goods and services, represented by industry and with the government, which regulates economic activity (Leydesdorff and Etzkowitz, 1996). On the other hand, OI stresses the ability of organizations to effectively articulate the use of their internal and external resources, such as ideas, skills, projects, infrastructure, technologies and capital (Rogbeer et al., 2014). Therefore, this model requires organizations to open their borders to enable innovations from internal and external combinations of resources, in view of two main objectives: to absorb external assets and to allow the licensing of the internal means that the firm will not use, avoiding the loss of investments already made (Chesbrough, 2003).

Yet, Foray and Lissoni (2010) present a proposal for the management of research, development and innovation (R&D&I), where they replace the vertical structure (by-product orientation), by a shared vocation, the joint-product. This view considers that products with shared technology achieve better results in terms of sales, in addition to lower R&D costs and risks. The development process must be shared with the most competent actors since the beginning, by involving companies and universities to shape strategic relationship networks.

The determinants of a stronger cooperation between institutions, as well as their beneficial effects for innovation, are well established in the literature. However, more studies are necessary to improve the visualization and interpretation of these relationships, allowing the identification of the main actors and those more prone to establish partnerships, as well as the dynamics of collaboration between institutions over time. The innovation process is complex, and the way actors interact with each other can define the result of the cooperative effort. As interactions between institutions to achieve innovative results shape a network structure, a valuable tool for understanding and better viewing cooperation between firms, government and universities is to use the metrics and concepts of social network analysis (SNA).

This study, in addition to presenting SNA’s methodological features to measure cooperation between institutions, examines a sample of cooperative projects on medical preparations that contain products of plant origin, which resulted in joint technological development with patent applications, where Brazil is the first country of deposit. The basis
of the study is the success of the new business model, flexible and open to partnerships, which the biotechnology sector has taken advantage of in the recent years. It focuses on a specific segment related to herbal products with medical and cosmetic application that were first protected in Brazil. This is a relevant topic as the variety of Brazilian biomes reflects the enormous richness of the country’s flora and fauna, which houses the largest biodiversity in the planet. The country owns about 20 per cent of the world’s biodiversity, and the largest regarding plants, with more than 50,000 listed species of trees and bushes. Higher plants, although better indexed, are still far from a reliable total count, and there are estimates that 10 per cent of the Brazilian species have not yet been cataloged (Lewinsohn et al., 2001).

This paper presents an analysis of the global scenario of these patents with the evolution of filings over the last 20 years, the main inventors and the kinds of actors – companies, universities and research institutes. It also shows the profile of the partnerships between institutions and highlights the main patent holders with technological capability to generate inventions that adopt the collaborative R&D business model.

Following the introduction, the structure of the article consists of a theoretical background on the positive aspects of establishing cooperation, and the importance of adopting SNA for its study. In sequence, we present the methodological approach used in the study, the results and discussion and at the end, the conclusions and future perspectives.

2. Literature review

2.1 Technological cooperation networks to foster innovation

Collaborative R&D efforts for new technologies are common in several companies and sectors, and their relevance to the innovation and technological development has been highlighted under different views. Crespo et al. (2015) argue that the knowledge built over the years through R&D management studies proves the importance of collaborations, which lead to higher capacity for innovation and growth. Geum et al. (2013) observe that the benefits of collaborative efforts are evident and stem from the use of external knowledge, which results in diversification of technological skills and increases the pace of production of new technologies. In a recent study, Su (2017) drew on the phenomenon of economic globalization to investigate the interdependency between R&D global partners, pointing to the relevance of international partnerships, which would increase the creation and flow of knowledge, along with the expansion of potential applications of the developed technologies.

Mitze et al. (2015) conducted a survey in Germany to measure R&D performance in small and medium companies; they concluded that the most important R&D performance indicators are higher in organizations that make collaborative efforts, in comparison to those that do not conduct them. Spanos et al. (2015) also used surveys to investigate the impact of R&D partnerships funded by governments on the innovation of products and processes, as well as on the inimitability of technologies; they concluded that companies that cooperate show a better performance. Masum et al. (2013) suggest ten rules that should be applied for the effective execution of collaborative R&D and open innovation, suggesting that such efforts can help minimize the two main problems of technological development: the complexity and high costs of applying scientific developments to produce changes and social advances. According to the literature review, globalization is one of the big reasons collaborations have become more important and attractive, especially since the culture of foreign direct investment intensified, as of the 1990s (Su, 2017).

Regardless of the advantages that literature associates with collaborations, one of the major challenges is the correct identification and selection of partners (Geum et al., 2013), and there is evidence that partnerships between private companies and universities have the
highest potential to achieve good results (Mitze et al., 2015). As for the information used in studies of collaborative networks, bibliographic data (Geum et al., 2013) and patent data (Crespo et al., 2015; Mitze et al., 2015; Su, 2017) prevail.

Although still not as plentiful as abroad, Brazilian studies on collaborative networks and on cooperation in R&D activities are growing in national literature. Alonso-Arroyo et al. (2016) conducted a survey to analyze research collaborations between Brazilian and Spanish institutions in the medical sector, through bibliometric analysis. They concluded that the amount spent on collaborative research as well as the number of collaborations have increased significantly in Brazil, either through partnerships with European and Latin American countries or with the USA. Another study used SNA to investigate scientific cooperation in nanotechnology in the agricultural sector, and observed a strong integration between Brazilian researchers in this area (Campos et al., 2017).

A study led by de Sousa et al. (2015) observed that R&D collaborations improve the flow of knowledge which positively influence the performance of Brazilian industrial firms as well as the rate of success in product innovation. They further expanded the analysis and concluded that collaborative efforts between private companies and public sector organizations bring economic benefits by stimulating the country’s growth and improving the performance of the national innovation system. Gomes Costa et al. (2018) examined the curricula of researchers, between 1980 and 2010, to investigate scientific collaborations in biotechnology in Northeastern Brazil. They observed the formation of some collaboration clusters (based on geographic proximity and laboratory infrastructure), although with a stronger emphasis on intra-institutional partnerships.

The literature on R&D collaborative networks in biotechnology shows that all the advantages of cooperation mentioned before apply to this sector. In addition, owing to their own features, collaborations for scientific and technological development in this field have an even more relevant role as they focus on knowledge and innovation; therefore, companies that make alliances for technological development are more likely to get patents (Al-Laham et al., 2011).

Regarding intellectual property policies, Stevens et al. (2016) noticed that there is a strong trend in the biotechnology sector to use public–private partnerships (PPPs) to develop better therapies. Chen and Lin (2016) concluded that biotechnology companies should maintain partnerships with universities to increase their innovation capabilities and improve the marketing of new products. After examining potential trading strategies for biotechnology products, Fernald et al. (2015) mention three types of collaborations used in this sector:

1. informal interactions and knowledge transfer within clusters;
2. intellectual property licensing and collaboration agreements; and
3. acquisition of small companies that hold intellectual property.

Other studies restate the advantages of collaborative efforts for this sector. Such collaborations would be advantageous for companies by bringing faster advances to technological development (Eslami et al., 2013), by providing start-up companies with the necessary expertise to market their products (Fernald et al., 2015) and by facilitating the transfer and absorption of skills that result in innovations and new products (Al-Laham et al., 2011).

Collaborations are important for biotechnology owing to the multidisciplinary profile of this sector: they involve multiple institutions of different kinds (Powell et al., 1999); they facilitate the flow of information between the participating organizations (Hazir and Autant-Bernard, 2014); and they allow access to external knowledge, which is an efficient way to
achieve strategic competitiveness (Al-Laham et al., 2011). In addition, collaborations in biotechnology result in better products, more innovation and lower risk of development (Kamuriwo and Baden-Fuller, 2016) and the increase in knowledge flow from cooperation efforts may be an advantage for companies of this and other high-tech sectors (D’Amore et al., 2013).

2.2 Social networks analysis related to cooperation studies

SNA is considered an appropriate method to view the relationships between network participants, and has gained relevance in scientific articles (Su, 2017), with applications in several cases (Chen and Lin, 2016; D’Amore et al., 2013; Schiffauerova and Beaudry, 2012). In SNA, the network is a non-linear, decentralized, flexible, dynamic structure, with undefined boundaries, self-organizing, established through horizontal relations of cooperation (Borgatti and Halgin, 2011; Tomaël et al., 2006). Nodes, also called actors, spots or vertices, are the discrete units that connect to each other through their intrinsic attributes, previously defined by the researcher. Their study stems from the analysis of the relationship between these nodes, also called a link or arch. Such relationships can be divided into directed, where actors either transmit or receive connections, and nondirected, where they carry out the two functions simultaneously.

Among the studies that investigated the results of R&D&I through network analysis, two main areas of application stand out. One aimed at understanding how networks can affect economic activity, such as R&D and patenting in an industry; and the other focused on the ability to reveal the process of networks formation and their influence on a particular topic. Cantner and Graf (2006) applied SNA to describe the evolution of the innovation network in Germany between 1995 and 2001; Owen et al. (2012) focused on R&D cooperation by comparing the organization of scientific research in the USA and Europe through network analysis.

A second set of papers shows the use of SNA to study the relationship between common academic inventors in patenting processes, with a focus on different technological categories (Balconi, et al., 2004). Paci and Batteta (2003) investigated localized transfer of knowledge and examined technological networks represented by patent citation flows in different sectors. Studies on collaboration networks seek to explain the performance of individual actors by using the attributes of the network where they take part, by describing the structures of the collaboration network or even justifying the network’s development and dynamics (Van Der Valk and Gijsbers, 2010).

Bazzo (2010) analyzed technological cooperation that resulted in patents in Brazil and found that subsidiaries of foreign firms, universities and research institutes exhibit a low sharing of patent ownership; that is, they do little cooperation, which is an indication of the institutional fragility of local innovation. The number of publications and patents in common is a very important indicator for measuring innovation activities and knowledge interaction between actors (Inzelt, 2004). A recent study, also using patent data, carried out a dynamic comparative analysis of interorganizational innovation networks of Brazilian and Spanish biotechnology companies, and used SNA to design and measure network attributes (Gomes et al., 2017). Results showed an impressive growth of innovation networks in the two countries, but Brazil had a lower rank in terms of frequency, volume of partnerships, diversity of partners and the main types of actors.

Patent data are one of the key indicators used by researchers to evaluate R&D&I results (Jaffe and Trajtenberg, 2002; Trajtenberg, 1990). Although they are not perfect indicators (Dosi, 1982), they are a significant factor of income generation from technologies, especially in industries that require large R&D investments, such as the chemical–pharmaceutical,
responsible for launching active agents and formulations, and the biotechnology. Patent analysis provides key information to executives in charge of research and development, technological policies or technological strategy in a company (von Wartburg, Teichert and Rost, 2005; Yoon and Park, 2004), especially in the biotechnology sector.

Along with information technology, this is the fastest growing industry in the twenty-first century (Gartland et al., 2013). Global market was estimated at US$369.62 billion in 2016 and is expected to reach US$727.1 billion in 2025, mainly owing to the establishment of partnerships (Grand View Research, 2017). The largest segment of the biotechnology market is healthcare and medical applications, accounting for 66.2 per cent of the total market value (Soh and Subramanian, 2014). With the increasing importance of this sector and large R&D investments and efforts worldwide, it becomes critical to ensure appropriate protection for the new and revolutionary technologies (Gupta and Subbaram, 1992; Karki and Garg, 1993).

3. Methodology
The study is an exploratory–descriptive research of qualitative and quantitative nature, regarded the analysis of patent databases in biotechnology, especially the use of plants (and their derivatives) for the formulation of drugs and cosmetics. As an indicator of technological production, we used the patentometrics technique, associated with the analysis of co-ownership of patents filed primarily in Brazil. With this study, we expect to present an overview of the patent scenario in a segment of biotechnology, as well as to understand how institutions established partnerships that resulted in patent filings. Next, we present the topic of the research; how we accessed, collected and analyzed the patent database; and finally, how we used the SNA approach to study cooperation between institutions.

In the last decades, great expectations emerged regarding potential developments in biotechnology. Brazil has been following this process and has systematically implemented policies for its evolution. Among the most relevant aspects of these policies are the support of new companies and the growth of the business sector devoted to biotechnology (Bianchi, 2013). The mastery and use of modern biotechnology require access to advanced technologies that are already available in developed countries; in Brazil, these are located in regions where academic, technological and business development are strongly concentrated, such as Southeast and South regions (Gomes Costa et al., 2018). Thus, this shows the critical importance of establishing partnerships.

The rich Brazilian biodiversity is one of the most important global sources for the development of phytocosmetics and drugs that contain active principles of plant origin. The cosmetics sector benefits from it and has gained prominence in recent years. Cosmetic preparations with natural raw materials grow at considerable annual rates in the international market, between 8 and 25 per cent above the observed growth rates among products formulated with synthetic ingredients. Owing to the wide diversity of chemical derivatives from plant extracts, which have different actions, a major effort is taking place to generate investments in research and development for the discovery of new drugs containing natural ingredients. About 30 per cent of the available drugs derive directly or indirectly from natural products, mostly from plants. In diseases like cancer, the use of drugs derived from plants is even higher, reaching 60 per cent (Boldi, 2004; Newman et al., 2002).

Although Brazil has a huge biodiversity, it has not been able to develop a significant amount of innovative products. The local industry of herbal drugs holds a technical capacity and is willing to invest in new products; however, it has faced practical difficulties that
obstruct and sometimes render impossible the realization of its projects (ABIFINA, 2011). Hence, it is extremely important that the country keeps investing in the sector, and to do this, it is necessary to join experiences and share knowledge through institutional partnerships.

3.1 Patent database
We selected the technological area by using the International Patent Classification (IPC) code A61K 36/00, which addresses “Medical preparations of indeterminate constitution containing material from algae, lichens, fungi or plants, or their derivatives”. These include all subgroups, except codes A61K 36/02 to A61K 36/09, which deal with drugs that contain materials derived from algae, fungi and lichens (WIPO, 2017). We extracted the patent database from Derwent Innovation database, of Clarivate Analytics, by searching patents using the field “IPC Current”, for all IPCs previously described, along with the field “Publication year”, between 1995 and 2014.

Next, we used the subfilter for adding the country “Brazil” to the field “Priority Country”. Altogether, we examined 191 IPCs’ classes and subclasses, totaling 225,327 International Patent Documentation (INPADOCs), of which 466 were object of the research. We selected all INPADOCs’ families resulting from the search and exported them in a Microsoft Excel file, to create the patent database. Due to the 18-month confidentiality period, we decided not to include the years 2015 and 2016 as most of the patents of this period have incomplete information.

3.2 Document analysis and data preparation
Information on patent number, country code for technology protection, inventors, holders (assignees), date of publication and filing of patents and technology areas (IPCs) were collected for further comprehensive analysis of the documents and graphic design. We standardized the names of all patent holders using the OpenRefine freeware tool (openrefine.org), to generate the collaboration networks.

3.3 Social network analysis
We carried out the building and analysis of cooperation networks according to the method and protocol described by Pereira and Porto (2018) and Pereira et al. (2018) and their adaptations. Briefly, information of assignees and code of all patents, represented by INPADOCs, were grouped in an Excel spreadsheet. The presence of co-owners in the “Assignee” field indicates partnership relationships, and as peers share more patents between them, higher is the weight given to the link between holders. We uploaded data on patent code and owners to freeware Gephi (www.gephi.org). To analyze data, we created a bipartite network, containing a spreadsheet of nodes (patents and holders) and a spreadsheet of edges (patents related to their owners). In the global network, nodes’ sizes were adjusted according to their degree, and the color according to their category (patents in blue and owners in red). The holders’ network was created by using the plug-in Multimode Networks Transformation (https://github.com/jaroslav-kuchar/Multimode-Networks), which eliminated patent nodes and turned them into a criterion of link between holders. Standard statistical measures available in Gephi were used, such as modularity (Blondel et al., 2008), average degree, weighted average degree and centrality. The network of the largest holders was extracted from the global network through the “ego network” filter, following the node’s ID command.
4. Results and discussion
The study addressed the analysis of technological collaboration networks that resulted in patents in biotechnology related to drugs and cosmetics containing products of plant origin and their derivatives (IPC classes A61K 36/10 to IPC A61K 36/9068), whose invention has Brazil as the priority country, that is, the first country where patents were filed. Altogether, we found 742 documents, of which 466 INPADOCs (patent families), that is, distinct inventions that were first filed in Brazil. The trend line shows that since 2006, there has been an exponential growth in the number of patent publications in this topic in Brazil [Figure 1(a)].

Notes: (a) Rising trend curve of the number of patent publications over 20 years; (b) global coverage of patent documents deposited primarily in Brazil. A total of 466 patent documents (INPADOCs) were analyzed according to the country code of where the patent was deposited or granted.
This considerable increase in the number of patents may reflect the National Policy for Medicinal Plants and Phytotherapics, approved by Decree No. 5,813, of June 22, 2006. This policy favors the safe access to these plants and their rational use in Brazil, with the development of technologies and innovations, as well as the strengthening of chains and productive arrangements, for the sustainable use of Brazilian biodiversity and the growth of the Healthcare Productive Complex (Ministério da Saúde, 2006).

We also examined the inventions with regard to the coverage of countries where patents were filed or granted, after the first request in Brazil. Results showed that of the 466 INPADOCs, 378 applied for protection only in Brazil, 69 were filed internationally through Patent Cooperation Treaty (PCT) and 8 were filed in the USA. Requests for protection at the Canadian and Australian offices followed, with six and three inventions, respectively [Figure 1(b)]. It is worth noting that although Brazil has several native plants with technological potential, shown by patent requests, most of them are still filed only by foreign companies (Moreira et al., 2006).

Among the technological areas represented by IPCs, which classify inventions, we highlight the top 10 IPC codes [Figure 2(a)]. The two most frequent, with 68 documents each, were A61K 8/97 (cosmetics or similar preparations for personal hygiene characterized by a composition containing materials or their derivatives of unknown plant origin constitution, such as plant extracts) and A61K 36/185 (medicinal preparations containing materials of undetermined constituents derived from dicotyledonous plants). In sequence, with 66 documents, comes IPC A61K 36/28 (medicinal preparations containing materials of undetermined constituents derived from Asteraceae or compositae plants – family of the aster or sunflower – like chamomile, tansy, Aquileia or Echinacea) and IPC A61K 36/48 (medicinal preparations containing materials of undetermined constituents derived from Fabaceae or leguminosae plants – pea and legumes) [Figure 2(a)]. Plants of the family Asteraceae and Fabaceae are the most diverse in number of species found in the country (Giulietti et al., 2005), which justifies the higher number of patents in these specific classes.

Among patent holders, we found 51 universities, with 200 documents (with proprietary technology or in collaboration). On the other hand, we identified 56 companies as assignees of 100 patents. These results show that although the number of universities is smaller than the number of companies, they have twice the potential to generate technologies (represented by patents) in this sector. Another fact that confirms this finding is the
presence of public universities among the seven largest patent holders [Figure 2(b)]. On this issue, Soh and Subramanian (2014) argue that collaborative R&D efforts in biotechnology are extremely important because universities and research centers are those that develop more technologies in this area. In Brazil, companies are much dependent on knowledge generated by universities, which are their main partners (Gomes et al., 2017). The use of knowledge produced at Science and Technology Institutions (ICTs) represents a rich source of information and qualification for the development of new technologies; once transferred to the manufacturing sector, they promote an alternative and complementary path for companies to reach a higher technological level (Garnica and Torkomian, 2009).

In a list of the top 15 patent holder institutions, the first is University of Campinas (UNICAMP) with 20 filings. Next come the Federal University of Minas (UFMG, Gerais) and University of São Paulo USP) with 14 patents each, UFPR (Federal University of Paraná) in the third place with 13 documents, fourth is the Federal University of Maranhão (UFMA) with 10 and in the fifth place is UEM (State University of Maringá), with nine documents. Among the 15 largest holders, 10 are universities, two are Research Support Agencies (FAPs), two are private companies and one is an individual. It is important to highlight the presence of individuals or inventors as patent holders. Altogether, we found 353 different individuals, either with proprietary technology or as co-owners. Buttow and Steindel (2012) analyzed patent filing in subclass C12N (also related to biotechnology) in Brazil and found that the four largest holders present in our research were the main requesters in the period 2001-2005, showing that these institutions are still operationally relevant.

The network, which shows the connections between patent holders and the patents they share, is called a bipartite network, where two different categories of nodes are displayed (Figure 3). Blue nodes represent the patents and red nodes the holders. The relationship between them is established according to the information of co-ownership in the patent document. The bipartite network has 225 connected components, with a value diameter equal to 13, and average degree equal to the weighted average degree of 1,627; that is, in this network, the holder relates to the same patent only once (that is why the edges have a weight equal to 1). In addition, we identified the node of higher centrality of the eigenvector type – UNICAMP – as the node of greatest influence in the network, owing to its connections.

The technology collaboration network between the holders emerged from the general network, through the application of the multimode networks transformations plugin, available in Gephi (Figure 4). In this case, the network only shows the connections between the holders (nodes), represented by the patents in partnership and the number of patents they share, which is an element that affects the weight of the edge (edge thickness) that connects the nodes. In this case, the collaboration network has 477 nodes (or holders), among which are companies (56), governmental institutions (17), universities (51) and inventors registered as holders (353). The technological cooperation network has 222 components, with a value diameter equal to 6, average degree of 3.11 and a weighted average degree of 3.417, showing that partnership relationships are still scarce. UNICAMP stands out as the institution with the highest number of connections (45), greater centrality of intermediation and greater centrality of the eigenvector type, assuming the role of the holder that most builds partnerships among Brazilian institutions. UNICAMP was previously cited as the second largest requester of medicinal plants, specifically the use of andiroba, only behind Fiocruz (Amaral and Fierro, 2013).

Although UNICAMP is the institution with the largest number of cooperation agreements, these have resulted, at most, in two patents with the same partner; this means that cooperation relationships are not persistent and lasting, and the institution is not...
In this respect, it is worth emphasizing that there is indeed a gain in strategic competitiveness by using collaboration, but there is a limit to that gain, and companies must be careful when establishing partnerships to avoid an excessive number of alliances that could undermine their innovative capacities, rather than help them (Fernald et al., 2015).

Among the collaborations with greater sharing of patent ownership, we highlight the Federal University of Viçosa (UFV) with FAPEMIG (Research Support Agency of the State of Minas Gerais), and USP with FAPESP (Research Support Agency of the State of São Paulo), and these collaborations yielded five patents to each institution. This shows the important role of these state agencies for the incentive and strengthening of research and technological development in Brazil. There are also significant partnerships between universities of the same state, such as UFV with Federal University of Ouro Preto (UFOP), in Minas Gerais, and USP with UNESP (São Paulo State University), which resulted in four and three patents, respectively (Table I).

For a better view of the collaboration networks between the institutions, we selected, from the general network of holders, the ego network with depth 2 (except UNICAMP) for the owners with the highest number of patents (Figure 5). UNICAMP’s ego network had

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<tbody>
<tr>
<td>Nodes</td>
<td>943</td>
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<tr>
<td>Edges</td>
<td>767</td>
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<tr>
<td>Average Degree</td>
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<tr>
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<td>1.627</td>
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<tr>
<td>Network Diameter</td>
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</tr>
<tr>
<td>Graph’s density</td>
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<tr>
<td>Connected Components</td>
<td>225</td>
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</tbody>
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Figure 3.
Global bipartite network of interactions among patents and its assignees. The knots in blue are patents and their holders are in red.
depth 1 as the institution has partnerships with a series of other owners and many of them are individuals who, in turn, also have subsequent partnerships; in this case the ego network with depth 2, would be very large, which would hamper the analyses. We highlight that UNICAMP mainly cooperates with individuals, and these collaborations did not result in other patents (few edges with weight above 1).
Yet, in the case of UEM, we observed that it has collaborations that resulted in more than one patent, with private institutions such as Bionatus and Apsen Pharmaceutical, indicating that these partnerships are lasting. In relation to USP’s ego network, we observe a collaboration hub of this university with FAPESP (five patents) and UNESP (three patents), showing a strong connection between them. A recent study that examined patents from the twelve largest Brazilian universities showed the central role of FAPESP in promoting innovation, by interacting not only with universities located in the state of São Paulo, but also with UFMG (Fischer et al., 2018). In our study, FAPESP showed a similar performance, with cooperative ties with the Federal University of Lavras, located in Minas Gerais.

UFMG’s ego network shows the importance of partnerships between geographically close universities located in Minas Gerais, and the relevance of FAPEMIG actions to encourage research that results in innovation. There is also a strong cooperation between distant institutions, such as those in the State of Pará, with collaborations with Federal University of Pará (UFPA), Evandro Chagas Institute, State Secretariat of Public Health and Emilio Goeldi Museum, which shows a common interest of these ICTs toward medicinal preparations containing plant extracts. In a recent study, Gomes Costa et al. (2018) highlight the positive side of partnerships between Northeastern and Southeastern institutions to foster the development of biotechnology in that region, as they observed, through SNA, a strong interaction between UNICAMP and UFRGS with organizations in the Northeast.

Other holders stand out in patent number, but do not invest in technological development in cooperation with other institutions (Figure 6). These are UFPR (13 patents), UFMA (11), Federal University of Santa Maria (UFSM; seven), Chemyunion Química Ltda. (eight), Federal University of Goiás (UFG, six), Solâbia Biotecnologia (five), Douglas Guimarães...
Cucio (inventor with nine patents), UFPI (Federal University of Piauí; four patents) and UEL (Londrina State University; two). These demonstrate that non-participation in collaborative projects that result in technological development is widespread in the country, and not concentrated in regions where research incentives are scarce; and it is an attitude found in both public and private sectors.

5. Conclusion and future perspectives

This study analyzed collaboration networks between institutions that produced patents in a specific sector of biotechnology, and had Brazil as the priority country. Technologies protected by patents regarding medicinal preparations containing plant materials have a high worldwide interest. With more than 200,000 inventions around the world, Brazil has only 466 patent families as the priority country, that is, inventions that were first filed in Brazil, at INPI (National Institute of Industrial Property). The study highlights the importance of cooperative relationships and the advantage of using SNA to better view these ties between actors.

Universities and FAPs are the key drivers of innovation in Brazil, whose actions are seen through the higher number of patent filings and the interactions they establish. However, national participation in innovation in biotechnology is still low, although investments have been a priority of the national policy for science, technology and innovation for more than a decade and the country’s basic science is significant in this area. We conclude that basic science and technology development in biotechnology still lack knowledge transfer that corresponds to the efforts made.

The study has important empirical implications, mainly regarding the urgent need to establish partnerships to create technological solutions that are relevant not only locally, but also for the international market, through decisions that foster the participation of foreign companies in projects developed in Brazil. In addition, we noticed that applied knowledge for the creation of new technologies comes mainly from public universities. Hence, universities must spread this knowledge back to industry, through improved education and qualification of human capital concerned with technology transfer activities (Fischer et al., 2018). In addition,
there are institutions that develop technology separately, but still have a high capacity of innovation, proved by the number of patent requests. These institutions could better use their skills by establishing cooperation with other organizations to promote their innovative efforts and drive new discoveries in the area.

One limitation regards the restricted field that we chose to examine. Although biotechnology related to herbal medicine has an extensive knowledge and technical capacity, the study addressed only part of what the country produces in this sector. Therefore, it is necessary to extend the study to other sectors. In addition, future research should include the analysis of the collaborations of Brazilian institutions with the global market, and investigate if the technologies protected primarily in the country attract the interest of international institutions. Another study proposal that emerges from our results is to check which of the Brazilian institutions that we studied take part in the routes of technology trends.

References


Further reading


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