Innovation in the main Brazilian business sectors: characteristics, types and comparison of innovation

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Abstract

Purpose – *The purpose of this paper is to analyze the innovation process of organizations representing the main sectors of Brazilian economic activity.*

Design/methodology/approach – *The literature review focuses on analyzing the innovation process characteristics regarding the innovation types. The authors carried out interviews with executives and managers in charge of innovation at the leading large companies in the respective sectors analyzed. The data analysis of this qualitative research was structured in three steps. The first step is the analysis of data collected for encoding, the second step, the summarization of the common points presented by the companies in each sector and, finally, the interpretation of these data, aided by triangulation from secondary data that support the analysis of the collected primary data.*

Findings – *The main contribution of this study is to characterize the innovation process of organizations representing the main sectors of the Brazilian economy, with a classification regarding the sectoral innovation standard.*

Practical implications – *The authors' intent is that the paper can contribute with a comparative analysis among companies of the same sector and, subsequently, among companies of the different surveyed sectors. Thus, the characterization aims to present the companies' innovation process and the comparative analysis aims to verify the innovation sectoral patterns. In addition, as implications for management practice, some strategies for better knowledge management in the organization are suggested for each type of innovation.*

Originality/value – *The main theoretical contribution focuses on the development of a conceptual model that structures the analyzed variables of the constructs "innovation process" and "innovation sectoral patterns", allowing not only the characterization but also the comparative analysis of the representative organizations present in the sample.*

Keywords *Innovation, Emerging economies, Process innovation, Innovation in main Brazilian business sector, Types of innovation*

Paper type *Research paper*

1. Introduction

Innovation is crucial for sustainable development and is a source of competitive advantage for organizations in the current context of globalization and market competition (Thomas *et al.*, 2012). Baregheh *et al.* (2009) argue that owing to the increasing dynamism of markets, organizations now have greater interest in innovation, its processes and its management, and keeping in view this organizational context, they innovate to respond to changes in demands and lifestyles of consumers, to capitalize on the opportunities offered by technologies and changing markets.

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The different types of innovation, subdivided into technological innovations (products/services and processes) and non-technological (organizational and marketing; The Organization for Economic Co-operation and Development [OECD], 2005), are influenced by aspects related to the company's characteristics, business environment, market dynamics and country's development level (Figueiredo, 2005; Hobday, 2005; Laursen and Meliciani, 2002; Singh and Gupta, 2009; Quintane *et al.*, 2011), as well as particularities identified in the sector in which the company operates (Pavitt, 1984). The study of sectoral innovation patterns has received highlighted attention of the academy in recent decades. The sectoral perspective in the company's innovation process is a direct consequence of the Schumpeterian economic view, according to which the innovation process is the result of the technological accumulation process in the sector, causing a change in the state of economic equilibrium owing to, for example, the introduction of a new product that faces a monopoly (Castellacci, 2008; Frank *et al.*, 2016; Gault, 2018).

Eveleens (2010) highlights the growing trend of the emergence of models that seek to describe the innovation process, its implications and patterns. However, it is still noticeable that the identification of the most appropriate model for each situation is still at an incipient stage, which drives the assessment of what occurs in the different sectors of the economy.

According to Malerba (2006), sectors differ greatly in terms of market structure and organization of innovative activities. In this sense, Castellacci (2008) explains that innovation patterns differ according to the sector in which the company operates. In some sectors, these activities are concentrated in a few companies, while in other sectors, innovation patterns are distributed through a large number of companies. These patterns were found in several industries, and might be related to the concentration of the sector and its technological level, among other factors intrinsic to the organizations that make up them (Malerba, 2006).

In general, the literature on the subject of sectorial innovation presents three aspects of sectoral innovation studies: sectoral, sectoral trajectory and relational views. The sectoral view focuses on the dynamics and competitive process of the sector, with technological opportunities, knowledge base and adaptation conditions that distinguish innovative activities in different sectors. The sectoral trajectory view focuses on the understanding of the industry's technological trajectories as well as a variety of characteristics of the companies' innovative strategies. The relational view focuses on the study of inter-organizational relationships to explain the patterns of innovation in the different sectors (Dosi *et al.*, 1990; Lee and Malerba, 2017; Pavitt, 1984; Frank *et al.*, 2016; Kaiser, 2002; Laursen and Meliciani, 2002; Corradini and De Propris, 2017).

The main objective of this research is to analyze the innovation process of organizations representing the main sectors of the Brazilian economy. The selection of sectors is based on its importance to the Brazilian economy, with five sectors belonging to the industrial economic activity (automotive, consumer goods, pharmaceutical, telecommunications and creative and high technology industries [ECAT]) and one belonging to the services sector, which is the banking sector [Instituto Brasileiro de Geografia e Estatística (IBGE), 2014, 2017a, 2017b; Federação Brasileira de Bancos (FEBRABAN), 2017]. In this manner, first, the article intends to present inherent peculiarities to the innovation process of each sector, and then, be carried out the classification of the innovation process from the variables of the construct innovation. In the sequence, the comparative analysis presented aims to verify the innovation pattern across sectors, showing their similarities and differences. Finally, as implications for management practice, we present for each type of innovation some strategies for the best knowledge management in the organization.

To achieve the objectives of this study, developed a literature review focuses in four theoretical elements:

1. innovation and its typology;
2. sectoral determinants of innovation;
3. sectoral innovation standards; and
4. innovation and knowledge management.

Regarding the methodological aspects, considering the objectives, the study can be positioned as a qualitative exploratory–descriptive study. Considering the research method, the study can be positioned as the multiple-case study. The primary data collection was through interviews with executives and managers responsible for innovation in the large companies leading the respective sectors analyzed. The data analysis method was structured in three stages:

1. analysis of the data collected for coding;
2. summarization of the common points presented by the companies in each sector; and
3. interpretation of the data through the primary and secondary data collected.

2. Theoretical framework

Innovation can be defined as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations" (OECD, 2005, p. 46). In addition to this definition, Tidd *et al.* (2005) define innovation as a process that seeks to develop the practical use of a previously conceived invention, thus representing the diffusion and the effectiveness of an idea. It is noteworthy in this manner, the difference between invention and innovation, as not every invention becomes innovation, keeping in view that such innovation is only truly effective if it 0is implemented and the market accepts it. The next section reviews the types of innovation and its typology.

2.1 Innovation and its typology

Innovation concepts are grounded in the principles of creative destruction and the economic cycle, developed by Joseph Schumpeter in the first half of the twentieth century. According to Schumpeter (1939), economic development is driven by innovation through a dynamic process of evolution, capable of destroying the old models, replacing them with new ones.

According to the Oslo Manual (OECD, 2005), innovation can be classified into four types: product, process, marketing and organizational. Utterback and Abernathy (1975) explain product innovation as new technologies or technological combinations introduced in the market to meet its demands and needs. In turn, process innovations are differentiated by new uses of the workforce, information and flows, job specifications and inputs of materials used in production.

The Oslo Manual (OECD, 2005) also deals with the marketing innovation and organizational innovation. The marketing innovation considers the amendment or adaptation of the company's marketing strategies. However, it is necessary to apply new marketing methods, involving significant improvements in the product design or packaging, price, distribution and promotion (OECD, 2005; Tidd *et al.*, 2005) as well as in new forms of marketing and products distribution (Oliveira *et al.*, 2014). In addition, Gupta *et al.* (2016) present research that relates competitiveness and innovation in marketing through the understanding that marketing innovation is a result of the competitiveness of the brand and its resellers. Organizational innovation, in turn, takes into account the changes in the company paradigm, in other words, the adoption of new mental models in the guidance of business activities and the workspace reorganization (OECD, 2005; Tidd *et al.*, 2005). Considering a more current view, the innovation coming from the business model consists in the generation and maintenance of value for the main stakeholders through innovation in value

proposition, the relationship with customers, the segmentation of clients, relationship with the distribution channels and the development of partnerships that consist of the main structural elements of the business (Teece, 2010; Foss and Saebi, 2018). Table I summarizes the main types of innovation, classified according to the business area in which they occur.

As innovation involves the success in the development, implementation and use of new or structurally improved products, processes, services or organizational forms, the literature review on the subject reveals that the definitions and typifications of innovations are quite diverse (Adams *et al.*, 2006; Eveleens, 2010). In this manner, the very categorization of innovations can be made differently. This research proposes the classification of innovations as:

- technological or non-technological;
- according to the novelty degree;
- the impact degree; and
- the control degree over the innovation process.

In relation to the novelty degree, innovations can be classified as radical or incremental. Radical innovations are more revolutionary as they assume long-term investments aimed at creating something new in a current market. Radical innovation can encompass products, processes or services that provide unprecedented performance characteristics or yet, attributes already known that generate significant performance or cost improvements and alter existing markets or create new markets, generating a new value proposition for society (Chandy and Tellis, 1998; Stringer, 2000; Leifer *et al.*, 2002). In turn, incremental innovations are carried out from the use of current technologies and knowledge to improve products already existing in the market or to improve production processes, becoming relevant, not only for the cumulative effect of the changes provided but also for the versatility generation (Utterback and Abernathy, 1975; Abernathy and Clark, 1985). Hobday (2005) points out that the incremental innovations can provide significant gains in business productivity and quality of manufactured products, and encompass processes that may consider the absorption of capabilities and technologies. This view expands the concept of innovation as it considers improvements beyond the development of new products and processes. It is worth noting that according to the Oslo Manual (OECD, 2005), the minimum requirement to consider something an innovation is that the change introduced has been new to the company. However, two other concepts can be highlighted: the creation of something new to the market or to the world.

Regarding the impact degree, there are, in addition to the radical and incremental innovations, explained above, the disruptive innovations, which refer to those that usually start in unattractive and/or limited markets and that, after improvements and replacement of

Table I Types of innovation

Type of innovation	*Characteristics*
Technological innovations	
Product innovation	Development of a new product, service or a combination there of
Process innovation	New methods to perform value-adding activities (example: production, distribution) better or cheaper
Non-technological innovations	
Marketing innovation	New *marketing* methods related to the product, packaging, product or brand positioning, promotion or pricing
Organizational innovation	New methods of organizing, coordinating and controlling employees, tasks and responsibilities

Source: Adapted from OECD (2005)

existing technologies, have a significant impact on the market and on the economic activity of companies in this market. This impact may, for example, change the market structure, create new markets or make existing products obsolete (Christensen and Overdorf, 2000). Disruptive innovation involves the development of products with lower performance and lower prices. These products still meet the needs of some consumers because they are a little simpler and much less costly. However, it is a mistake to assume that disruptive innovation boils down to delivering simplified versions of the company's core products.

As innovation is disruptive in nature, it must change the company's business model (Christensen, 1997). Chesbrough (2010, p. 1) recalls the importance of innovative business models as "a mediocre technology with a good business model is better than a mediocre business model explored by means of an ingenious technology". Thus, disruptive innovation contrasts with the concept of radical innovation as the latter, also known as revolutionary, has the attribute of transforming the relationship between consumers and suppliers, restructure economic aspects of the market, destabilize existing products and originate completely new product categories (Leifer *et al.*, 2002; Feder, 2018). It should also be noted that this classification proposes an approach based on the innovation impact degree and not on its novelty degree.

Regarding the control degree that the company has over the process, the innovations can be classified as open or closed. The open innovation model contrasts with the traditional innovation model that prevailed during the twentieth century, called closed innovation. In the traditional model, companies relied on research and development (R&D) processes, which took place in their internal laboratories to hold a sustained competitive advantage (Chesbrough, 2003). Unlike this approach, open innovation is based on the premise that in a world where knowledge is widely available and dispersed, companies cannot rely solely on their knowledge and internal capabilities to innovate. One of the basic principles of open innovation is the recognition that not all components for a breakthrough are sourced from internal sources and that knowledge from outside sources can make their own innovation-driven efforts more effective or broader (Witzeman *et al.*, 2006; Oliva *et al.*, 2011; Bellantuono *et al.*, 2013; Hussein *et al.*, 2016; Natalicchio *et al.*, 2017). Thus, it is observed a transition from a closed research and development model to an open and interactive model of seeking solutions. This search will happen from within and from outside the organization in which the interactions among organizations play a significant role (Chesbrough, 2003). Table II summarizes the typologies presented in this section.

2.2 Sectoral determinants of innovation

The heterogeneity in the companies' innovation capacity has been persistent and widespread over time. Such a fact can be justified by the presence of idiosyncratic resources of the organization itself (capital intensity, company size, intention to innovate

Table II Typologies of innovation

Classification	*Detailing*	*Main authors*
Innovation type	Technological Non-technological	Utterback and Abernathy (1975), OECD (2005), Tidd *et al.* (2005)
Business area	Product, process, marketing or organizational	OECD (2005)
Novelty degree	RadicalIncremental	Abernathy and Clark (1985), Leifer *et al.* (2002)
Impact degree	Disruptive Non-disruptive	Christensen (1997), Christensen and Overdorf (2000)
Control degree over the innovation process	Open Closed	Chesbrough (2003)

Source: Prepared by the Authors (2018)

and absorption capacity, among others), as well as by the different standards imposed by the sectors in which they are inserted. Each sector of the economy presents its own dynamics of change and, consequently, its own dynamic of opening windows of opportunities to innovate (Malerba, 2006; Valladares *et al.*, 2014; Lee and Malerba, 2017).

In Brazil, studies on innovation suggest that the companies' technological behavior is subject to four main variables: the sector, the technical system of production, the size and origin of the company's capital (De Nigri and Salerno, 2005). In turn, Figueiredo (2005) understands that at least one of the following components would sustain the technological capacity of a company or industrial sector: physical technical systems, staff, organizational system, products and services. However, such capabilities may be associated with sectoral characteristics. For example, Quadros *et al.* (2002) emphasize that in the computer sector the introduction of product and process innovations is more frequent than that observed in the food sector.

Still on the subject, Quadros *et al.* (2002) found that in Brazil, there is a high concentration of R&D activities in the scale-intensive sectors and in sectors with suppliers specialized in mechanics and electrical. This result suggests that the innovative activities of Brazilian companies are most closely related to the nature of industrial sectors compared to more advanced industrialized countries. The authors explain this result by the very pattern of industrialization followed by the country, characterized by the strong stimulus to the basic input industries in the 1970s and 1980s.

Quantitative studies with large databases show certain characteristics of the Brazilian productive sectors in relation to business innovation. Basing his study on data from the Annual Industrial Survey (PIA), Innovation Research (PINTEC) and OECD, Zucoloto (2004) points out that scale-intensive industries that are dominated by suppliers (such as the industry of food, beverages, tobacco, textiles, clothing, leather and footwear) carry out more innovation processes as compared to science-and-technology-based industries. The science-and-technology-based industries, in turn, have more specialized suppliers and tend to innovate more in their products. Another study based on more than 30,000 companies and 34 Brazilian industrial sectors offers a quantitative analysis on national innovation sponsored by the Brazilian government (PINTEC). In this study, Frank *et al.* (2016) shows that Brazilian companies choose one of the two strategies when they invest in activities of innovation inputs: market-oriented innovation or innovation in the acquisition of technology.

In general, it can be said that some sectoral factors are crucial in the innovative activities of the companies, for example, the concentration degree, the technology level and the industry's level of expertise. Table III presents a compilation of the main factors of this issue, identified in the literature.

2.3 Sectoral innovation standards

Nelson and Winter (1977) explain that the diffusion of new technological paradigms in the economic system, and the way companies start to use them, influence the rise and fall of different industries and technologies. According to this thinking, the authors state that the industrial sectors whose knowledge base and capabilities are directly involved in the production and use of radical innovations have a greater set of opportunities and, therefore, tend to follow trajectories that are more dynamic.

On the basis of this knowledge, empirical research on sectoral patterns of innovation has developed rapidly in recent years, investigating both the characteristics of the innovation process in specific sectors as well as the inter-sectoral differences in relation to technological activities (Castellacci, 2008). A group of studies has focused on sectorial technological schemes, pointing out the various features, such as technological opportunities, knowledge base and appropriateness conditions, which distinguish

Table III Sectoral determinants of innovation

Factor	*Description*	*Reference*
Competitiveness and international competition	Dosi *et al.* (1990) state that there is a positive externality generated by the knowledge obtained from the R&D activities of rival firmsScott (1997) further states that R&D investment by industrial companies tends to increase in response to foreign competitionIn the Brazilian context, Cordovil (2004) states that exporting companies are involved in the innovation process more frequently than non-exporting companies do	Cordovil (2004), Dosi *et al.* (1990), Scott (1997)
Innovation strategy	Brazilian companies choose one of the two strategies when they invest in activities of innovation inputs: market-oriented innovation or innovation in the acquisition of technology	Frank *et al.* (2016).
Size of the companies	Studies suggest that the company's innovative performance has a direct and positive influence on the organization size	De Nigri and Salerno (2005), Valladares *et al.* (2014), Lee and Malerba (2017)
Participation of foreign companies in the sector	Zucoloto (2004) concludes that, observed by sector, there is an inverse correlation between the relative technological effort of the sector and the participation of foreign companies in the sectoral net operating revenue	Zucoloto (2004)
Regulatory environment and government incentives	Political aspects can influence the company's innovation process. Porter and Van der Linde (1995) suggest that industries are more likely to innovate in response to environmental regulationsGovernment incentives and the establishment of sectoral policies can support sectors of the economy with varying degrees of intensity. Such projects have, as benefits, the access expansion of the small companies to funds, the promotion of entrepreneurship and the development of areas considered priority by the governmental guidelines	Morais (2008), Nelson (2006), Porter and Van der Linde (1995)

Source: Prepared by the authors (2018)

innovative activities in different sectors (Dosi *et al.*, 1990; Malerba, 2006; Lee and Malerba, 2017).

Other set of studies, rather than focusing the dynamics and the competitive process of the sector, analyze more closely the innovative strategies that companies follow in different sectors of the economy. In this case, the understanding of the sector technological trajectories is emphasized, as well as a variety of features of the companies' innovative strategies. One of the representatives of this study trend is Pavitt (1984), one of the first authors to analyze the technological trajectories in the investigation on the innovation sectorial patterns. Having the innovative company as the central focus, Pavitt (1984) emphasized that the sectoral technological trajectories are largely determined by the company's main innovative activities. Thus, the different activities can generate different technological trajectories. These different technological trajectories, in turn, can be explained by the sectoral differences in terms of technology sources, demand requirement (*users' requirement*) and consequent possibilities of knowledge appropriation (Pavitt, 1984). More recent studies confirm patterns of strategies in the process of business innovation. Frank *et al.* (2016) identify two main strategies when companies invest in innovation activities: market-oriented innovation or innovation in technology acquisition.

A study strand, recent in this field, deals with inter-organizational relationships to explain competitiveness patterns in different sectors (Kaiser, 2002; Laursen and Meliciani, 2002). The reason for this is that the systemic nature of the innovative process emphasizes the importance of the set of interactions, cooperation and exchanges among producers, suppliers and users of new technologies. Thus, these inter-sectoral exchanges are crucial factors in the study of innovation patterns across sectors. Corradini and de Propris (2017), in the current study, show empirical evidence that bridging platforms are likely to more effectively connect innovations in distant technological domains, promoting inter-sectoral technology integration and the development of original innovations.

It is important to note that in recent decades, the introduction of radical innovations related to the semiconductor industry and subsequently to the sectors of software and telecommunications, has been also decisive to the advancement of many other sectors. The growth of the service sector, for example, is closely related to the emergence of this new technological paradigm. On account of this, it is important not only to understand whether the innovation takes place in the productive or service sector, but also to evaluate them in an integrated manner. Thus, the interconnections and influences among sectors can be identified, when walking vertically or horizontally along the production chain (Castellacci, 2008). In line with this thought, Weber and Shaper-Rinkel (2016) argue that in intensely innovative scenarios, the boundaries among sectors tend to decline. Innovations carried out by a particular industry influence others; for example, innovations in the textile sector influence the automotive and agricultural sectors and innovations in the automotive sector, such as the electric car, are linked to innovations in energy storage technologies. Bearing this in mind, the analysis of sectoral relations, their features and interdependencies, must be taken into account for an effective policy of sectoral innovation.

Table IV presents a summary of the main strands regarding the study of sectoral innovation.

2.4 Innovation and knowledge management

As already mentioned, the innovation process can be understood and classified in different ways: technological or non-technological; radical or incremental; disruptive or non-disruptive; open or closed; local or reverse innovation. Innovation first and foremost is an organizational state of mind. Innovation is a concept that must permeate all the processes of the organization that uses this resource to promote changes in the business environment or to respond to changes in the business environment (Utterback and Abernathy, 1975; Tidd *et al.*, 2005). In this manner, the adoption of the innovative culture promotes improvements in the products offered to society, improvements in production processes with efficiency gains, improvements in marketing activities and in the business model, which makes it possible to better fulfill the economic and social role of organizations (Cegarra-Navarro *et al.*, 2016; Hernández-Mogollon *et al.*, 2010).

In an increasingly volatile, complex, ambiguous and uncertain environment, organizational agility is an imperative concept for meeting the changes required by customers, suppliers, government and other important agents of the business environment. The proper interpretation of the opportunities and threats of the business environment to know what to change, the internal change of products and processes and the effective supply of tangible and intangible assets in search of value creation for stakeholders are the three pillars of sustaining the dynamic capabilities of an agile organization (Teece, 2007; Teece *et al.*, 2016). In this sense, the characteristics of the agile organization as mentioned facilitate from

Table IV Studies' strands of sectoral innovation

Sectoral view	*Sectoral trajectory view*	*Relational view*
They focus on the dynamics and on the sector competitive processTechnological opportunities, knowledge base and appropriateness conditions that distinguish innovative activities in different sectors Dosi *et al.* (1990) (Malerba, 2006) Lee and Malerba (2017)	Emphasis is given to the understanding of the sector technological trajectories, as well as to a variety of features of the companies' innovative strategies Innovative strategies that companies follow in different sectors of the economy Pavitt (1984) Frank *et al.* (2016)	It emphasizes the study of inter-organizational relations to explain the innovation patterns in the different sectors Kaiser (2002) Laursen and Meliciani (2002) Corradini and De Propris (2017)

Source: Prepared by the authors (2018)

the acquisition to the application of knowledge in organizational processes, thus increasing organizational performance through efficient and effective knowledge management (Cegarra-Navarro *et al.*, 2016).

As mentioned, the innovation process presents itself differently in the various sectors of the economy. In this manner, the demand for change manifests itself in different ways in relation to expected speed, intensity and impact. Either way, innovation is imperative, and managing it efficiently and effectively can be the key to organizational success. Considering the classic process of innovation – design, definition of scope, elaboration of planning, development, testing and validation and launching – demand, in each step, specific knowledge; for example, the innovation design demands knowledge of the consumer market, existing technologies and emergencies and other knowledge. Knowledge management is an administrative tool that must be closely connected with innovation management. Considering the stages of definition, acquisition, dissemination, storage, application and evaluation of knowledge, it can be considered that each step can be more important to meet the specifics of innovation of each company in its sector of activity in the economy; for example, high technology sectors demand that the stage definition of knowledge be more intense in the identification of opportunities that sustain the dynamic capacity of an agile organization. Thus, the integration between the innovation processes and the knowledge management processes demand from the organizations certain capacities to coexist with different situations imposed by the business environment, which, for example, awaken the need of the organizational ambidexterity to coexist with incremental innovations and disruptive innovations (Darroch and McNaughton, 2002; Darroch, 2005; Singh, 2009; Cooper, 2014; Oliva, 2014; Inkinen, 2016; Teece *et al.*, 2016; Bilgili *et al.*, 2016; Natalicchio *et al.*, 2017; Boari *et al.*, 2017; Petruzzelli *et al.*, 2018; Cegarra-Navarro *et al.*, 2018).

3. Methodology

3.1 Methodological aspects

Keeping in mind the proposed objectives, this article adopts the research qualitative approach, consisting of a set of interpretative techniques that seek to understand and give meaning to the given phenomenon (Cooper and Schindler, 2011). This approach includes the understanding and the perspective of the agents involved in the researched phenomenon (Creswell, 2007; Flick, 2009; Godoi and Balsini, 2006). Specifically, in this research, the interviews focus on executives or senior managers involved with the innovation of their company and the industry of their business. The focus on these professionals is because the objective of the research is concentrated on identifying the opinion of the main managers involved about innovation in the sector in which their company operates; essentially the focus is the identification of the characteristics of innovation in the sector economic of the company, not specifically the innovation in the company of the interviewee. Thus, executives or senior managers from three leading companies in each researched sector were chosen: banking, automotive, consumer goods, pharmaceuticals, telecommunications and creative economy and high technology. Certainly, the innovation in the respondent's own company is evaluated when we ask about innovation in the sector of action of your company.

As for the objectives, it is classified as exploratory–descriptive. Exploratory, because it seeks to develop a better understanding of innovation in Brazil, and descriptive, because it seeks to concomitantly describe the innovation process in the main sectors of economic activity (Cooper and Schindler, 2011; Hair *et al.*, 2005).

The multiple-case study was the preferred method because it allows the analytical generalization and the understanding of the issues involved as from multiple evidences (Yin, 2010). Yet, unlike the single case study, the multiple case study method allows the identification of similarities and differences among the analyzed cases (Eisenhardt, 1989;

Eisenhardt and Graebner, 2007; Yin, 2010). Therefore, this article is a qualitative, exploratory–descriptive study of multiple cases of organizations representing the main sectors of Brazilian economic activity.

3.2 Conceptual model

To meet the proposed objectives, a bibliographical research was carried out to identify the main concepts and models that seek to describe both the process of innovation in companies and the sectoral patterns of innovation. From this, the conceptual model represented in Figure 1 was developed, which presents the conceptual definitions of the constructs "innovation process" and "innovation sectoral patterns".

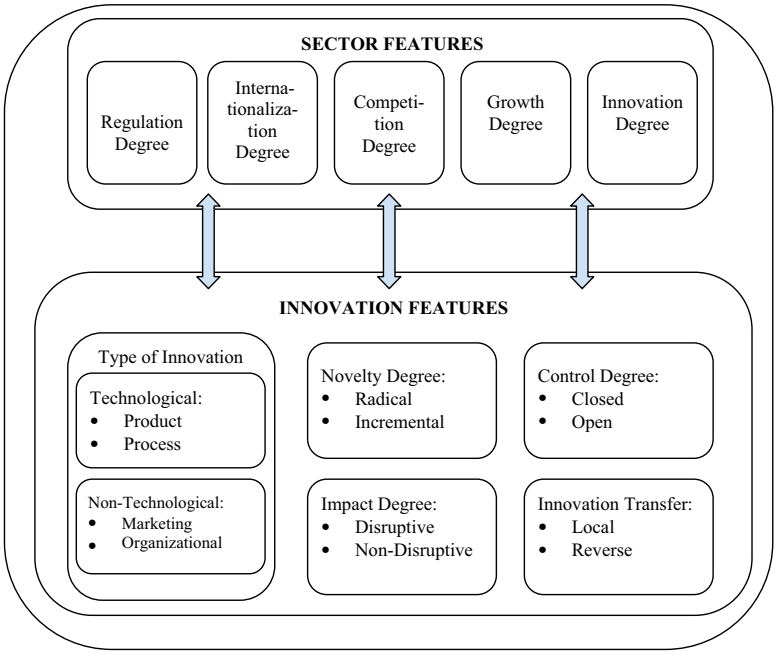
Figure 1 presents the two dimensions involved, the innovation process and the sectorial patterns of innovation, while the vertical arrows represent their inter-relations. Circumscribed to each dimension are the concepts derived from previous works and operationalized in five features of each dimension. Table V presents the features of each dimension of the conceptual model and summarizes the theoretical reference that originated it.

The resulting conceptual model directs the research development and provides theoretical support as the collection planning up to the case's data analysis, to systematize the observation of each sector in relation to the innovation process. For Gil (2008), a virtue of descriptive research is the use of standardized techniques, such as systematic observation, for the relation of its features.

3.3 Data collect

To research the proposed problem, primary data collection was carried out through semi-structured interview technique. This technique was preferred because it allows the guided

Figure 1 Conceptual model developed for research



Source: Prepared by the authors (2018)

Table V Theoretical framework of the research conceptual model

Dimension	*Characterization*	*Basic theoretical framework*
Innovation sectoral standard	1 – Degree of regulation 2 – Degree of internationalization 3 – Degree of competition 4 – Degree of growth 5 – Degree of innovation	Castellacci (2008), Cordovil (2004), Corradini and De Propris (2017), De Nigri and Salerno (2005), Dosi *et al.* (1990), Figueiredo (2005), Frank *et al.* (2016), Kaiser (2002), Laursen and Meliciani (2002), Lee and Malerba (2017), Malerba (2006), Morais (2008), Nelson (2006), Quadros *et al.* (2002), Pavitt (1984), Porter and Van der Linde (1995), Scott (1997), Valladares *et al.* (2014), Weber and Shaper-Rinkel (2016), Nelson and Winter (1977), Zucoloto (2004)
Innovation process	1 – Type of innovation (technological or non-technological) 2 – Degree of novelty (radical or incremental) 3 – Degree of impact (disruptive or non-disruptive) 4 – Degree of control over the innovation process (open or closed innovation) 5 – Transfer of innovation (local or reverse)	Abernathy and Clark (1985), Chesbrough (2003), Christensen (1997), Christensen and Overdorf (2000), Leifer *et al.* (2002), OECD (2005), Tidd *et al.* (2005), Utterback and Abernathy (1975), Abernathy and Clark (1985), Adams *et al.* (2006), Chandy and Tellis (1998), Bellantuono *et al.* (2013), Chesbrough (2003,2010), Christensen (1997), Christensen and Overdorf (2000), Eveleens (2010), Feder (2018), Foss and Saebi (2018), Gupta *et al.* (2016), Hobday (2005), Leifer *et al.* (2002), Natalicchio *et al.* (2017), Oliveira *et al.* (2014), Schumpeter (1939), Stringer (2000), Teece (2010), Utterback and Abernathy (1975), Weber and Shaper-Rinkel (2016), Witzeman *et al.* (2006)

Source: Prepared by the authors (2018)

conduction of statements through a script, developed from the conceptual model of the research and that, therefore, led to data collection (Cooper and Schindler, 2011; Martins and Theóphilo, 2009).

The interview script presents a brief conceptual introduction for each question to subsidize open answers and direct the issues developed between researchers and interviewees. On the basis of the guidance of the conceptual model of research, structuring of investigative questions has the following logic, divided into two blocks:

1. questions related to the characteristics of the sector; and
2. those related to the characteristics of innovation in the sector in which your company operates.

The questions related to the characteristics of the sector were based on the five elements characterizing the sector:

1. degree of regulation;
2. degree of internationalization;
3. degree of competition;
4. degree of growth; and
5. degree of innovation.

For example, "We consider regulation as the level of government interference in one sector of the economy. In this context, what is the level of regulation of your industry, considering 1 as no regulation and 5 as total regulation? Please provide some examples that justify your response".

The questions related to innovation characteristics in the industry in which his company operates were based on the five elements that characterize innovation:

1. type of innovation;
2. degree of novelty;
3. degree of impact;
4. degree of control over the innovation process; and
5. transfer of innovation.

For example, "Innovation can be characterized as technological and/or non-technological. Technological innovation is product innovation with new technologies or combinations of technologies that are introduced to the market to meet their demands and needs. Non-technological innovations are differentiated by new uses of the workforce, information and their flows, task specifications and inputs of materials used in production. In this context, in your industry, are innovations technological and/or non-technological? Please give an example of each case".

Respondents were also submitted to a third block, which allowed reevaluations with possibilities for reconsiderations or endorsements of previous answers. In this third phase of the interviews, a framework with percentage ratios was associated to the questions and, therefore, enabled the comparison and corroboration of the content in a systematic and aggregate manner.

After completion of the search script, three representative organizations were selected, all of which were established in Brazilian territory, for each of the six sectors studied – banking, automotive, consumer goods, pharmaceutical, telecommunications, the creative and high-technology economy sectors. The selection of respondents, executives and managers of innovation was defined according to accessibility without, however, disregarding their involvement and knowledge on the theme under analysis: the innovation process (Gil, 2008; Godoi and Balsini, 2006).

The data collection strategy aimed to enhance the achievement of specific complementary information, and therefore, it was carried out by 13researchers who were specialists in the various sectors studied, in the period between June and December 2016. The average length of the interviews was of 1 hour and 30 minutes.

3.4 Data presentation and analysis

The methodology used to guide the data analysis was that of Miles *et al.* (2014) because it is adherent to the content analysis and well-structured in three different stages: coding, summarization and interpretation (see Table VI). The textual structure of the data analysis,

Table VI Data analyze stages

Content analysis	*Applied techniques*	*Results achieved*
Coding	*Software* ATLAS.ti version 7.5.10.	Creation of analysis categories through words and key expressions
Summarization	Group common points and points of disagreement	Grouping of categories
Interpretation	Development of descriptive analysis;Confirmatory analysis using secondary data; Triangulation of data	Textual analysis of data, tables and tables of synthesis

Source: Prepared by the Authors (2018)

therefore, is in accordance with the steps, and presents the data exploratory–descriptive analysis for each sector.

After transcription of the interviews and the content exploratory data analysis (EDA), it was used the *software* ATLAS.ti version 7.5.10, licensed from ATLAS.ti GmbH, for the codification of documents and creation of analysis categories. The coding is based on words and key expressions characteristic of common elements of the speeches of each respondent of the respective sectors studied, and allow the composition of representative sentences to the data analysis.

The coded elements summarization was then organized to describe the respondents' points in common and points of disagreement, found in each question, for each sector studied. The specificities and disagreements of each speech are justified as it was possible to observe contributions from them to understand the innovation process of the researched organizations.

The subsequent stage, interpretation, the data analysis, was carried out initially in a descriptive manner and, thereafter, in a confirmatory manner, aiming at understanding the innovation process of the sectors studied; respondents from each sector were called Q1, Q2 and Q3, following the order in which the interviews were carried out. To do so, the data triangulation, a technique that seeks to corroborate the research findings, was of great relevance. In addition to the data textual analyzes, synthesis charts and tables were elaborated, on the basis of the conceptual model, for better presentation, organization, visualization and comparison of the research results.

The text of the result analysis is organized into six parts, one for each economic sector surveyed: banking, automotive, consumer goods, pharmaceuticals, telecommunications, creative economy and high technology. For each economic sector, based on the conceptual model, there are three sub-items:

1. a general analysis of the economic sector;
2. the characteristics of the economic sector: regulation, internationalization, competition and growth; and
3. the characteristics of the innovation of the sector: innovation technological, degree of innovation, degree of impact, degree of control and innovation transfer.

4. Results analysis

4.1 Banking sector

Brazil has a significant banking sector. According to the Brazilian Federation of Banks (Federação Brasileira de Bancos [FEBRABAN], 2017), 173 banks operate here. In the State of São Paulo alone, there are 113 of such banks, followed by Rio de Janeiro, with 15. The ten largest banks, by financial assets, are Banco do Brasil, Itaú, Caixa Econômica Federal, Bradesco, Santander, BTG Pactual, HSBC, Safra, Votorantim and Citibank.

When examining the number of agencies and number of checking and savings accounts, it is noted that the figures are significant. The total number of bank branches in February 2016 was 22,790, of which 7,166 were in the State of São Paulo. The institutions that have the largest branch network are Banco do Brasil, followed by Banco Bradesco. The number of checking accounts in 2014 was 108 million and savings accounts were 130 million (Federação Brasileira de Bancos [FEBRABAN], 2017, pp. 97-106).

According to a survey by Gartner, of the US$51 billion in investments in the IT spending in Brazil, the banking sector accounts for 13 per cent, behind only the Government, which invests 14 per cent. This fact positions Brazil in the seventh position in investments in technology in this segment among the ten largest economies in the world. Of this total, 44

per cent was put into *software*, 35 per cent into *hardware* (equipment) and 20 per cent into telecommunications. Considering these numbers, among the BRICS countries, Brazil is the country that invests the largest percentage of its GDP in IT (Revista América Economia, 2017).

These data, therefore, reinforce the importance of IT development in the banking sector. The application of technologies coming from this segment converges for the development and expansion of the banking services. The next section presents the data analysis of the banking sector.

4.1.1 Characteristics of banking sector.

4.1.1.1 Regulation. Regarding the variable regulation, most of the interviewees considered that innovations in the banking sector, such as innovations in process and marketing, which are represented by innovations in operations and communication with the customer (Q2), are strongly regulated by the Government, through the Central Bank of Brazil (BACEN) and according to guidelines established by the National Monetary Council (CMN; Q1 and Q2). So many regulations limit these innovations development (Q3; Law 4,595, of December 31, 1964). However, innovations can be observed, for example, in the use of *compliance*-enhancing technologies (Q2) and customer relationship (Q3).

4.1.1.2 Internationalization. For the interviewees, the degree of internationalization of the Brazilian banking sector is high, characterized by physical presence in several countries of Europe and the Americas; one of the interviewees (Q2) mentions the participation in international banks' networks. However, this advancement in relation to internationalization still requires further promotion in the operation of the provided basic services of financial transactions when compared to the national ecosystem (Q3).

4.1.1.3 Competition. The presence of a few large players, public and private, holding large portions of the domestic market (Q1, Q2 and Q3) features the Brazilian-banking sector. According to respondents, this market feature does not diminish the sector's competitiveness; on the contrary, it encourages the products and services innovation among them in an attempt to aggregate and provide proposals for differentiated value in the race for market share (Q2 and Q3) but stifles disruptive innovations coming from small banks (Q3).

4.1.1.4 Growth. The growth rate of the Brazilian banking sector in recent years seems to be constant and moderate (Q2). However, based on speeches, it is observed that the growth of the banking sector may be partly influenced by crisis or prosperity times as new types of services such as loans and financing are required by the population, in periods of instability, as well as applications and purchases with credit card are demanded in times of heating consumption (Q1 and Q3). Thus, it is observed that the national economic scenario is directly related to the type of product and service most demanded, while driving innovation to satisfy the latent demand (Q1 and Q3).

4.1.2 Characteristics of banking sector innovation. The sector innovation degree is directly influenced by the BACEN regulation through the policies of the CMN, which, according to the interviewees, decreases the sector innovation capacity when compared to the others (Q2). However, investments in process innovations are common, mainly related to the cost reduction and operations efficiency, through innovations in business models and automation technology (Q1 and Q2).

Innovations in products and services can also be observed. Product innovation occurs through automated products, creation of the recommended portfolio product Brazilian Depositary Receipt (BDR; Q2) and differentiated investment modalities (Q1). In services, for example, innovation occurs through the *online* service and at differentiated times (Q1).

4.1.2.1 Technological innovations. The Brazilian banking sector develops technological and non-technological innovations (Q2 and Q3). Technological innovations are mostly related to the development of new access and customer relationship technologies, aimed at

optimizing and facilitating this process, such as the *mobile banking* and automated service (Q1; Q2; and Q3). The automation of processes is also the focus of non-technological innovations, in the search for lower costs (Q2 and Q3).

4.1.2.2 Non-technological innovations. Technological innovations are the focus of the banking sector when compared to the non-technological innovations (Q1; Q2; and Q3). This can be explained by the objectives of process automation, reduction of costs and the offer of products and services that differ from other market *players*, ability to reach different customer needs through different channels (Q2 and Q3). This last characteristic also drives the development of marketing innovations in an attempt to reach different generations, persuades them as well as differentiates and positions the brand in the context of large *players* (Q3).

Organizational innovations, however, appeared less developed in the sector that is considered hierarchical and structurally traditional (Q3). In this sense, the governmental regulations imposed on the operation are limiting factors for this type of innovation.

4.1.2.3 Novelty degree. In a sector where innovation is highly regulated by government policies and laws, innovations are expected to be mostly incremental. Thus, the innovations developed by the major *players* in the banking sector are usually incremental (Q1; Q2; and Q3), characterized mostly, by improvements in products and processes.

However, the recent radical changes in the way of offering value to customers, through financial products and services, carried out by the so-called Fintechs companies, already seem to draw the attention of the major sector players (Q3). The technological evolution speed is seen as a threat to the financial institutions growth. Thus, integrating and supporting the development of Fintechs, or financial startups, help to develop the offerings of new product and service more quickly, with improvements in price and efficiency, mainly because it is a lean business model and without the need for the enormous structure that banks demand (Revista Exame, 2016).

4.1.2.4 Impact degree. In the same manner that a degree of incremental innovation is expected, non-disruptive innovations predominate in the country's banking sector (Q1; Q2; and Q3), marked by the constant improvements in the service channels and operating processes of financial institutions. Disruptive innovations such as the use of *wearables* and the creation of *Home Broker* are less common in the sector, as noted.

4.1.2.5 Control degree. As for the control degree, the innovations are mostly closed (Q1 and Q3), despite the important role of BMF and BOVESPA as an external source in supplying new products in response to the demands of several *players* (Q2). According to one of the interviewees (Q3), there are occasional open innovations, but these are subject to governmental interferences. The predominance of closed innovations is a result of the high degree of competitiveness among the market *players* (Q1), which allows institutions in ensuring their competitive advantage and differentiate themselves from others.

On the open innovations, it stands out the importance of partnerships among market *players* and universities in the development of new solutions (Q1). According to Varrichio (2016), there is a tendency, adopted by large Brazilian companies, to approach *startups* companies to stimulate innovation. This author emphasizes that the positive point of this movement is the promotion of entrepreneurship and the development of innovation ecosystems, although it presents an unequal relationship, given the different absorption capacities of those involved.

4.1.2.6 Innovation transfer. Local innovations are predominant in this sector, mainly owing to the particular characteristics of the Brazilian market, such as high interest rates and government regulatory policies (Q1 and Q3). Another feature also capable of promoting local innovations is the existence of a few *players* available for the care of a large number of people when compared to other countries. This causes the market to require particular technologies related to the structure and data processing capable of meeting the operation

needs (Q3). Reverse innovation, if any, are more related to the technologies of relationship and customer services, as well as the security of the information systems (Q2 and Q3).

Table VII summarizes the characteristics of the banking sector in the innovation process. This overview allows visualizing, jointly, the innovation process of the studied companies.

This section looks at the banking sector. The next section presents the analysis of the automotive sector, also focused on the variables of the innovation process.

4.2 Automotive sector

The automotive industry is one of the country's main industrial sectors owing to its significant importance for the national productive and technological development. However, after years of growth, the industry is undergoing a period of stagnation as the withdrawal of discounts or exemptions from the Tax on Industrial Property (IPI), with a slowdown in growth in the years 2014 and 2015. In addition, inflation, competitiveness, lack of financing lines for exports, economic crisis in Argentina (main importer of cars and auto parts of Brazilian companies) and rigidity in contracting bank credit are the macroeconomic factors that have impacted this slowdown (Intelligence Bulletin of the Brazilian Service for Supporting the Micro and Small Enterprises [SEBRAE], 2015).

However, even when facing a slowdown, according to the Annual Industrial Survey – Company of the Brazilian Institute of Geography and Statistics (PIA–IBGE), in 2014, of the 89.7 million vehicles produced worldwide, 3.1 million were produced in Brazil, positioning the country as the eighth largest producer of vehicles in the world. Still this year, the revenues (adding auto parts) were U$110.9 billion, exports reached U$11.51 billion and imports, including auto parts, were at U$30.2 billion (SEBRAE, 2015).

Because of the strong economic fluctuations of the last 15 years, amidst recovery and loss of performance in indicators such as production, employment and foreign trade, which aggravated especially after the economic crisis of 2008-2009, the Brazilian Federal Government established public policies for fiscal incentives to increase this sector competitiveness. In 2012, it was sanctioned the Innovate–Auto Program (*Incentive Program for Technological Innovation and Densification of the Productive Chain of Motor Vehicles*), created by Law n. 12,715, of September 17, 2012, with validity (initial) until December 31, 2017 (Lima, 2016).

Macro trends such as innovations related to new drivers based on renewable energy, robotics and automation are opportunities for the sector in general. In this sense, the Brazilian industry stands out with the production and consumption of ethanol and *flex fuel* automobile (SEBRAE, 2015).

Table VII Overview of the banking sector

	Banking sector
Regulation	High level
Internationalization	High level, needs improvement if compared to the national ecosystem
Competition	High level, few players with large market share
Growth	Constant and moderate
Innovation	Influenced by BACEN regulations
Type of innovation	Technological and non-technological
Result of innovation	Mostly in products and processes
Novelty	Mostly incremental
Impact	Predominantly non-disruptive
Control	Open and closed
Transfer	Mostly local

Source: Prepared by the Authors (2018)

4.2.1 Characteristics of automotive sector. 4.2.1.1 Regulation. The variable regulation, in the automotive sector, presents a high level of governmental intervention. According to the grades assigned to this variable, the government plays a key role when it comes to the sector regulation. By regulation, it is understood the degree of government interference in a particular sector of the economy. Regarding the main regulatory policies, there are the taxes, the incentives and the pricing determination. In the legal sphere, there are import and export laws, emissions of pollutants, specifications for automotive vehicle manufacturing, the Incentive Program Innovate-Auto and labor and employment protection legislation.

The incidence of regulatory policies in the automotive sector relates to aspects such as tax and fiscal incentives, and of demand stimulation, aimed at warming the market. The incentives for this sector are conditioned to the execution of specific goals of productive activities, such as minimum investments in R&D, engineering, technological efficiency and product safety. These incentives are linked to determining that part of the goods production process is carried out within the national territory. By complying with these requirements, the company benefits from tax incentives such as IPI reduction and presumed IPI credits for R&D application, technology development, acquisition of strategic inputs and tooling, as well as training of suppliers.

As of 2014, the compulsory law concerning *airbag* device and the ABS brake system for vehicles manufactured in the national territory were established (Brazilian Traffic Code, Law No. 11,910, dated March 18, 2009). The laws for motor vehicles for public transport must also be mentioned. The city of São Paulo seeks the gradual replacement of fossil fuels with renewable energies, with a view to reducing the emission of greenhouse gases (Law No. 14,933, dated June 5, 2009). It is important to mention this law because, in addition to environmental benefits, this law requires changes in the production process of automakers.

The Incentive Program Innovate-Auto, which will be applied until December 31, 2017, is of great importance as this law not only determines how the production process is structured in terms of product specifications and index of nationalization, but also restricts strategic business decisions, determining whether the market focus will be domestic or international. According to legal requirements, the production cost is determined both internally and externally as there is the risk that the cost of the good produced domestically will be higher or lower than its cost of imports.

4.2.1.2 Internationalization. The focus of internationalization in this sector is markets such as Latin America, Africa, the Middle East and Southeast Asia. In the Brazilian case, the importing technology standard for developing the product domestically causes a deficit in the international trade balance sheet as with the technological advancements, there is a need to import technology, which, in turn, generates a downward trend in the export balance of this trade balance. It is interesting to note that respondents Q1 and Q2 highlight this aspect. Respondent Q1 mentions that the Japanese, French, Korean and Chinese companies initially only import technology.

4.2.1.3 Competition. Regarding the competition degree, the sector is highly competitive. Brazil is center of attraction for major automakers in the world, equaling the USA. In this variable, it can be seen once again the incidence of the Incentive Program Innovate-Auto as the companies that establish themselves within the national territory, investing in technology and innovations, benefit from tax incentives. On the other hand, Chinese automakers, as exemplified by respondent Q3, which only aim to install the factory plant without prior investment in these factors, see Brazil as a country that presents barriers to new entrants.

4.2.1.4 Growth. There was a consensus among respondents on the variable economic growth. During the data collection period until today, Brazil is going through a political and economic crisis that directly affects the sector, which is linked to the consumer confidence index and the country economic activity. As the country has high rates of unemployment,

low economic growth and a lower level of consumer confidence, the decrease in sales is thus significant.

4.2.2 Characteristics of automotive sector innovation. The innovation in the Brazilian automotive sector is currently under development, mainly in issues related to energy technologies. Again, the Incentive Program Innovate-Auto has influence on this variable. As conditions to participate in this program, the automaker must comply domestically with the following requirements, as set forth in the decree: the carrying out of manufacturing and engineering infrastructure activities, investments in research, development and innovation, engineering expenditure, basic industrial technology and training of suppliers as well as adherence of the company to the Vehicle Labeling Program.

4.2.2.1 Technological innovations. Technological and non-technological innovations are found in this sector (Q1; Q2; and Q3), driven by competitiveness, regulation and market volatility (Q1). The technological innovations are incremental, and the products present technological evolution when compared to previous versions (Q1; Q2; and Q3) and new products, such as the electric car, for example (Q3). Respondents pointed out also the process improvements as well as acquisition of new materials and the development of production platforms (Q1; Q2; and Q3). Issues such as quality and sustainability are also important for companies in this sector.

Innovations in product and processes are a majority (Q1; Q2; and Q3). Innovations in the process are also of great importance as they aim to reduce costs and the nationalization of components (Q2) owing to the requirements of the Incentive Program Innovate-Auto. In manufacturing terms, the use of substitute materials in the production process is also mentioned (Q1), as well as the deployment of industrial models whose focus is the robotics and the artificial intelligence.

4.2.2.2 Non-technological innovations. The non-technological innovations are the new forms of commercialization and the adoption of organizational models that evolve continuously. Q3 mentions the importance of the service management and sales management. In addition, the company conducts audits to verify the performance in the execution of sales services besides granting awards.

In the legal sphere, Law no. 13,189, of November 19, 2015 also exerts great influence in this sector (Q2). This Insurance–Employment Program influences the labor relations established in the companies.

4.2.2.3 Novelty degree. In the automotive sector, innovations are predominantly incremental (Q1; Q2; and Q3). As examples of incremental innovations, it mentions new design, safety systems, connectivity and interactivity, energy efficiency technologies and new segments (SUVs). Although incremental innovations are the focus, radical innovations should be expanded in the future. As examples are the new forms of connectivity and interactivity, as well as new propulsion concepts (Q2 and Q3).

4.2.2.4 Impact degree. Just as innovations are predominantly incremental in this sector, they are also predominantly non-disruptive (Q1; Q2; and Q3). Even the electric propulsion vehicle does not yet have a significant amount of sales to the extent that it can be said that they have radicalized the market (Q1). Processes also evolve, but there are still no paradigm breaks (Q3).

However, *flex* vehicles (fueled with ethanol or gasoline) are considered a disruptive innovation that significantly affected the market. Today, more than 80 per cent of the cars produced in Brazil are *flex*. Other disruptive innovations may come, such as the standalone car that may be able to change significantly the consumers' relationship with the car, including in property terms (Q2).

4.2.2.5 Control degree. Innovations in this sector are predominantly closed (Q1; Q2; and Q3). Developments are concentrated within the R&D areas of the automakers and suppliers

themselves (Q2). There is a partnership for the development of technologies applied in cars in a closed form, between the original equipment manufacturer (OEM) and suppliers (Q1 and Q3). Abroad, there is currently a partnership between OEMs and universities for the development of new technologies, but this type of partnership is considered closed (Q3) as it serves the purposes of developing new technologies for automakers.

4.2.2.6 Innovation transfer. Innovations in this sector are predominantly local, with few cases of reverse innovation. Most automobile companies currently produce in Brazil global models developed in their headquarters (Q1; Q2; and Q3). The reverse innovations are some car models developed in Brazil (Q1 and Q2) and the *flex* engine, as a technology harnessed to countries where there is a mixture of ethanol and gasoline (Q1; Q2; and Q3).

Table VIII summarizes the characteristics of automotive innovation process. This overview allows visualizing, jointly, the innovation process of the companies studied.

This section looks at the automotive sector. The next section presents the analysis of the consumer goods sector, also focused on the variables of the innovation process.

4.3 Consumer goods sector

The consumer goods industries produce goods for the end consumer, which are commercialized by both, retailers and wholesalers. These products are marketed under well-known brands, which show global presence and are owned by the major companies in the sector (Deloitte Touche Tohmatsu, 2014).

The Monthly Industrial Survey of Physical Production – Brazil (PIM–PF), of the IBGE, produces short-term indicators, which started in the 1970s, for the actual product behavior of extractive and manufacturing industries (Instituto Brasileiro de Geografia e Estatística [IBGE], 2017a, 2017b). Starting in May 2014, the IBGE began to publish a new series of monthly industrial production indices based on the reformulated PIM–PF (Instituto Brasileiro de Geografia e Estatística [IBGE], 2017a, 2017b).

The PIM–PF for the month of March 2017, released on May 03, 2017, presents the national data of the industrial physical production by sections and industrial activities. Among the major economic categories are sections 32 – semi-durable and non-durable consumer goods, with subsection 322 being non-durable consumer goods. The percentage variation accumulated in the last 12 months, based on the previous 12 months, from March 2016 to February 2017, of subsection 322 was −6.8 per cent (Instituto Brasileiro de Geografia e Estatística [IBGE], 2017a, 2017b). In this case, there was a decrease in the industrial activity.

Table VIII Summary of the automotive sector

	Automotive sector
Regulation	High level
Internationalization	Technology import for product development domestically
Competition	High level
Growth	Lower growth owing to the economic crisis
Innovation	Innovation in maturation, driven by the Incentive Program Innovation-Auto and by competitiveness
Type of innovation	Predominantly technological
Resulting from innovation	Majority in products and processes
Novelty	Majority incremental
Impact	Predominantly non-disruptive
Control	Majority closed
Transfer	Local and reverse

Source: Prepared by the Authors (2018)

4.3.1 Characteristics of the consumer goods sector.

4.3.1.1 Regulation. The level of government interference in this sector appears to be quite varied (Q1; Q2; and Q3). This variation occurs in response to the variety of products classified as consumer goods given that these products serve different markets governed by different regulations.

4.3.1.2 Internationalization. In the same way as the variable regulation, the behavior of the variable internationalization also presents relative variation (Q1; Q2; and Q3) in response to the company strategy for the product (Q3). In this regard, some products are primarily produced and sold in the local market (Q3) while others are exported (Q1; Q2; and Q3). By reading the speeches, it is noticeable the growing interest of the analyzed companies by the international expansion of product (Q1) as the markets of each of the product lines are independent and allow this trend.

4.3.1.3 Competition. Intense competition between large market *players* (Q1 and Q2) characterizes the consumer goods sector. In this competitive environment, there seems to be a sort of taking turns dominance of market shares among them, according to the product analyzed (Q2 and Q3).

4.3.1.4 Growth. Despite being a relatively stable market (Q1), the current political and economic turmoil has directly influenced the sector economic growth, as presented by the Q2 and Q3 respondents. Through the increase in purchasing costs owing to currency fluctuations (Q2) profit margins of the companies surveyed are reduced, in addition to the decrease in the volume of consumption (Q1).

4.3.2 Characteristics of the consumer goods sector innovation. In this sector, innovation development is continuous (Q1; Q2; and Q3), mainly in the form of improvements in products of various categories in response to market demands and processes (Q2 and Q3) to maintain and gain competitive advantages, market differentials and market shares (Q1), in a highly competitive scenario. New solutions are also encouraged and developed in response to new consumer needs (Q3).

4.3.2.1 Technological innovations. As for the innovation types, both, the technological and non-technological innovation, are constantly stimulated by the sector, with emphasis on technological innovations (Q1; Q2; and Q3). This is mainly owing to the sector competitiveness degree and the race for improvements and new solutions in products capable of maintaining or increasing the market share of *players* present in the market. However, non-technological innovations, especially in marketing, can also be stimulated by certain companies in the sector, when their purpose is more related to increasing the market share of current product portfolios (Q1).

4.3.2.2 Non-technological innovations. The sector innovations are mostly product and process oriented (Q2 and Q3). However, if the company's goal is to increase the share in the current market, marketing innovations, such as packaging innovations and trade marketing, can be developed as a matter of priority (Q1). Organizational innovations can also be observed in the sector (Q1 and Q3).

4.3.2.3 Novelty degree. As for the novelty degree, the sector innovations are mostly incremental (Q1; Q2; and Q3). The development of incremental innovations is mainly justified by improvements in existing products and processes.

4.3.2.4 Impact degree. Non-disruptive innovations are the most observed in this sector when compared to disruptive innovations (Q1; Q2; and Q3). In other words, most of the sector innovations are not capable of changing the companies' business model, although they stimulate continuous improvements in the processes and products offered to the market. Disruptive innovations, however, such as new paperless gel diapers, for example, are success cases of the domestic sector and demanded a process and technologies re-adaptation of the market production (Q2).

4.3.2.5 Control degree. Although the innovation control degree depends on the segment and on the market leadership that a particular company holds on the market (Q3), it can be said that innovation in the sector is mostly closed (Q1 and Q2). This characteristic intends to ensure the competitive advantages in a highly competitive environment that is consisted of few dominant *players*.

4.3.2.6 Innovation transfer. On the basis of the arguments, with regard to reverse innovation, it can be concluded that the Brazilian market has developed itself as a supplier of technologies and products for the external market, which has enabled the transfer of some innovations developed in Brazil (Q1; Q2; and Q3). Therefore, the innovations are developed for the domestic market, based on the needs of the Brazilian consumer market, and subsequently, if necessary, adaptations are developed to carry out the transference (Q2 and Q1). Existing local innovations come from European countries (Q1), where the headquarters are located, and from then on, they are adapted to the Brazilian market (Q2).

Table IX summarizes the characteristics of the innovation process in the consumer goods sector. This overview allows visualizing, jointly, the innovation process of the companies studied.

This section looks at the consumer goods industry. The next section presents the analysis of the pharmaceutical sector, also focused on the variables of the innovation process.

4.4 Pharmaceutical sector

Although Brazil is not part of the US–Europe–Japan triad, responsible for around 88 per cent of the pharmaceutical industry's worldwide turnover, it presents attractive factors for this sector and has been an investment destination for large international *players* (Radaelli, 2008). Consolidated data for the year 2014 indicated 569 companies in the pharmaceutical and pharma–chemical sector established in Brazil, responsible for 114.8 thousand direct jobs and revenues of R$58.2 billion in that year (Instituto Brasileiro de Geografia e Estatística [IBGE], 2014).

Among the main attraction factors for Brazilian market are the demographic profile, especially the population size and aging and the socioeconomic profile, which has allowed increasing access to medicines in the last decades. In 1995, Brazil used 6.5 per cent of its GDP in health, with constant growth over the years up to 8.3 per cent of GDP in 2014 (World Health Organization [WHO], 2014).

In addition to the socioeconomic factors, it is important to highlight the Brazilian model of universal access to health, which positions the State as a major purchaser of medicines. Between 1995 and 2014, government spending on health accounted on average for 43.5 per cent of total expenditure on health in Brazil (WHO, 2014). For medicines, about 80 per

Table IX Summary of the consumer goods sector

	Consumer goods sector
Regulation	Varied
Internationalization	Varied, in response to the diverse product portfolio
Competition	High level
Growth	Stable
Innovation	Constant
Type of innovation	Technological and non-technological
Resulting from innovation	Majority in products, processes and marketing
Novelty	Majority incremental
Impact	Predominantly non-disruptive
Control	Predominantly closed
Transfer	Predominantly local

Source: Prepared by the authors (2018)

cent of household expenses were for low-cost products. Such local characteristics impose a highly complex and fast-changing business dynamics that show Brazil as one of the most attractive markets for this industry in the world (PricewaterhouseCoopers [PWC], 2013).

Among the challenges of this sector in Brazil are the regulatory risks mainly, which combine legal uncertainties of intellectual property, price maintenance and tax regime. With this complexity, local R&D investments are markedly disproportionate to the market size and, in 2009 – one of the best investment years – amounted to only US$140 million or 0.35 per cent of the world's US$40 billion (PricewaterhouseCoopers [PWC], 2013).

However, the *players* in this sector are far from being homogenous. Haag and Henkin (2013), on the basis of data from the Union of Pharmaceutical Industries in the State of São Paulo (SINDUSFARMA), classify these *players* into three groups of organizational structures and distinct strategies: companies with strategic positioning focused on innovation and product launching; companies that operate the generic products segment; and small companies that produce basic or traditional pharmacology products. Considering the nature of this research, data were collected only for the first group, focused on innovation and product launching.

4.4.1 Characteristics of the pharmaceutical sector.

4.4.1.1 Regulation. The Brazilian pharmaceutical sector is characterized by the high degree of governmental interference, exercised through regulations and policies that control the research activities and product innovation, such as Resolution 196 of the National Health Council (CONEP) and the National Policy of Medicines from the Ministry of Health, up to the marketing itself (Q1; Q2; and Q3). This role is exercised by the National Health Council, the National Sanitary Surveillance Agency (ANVISA) and the Research Ethics Committee (CEP), which, as observed, through criteria that are often overlapped or even conflicting, contributes to the bureaucratization of the sector (Q1) and hinders and burdens the incentive and the process of local innovation (Q1; Q2; and Q3). However, despite being bureaucratic, the Brazilian legal system is unable to reduce the perception of legal uncertainty regarding prices and royalties (Q2).

These characteristics, therefore, encourage multinational companies in their countries of origin to carry out the most complex innovation researches – for example, the development of new molecules – leaving to Brazil only a few initial researches or the development of associations of medicines, which is the combination of already existing molecules (Q3). Bureaucracy, in addition to other Brazilian regulations, makes the sector innovation process slow and financially risky, making it impossible to develop domestic projects of radical innovation in the sector (Q3).

4.4.1.2 Internationalization. International trade in the sector is highly developed and characterized by the presence of large multinational *players* in the market (Q2 and Q3). The production of pharmaceuticals in international chains is common practice in this sector (Q1 and Q3). In other words, the development of a product takes place in an integrated way in research centers of different countries. However, it is more common that the most complex innovations and the development of new molecules are imported into the domestic market given the conditions that make this process more expensive in Brazil (Q1 and Q3).

There are cases of product internationalization. Brazil has, for example, equipment that produces a kind of fermentation that is exported (Q3). Thus, the Brazilian pharmaceutical sector is fundamentally made up by multinationals, in which the export of semi-finished products is more common.

4.4.1.3 Competition. In the pharmaceutical sector, the level of competition is generally moderate (Q1; Q2; and Q3), varying in response to the type of product marketed and the patent intellectual property rights as well as the commercialization. Products with higher value-added and specialization degree have a lower competition when compared to expired patent products, where competition is sprayed (Q2 and Q3). In these markets,

competition is not only in price, but also in quality and even in the distribution channel, which requires significant marketing investments for launches and promotions (Q1). When observed, the patent market also has problems with piracy, copying of molecules and breaking of patents by governmental regulation (Q3).

4.4.1.4 Growth. Progress in access to medicines, which occurred in the last decade in Brazil, stimulated the growth of the pharmaceutical sector, especially toward the production and marketing of basic care products at retail (Q1 and Q3), which stimulated several industries to increase their products lines (Q3) and the price competition (Q1). The diversification of products sold in retail drugstores also contributes to the sector evolution and profitability. Currently, it is possible to find different products, besides medicines, available in Brazilian drugstores (Q3). However, these results are not repeated for industries that work directly with innovative or specialized products, which require them to search for acquisitions and partnerships with generic and similar companies (Q1).

4.4.2 Characteristics of the pharmaceutical sector innovation. Under the current Brazilian scenario, this sector innovation degree has evolved in a timid way (Q1; Q2; and Q3). As pointed out earlier, most innovations and investments in R&D (Q2) of the sector in Brazil are directed toward the production of existing drug associations (Q1) as the financial expenditures for creation of new molecules are high (Q1). The types of innovation in this sector are, for the most part, technological innovations, represented mainly by innovations in associations of existing molecules and, to a lesser extent, the development of new molecules (Q2 and Q3). Non-technological innovations are carried out by changes in the channels and means of product dissemination (Q2 and Q3).

This scenario, however, does not represent the sector history and evolution. Between 1990 and 2000, the pharmaceutical and chemical industries were successful not only in product launching but also in profitability.

4.4.2.1 Technological innovations. All kinds of innovation are observed (Q3). However, product innovations are usually the most developed ones (Q1 and Q2), although financially more costly (Q3). The molecules associations and the development of *blockbuster* drugs, in other words, highly marketable drugs, are examples of this innovation type (Q2). Process innovations are stimulated mainly to overcome the challenges in transforming laboratory production on an industrial scale production (Q1) and to adjust the conventional (Q1) and generic drugs (Q2) production.

4.4.2.2 Non-technological innovations. Organizational innovations happen to meet changes in the manufacturing process, the process of transferring the laboratory production process to a large-scale process and the products suitability (Q1). Innovations in Marketing, both in advertising and in pricing policy (Q1), are also strongly developed in the Brazilian context, which requires constant reinvention of marketing practices as a way of meeting the ever-changing rules and policies (Q3).

4.4.2.3 Novelty degree. Innovation in the pharmaceutical sector are predominantly incremental (Q1; Q2; and Q3), mainly represented by the drug combinations and molecules (Q2), as they are faster and less costly (Q1). The radical innovations developed by the pharmaceutical industry, although rarer, are generally drugs developed to treat more complex diseases (Q1).

4.4.2.4 Impact degree. In this sector, disruptive innovations are characterized by greater complexity in the development of new molecules, which, consequently, generate higher costs (Q1). Thus, non-disruptive innovations are the most common (Q1; Q2; and Q3).

4.4.2.5 Control degree. As for the control degree, innovations in the pharmaceutical sector can be characterized mostly as open (Q1 and Q3) as the complexity of developing a new drug makes the co-creation and the integrated development more efficient (Q1 and Q3). Thus, companies, usually of the same group (Q1 and Q2), associate with one another, or even invest in universities and institutes (Q2), to develop a new product.

4.4.2.6 Innovation transfer. Innovations are predominantly local. In other words, the research and development of new molecules happen mostly outside Brazil (Q1; Q2; and Q3). However, the development and production of new drugs, as seen, happen in an integrated way across multiple partner countries, in which Brazil plays an important role during the clinical phases (Q1). Reverse innovations are observed mainly in the development of products for the treatment of tropical diseases (Q2 and Q3).

Table X summarizes the characteristics of the innovation process in the pharmaceutical sector. This overview allows visualizing, jointly, the innovation process of the studied companies.

This section looked at the pharmaceutical sector. The next section presents the analysis of the telecommunications sector, also focused on the variables of the innovation process.

4.5 Telecommunications sector

The telecommunications sector is made up of the telecommunications services, value-added services and the products used to provide these services (Brazilian Telecommunications Association [TELEBRASIL], 2017). Thus, it includes services of fixed telephony, mobile telephony, SME, satellite telecommunications, internet access providers, transmission and reception of TV and radio signals and installation services.

Data from TELEBRASIL (2017) indicated that in the year 2016, the density of fixed telephones increased by 78.2 per cent and that of mobile telephones, by 2,563.4 per cent. Also in 2016, telecommunications services were provided to 347.1 million subscribers, generating a gross operating revenue of R$56.2 billion and a workforce of 469.1 thousand people.

In addition to the strong regulation, the telecommunications sector has a high burden of taxes and charges. Some of these are charged solely to the telecommunications sector, such as:

- Telecommunication Inspection Fund (FISTEL);
- Fund for the Universalization of Telecommunications Services (FUST); and
- Fund for the Telecommunications Technology Development (FUNTTEL).

FUNTTEL has a leading role in the sector, with the objective of stimulating the process of technological innovation, stimulating the formation of human resources, fostering the generation of jobs and promoting the access of small and medium-sized enterprises to capital resources to increase the competitiveness of the Brazilian telecommunications sector.

Table X Summary of the pharmaceutical sector

	Pharmaceutical sector
Regulation	High level
Internationalization	Products development integrated with foreign R&D
Competition	Moderate
Growth	Moderate
Innovation	Evolve in a timid way
Type of innovation	Technological and non-technological
Resulting from innovation	Majority in products, processes and marketing
Novelty	Majority incremental
Impact	Predominantly non-disruptive
Control	Open and closed
Transfer	Local and reverse

Source: Prepared by the authors (2018)

In addition, in relation to innovation in the telecommunications sector, the Information Technology Law may be highlighted as an important legal framework to foster the development of the sector (former Law 8,248, dated October 23, 1991, which gave rise to Law 10,176 , dated January 11, 2001, as amended by Law 10.664 of April 22, 2003). Such a law grants discounts in IPI, for companies that meet the criteria of Basic Productive Process (PPB) for the production of computer goods and services, including telecommunications equipment.

4.5.1 Characteristics of the telecommunications sector.

4.5.1.1 Regulation. The National Telecommunications Agency (ANATEL) regulates the telecommunications sector in Brazil. As presented by the interviewees, the regulation degree in this sector is high and ranges from the provision of the service up to customer service and support as the form of resources exploration (use of frequencies; Q1). Despite the government interference and as a counterpoint, regulations affect very little the innovation (Q2) and there are some situations where this sector works closely together with the regulatory agency for the development of new services (Q2 and Q3).

4.5.1.2 Internationalization. According to the respondents (Q1; Q2; and Q3), the telecommunication sector has a low degree of internationalization as most of the products and services development are located in R&D abroad (Q1 and Q2). The products developed domestically are intended to serve the Brazilian market.

The dynamics of the telecommunications sector, referring to the procurement procedures by the major consumers of these products and services, discourages the establishment of new market *players* and development of new products in the domestic market (Q1). Thus, products launched in the domestic market are adaptations of products developed in research and development centers outside the country (Q1). Even so, companies in this sector have agreements with telephone line operators in several countries (Q3).

4.5.1.3 Competition. The telecommunications sector has a considerable degree of competition. The industry went through privatizations that were crucial to stimulate competition in the late 1990s, but it has not yet achieved a perfect competition status (Q1). Currently, the competition happens because there are large telecommunications *players* already established in the country. It has also been identified that there is difficulty in establishing new competitors in this sector in Brazil (Q3) because the regulatory agency ANATEL establishes barriers for the entry of new competitors, especially the Chinese ones (Q2).

4.5.1.4 Growth. As presented by two respondents, the telecommunications sector in Brazil has its growth in a saturated state, once it already has most of the demand met (Q1), established technology (Q2) and because of the economic crisis in Brazil. Depending on the product type, growth in the sector is minimal, as in the case of tablets, although for smartphones the growth is faster. The economic crisis in Brazil causes the sector's growth momentum to be contrasting compared to the international dynamics, which has a high degree of growth for mobile devices (Q2).

Growth in the industry is driven by innovation (Q1; Q2; and Q3), highlighting the access by biometrics, *big data, cloud computing* and pressure sensitive screen (Q2 and Q3). Thus, if new disruptive innovations, such as the one that occurred with the iPhone, are not released, growth in the sector is undermined.

4.5.2 Characteristics of the telecommunications sector innovation. The telecommunications sector has a highly innovative profile. The innovations in this sector are related to new business models, massive use of *cloud computing* and *big data*, as well as *analytics*, security and chips, among others, and refer to technologies embedded in mobile devices and services offered (Q1; Q2; and Q3).

4.5.2.1 Technological innovations. The *players* that work in this sector develop technological and non-technological innovations. According to respondent (Q1), the

technological innovations are related to the massive use of *cloud computing, big data, analytics*, *mobile* devices and the *Internet of Things* (IoT) for the development of new products and services that have unmet demand. The technological innovations in this sector are a response to the decline in voice data consumption, especially for mobile operators, and affect other *players*. As for product innovation, there are the novelties that include use of mobile internet network instead of using voice data and improvements in mobile devices. In processes, there are the improvements for self-management of contracts and self-provisioning of services, eliminating part of the service of physical stores and related bureaucracies (Q2).

Respondent (Q3) evaluates that 90 per cent of the innovations in the sector are technological, such as the creation of cloud computing services and new services, logical security of information, anti-hacker services against data theft and the development of IoT contributes to the growth from the company. For the elaboration of new products and services that have unmet demand. The technological innovations in this sector are a response to a drop in voice network revenue, which according to Q3, undergoes a 40 per cent annual reduction. Product innovations include innovations that include using mobile internet network rather than using voice data and enhancements on mobile devices. Among the innovations in processes, there are ongoing improvements and processes aimed at sustainability and recycling (Q3).

4.5.2.2 Non-technological innovations. Non-technological innovations address marketing improvements such as branding, customer relationship and sales and organizational change. According to Q1, non-technological innovations focus on the use of customer information for various purposes, combined with their information from social networks, which can contribute to leverage the development of new products and services still unexplored; currently, this information is used for billing purposes only. In marketing, new business models, in which the customer becomes a user, differentiated services and additional facilities, and the B2B model contribute to revenue generation (Q1). With regard to organizational innovations, the new forms of leadership among teams, new forms of structuring areas such as human resources (HR) and IT stand out. A trend in this sector is the association of telecommunications companies with startups, for the establishment of partnerships aimed at providing integrated services. Respondent (Q2) mentions as an example of non-technological innovation the unique focal point of contact with the customer, so that the company can offer any type of product. In marketing, we highlight the facilities of new business models for individuals and business users (business-to-business; Q1 and Q2). The issue of the brand is also decisive in this sector as companies must pay attention to the degree of recognition of their brand by the customer, making it present when the customer thinks about technology.

4.5.2.3 Novelty degree. The telecommunications industry has undergone a period of radical innovation with the entry of the iPhone mobile device and later with the launch of the iPad, both Apple products. After this phase, there was the prevalence of incremental innovations, being presented to the market through devices such as smartwatches, wearables and IoT. These technologies need further maturation, such as device-integration, system and technology standards and market aspects (Q2). Respondent (Q3) highlights new products such as cloud computing. According to Q1, the telecommunications sector presents radical and incremental innovations, with radicals occurring less frequently than incremental innovations, which are continuously developed and are the sequel to a radical innovation. Among the radical innovations, SMS messages are presented in portable devices, the smartphones, which bring the computing power for use in mobility and touchscreen. Among the incremental innovations are the improvements in smartphones, color screens, functionalities and applications. Therefore, the innovations are predominantly incremental (Q1 and Q2).

4.5.2.4 Impact degree. Regarding the degree of impact, there are disruptive innovations in the telecommunications sector, such as WhatsApp, which have altered the way voice data are used, threatening the current forms of tariffs charged by mobile operators (Q1), as well as the introduction of wearables and television sets smart TVs (Q2) and new forms of data storage, cloud computing (Q3). Non-disruptive innovations focus on the customer's choice of service usage volumetric and on new business models such as prepaid plans (Q1).

4.5.2.5 Control degree. Respondents (Q1; Q2; and Q3) state that the development of innovations occurs in a closed way in most companies in the telecommunications sector. Respondent (Q2) states that there are some exceptions, such as strategic partnerships or the development of operating systems, which result in open innovation.

4.5.2.6 Innovation transfer. Innovations are local (Q1 and Q2), predominantly developed in matrices and adapted (or "tropicalized") to the Brazilian market to meet their characteristics and suitability to local regulation (Q1 and Q2). Part of this centralization is the protection of developed technologies (Q2). For other markets, there are also adaptations to local legislation and regulation. Countries such as China and India have part of the development provided by the low cost of labor. In Brazil, specifically, companies seek incentives, such as the Law of Good (Law No. 11,196, of November 21, 2005), for the development of products (Associação Nacional de Pesquisa e Desenvolvimento das Empresas Inovadoras [ANPEI], 2017; Q2). Table XI summarizes the characteristics of the innovation process in the telecommunications sector. This overview allows visualizing, jointly, the innovation process of the studied companies.

This section looked at the telecommunications sector. The next section presents the analysis of the technology sector, also focused on the variables of the innovation process.

4.6 Sector of creative and high technology economy

In 2013, the sector of Creative and High Technology Economy (ECAT), which includes sectors such as R&D, information and communication technologies and biotechnology, employed more than 892 thousand professionals, and during the period 2004 to 2013, there was an increase of 90 per cent in the number of professionals involved in activities related to ECAT in Brazil. This shows the dynamism of the sectors related to ECAT and the potential impact that can be generated in the Brazilian labor market with the growth of this set of activities. The technology sector is the second in labor allocation, with 34.30 per cent of professionals, and the R&D sector in Brazil is the one that counts most with working professionals among all sectors of ECAT, with 166.2 thousand (18.63 per cent of the total) and a growth of 102.3 per cent between 2004 and 2013 (Ruediger *et al.*, 2015).

Table XI Summary of the telecommunications sector

	Telecommunications sector
Regulation	High level
Internationalization	Low degree of internationalization, dependent on overseas development
Competition	High level
Growth	Moderate
Innovation	Adaptations of products/processes developed abroad
Type of innovation	Technological and non-technological
Resulting from innovation	Majority in products, processes and marketing
Novelty	Majority incremental
Impact	Disruptive and non-disruptive
Control	Mostly closed
Transfer	Local and reverse

Source: Prepared by the authors (2018)

In this context, according to the consulting company Grant Thornton UK, Brazil is the seventh most attractive country for investments in technology, technology being its main attractive points the economic stability, a strong base of local investors and the size of Class C, seen as a potential consumer. Despite these positive aspects, this perspective has not been enough to stimulate production in the country. In the last 6 years, technology imports have grown 177 per cent, reflecting the 76 per cent rise in the domestic industry demand. Domestic production grew by only 40 per cent (Vieira *et al.*, 2012).

According to BACEN (2016), the share of industrial products in the Brazilian export sector also shows a negative movement during the last decade: it fell from 77.7 per cent in 2006 to 59.2 per cent in 2011; it remained relatively stable until 2015, reflecting the currency depreciation (R$ – real) impacts. The reduction in the share of industrial products in the Brazilian export sector in the period 2006-2011 reflected declines in all categories of technological intensities, notably the medium–high technology, influenced by the negative performance of the automotive sector.

4.6.1 Characteristics of the creative and high technology economy sector

4.6.1.1 Regulation. The regulation degree in the creative and high technology economy sector is directly related to the type of the company's business activity (Q1; Q2; and Q3) in which government regulations and regulatory bodies can influence from the operation up to the companies' decisions (Q1). Companies operating in technology in the education sector, for example, operate under regulatory rules governing the production of content and textbooks (Q3). For companies operating in the fuel supply sector, government laws, despite exercising a high regulation degree, seek to protect the competitiveness of domestic industry, regulating purchases, for example and introducing or withdrawing tax incentives for sales promotion (Q2).

4.6.1.2 Internationalization. The level of internationalization of the companies analyzed varies according to their activity (Q1; Q2; and Q3), strategy and market focus (Q1 and Q3). Thus, the business and solution's characteristics (Q1; Q2; and Q3) as well as their market objectives (Q3) are factors that guide this process.

4.6.1.3 Competition. The competition degree in the creative and high technology economy sector is directly related to the business structure (Q2) and to the level of government regulation in the market, through laws that govern the sector via government concessions, limiting the number of competitors at domestic level (Q1). Thus, the sector is characterized by the presence of few and large *players* (Q1; Q2; and Q3).

4.6.1.4 Growth. The technological sector market is in a new consolidation, based on new trends and possibilities related to *big data*, *cloud computing*, *analytics* and *Watson*, which makes it possible to add services to the solution and increase the growth potential (Q1). However, for companies that operate with technology for education, market growth is more closely tied to the degree of enrolled students, which, in turn, is related to the country's population growth. Therefore, it is possible to observe a drop in demand for technological services for elementary education, for example, when compared to the market directed to higher education (Q3). Thus, it is observed that the sector growth is related to the company activity and to the economic, technological and demographic context in which it is inserted (Q1; Q2; and Q3).

4.6.2 Characteristics of the creative and high technology economy sector innovation. The innovation degree in this sector also varies according to the company activity. It is mainly related to the introduction of new technologies and materials in the energy distribution sector (Q2) and to digital media and new media to the telecommunications sector (Q1). For technology companies active in the education sector, however, the innovation degree is lower. However, some trends in recent years related to new ways of disseminating knowledge can stimulate innovation in this sector (Q3).

4.6.2.1 Technological innovations. Innovations in the creative and high technology economy are mostly technological (Q1; Q2; and Q3). The technological innovations are characterized by products innovations from the use of new materials (Q1) and digital platforms (Q2 and

Q3), thus guiding themselves by the search for energy efficiency (Q1) and the use of new digital technologies (Q2 and Q3), respectively. Technological innovations may also be related to process optimization (Q1 and Q2).

Innovations in this sector are predominantly in products and processes (Q1; Q2; and Q3). In addition to the inclusion of new, more efficient materials for manufacturing new products (Q2), product combinations and the addition of new technology services to the main product (Q1 and Q2) are constantly being developed. Regarding the processes, the so-called Industry 4.0, through the *IoT*, the *big data* and *data mining*, for example, were incorporated into this sector's processes to optimize them (Q2).

4.6.2.2 Non-technological innovations. Marketing innovations are characterized by constant discounts and new promotion practices of product (Q1), and organizational innovations in new horizontal industrial models, with reduced supervision (Q2) and the outsourcing of *core business* activities, partnerships with companies of other sectors and *joint ventures* (Q1).

4.6.2.3 Novelty degree. As for the novelty degree, the innovations of this sector are mostly incremental (Q1 and Q3). However, for the respondent Q2, incremental innovations are mostly process-related, while product-related innovations are mostly radical. Also according to the interviewee, the new materials used in manufacturing provide unprecedented performance characteristics, sometimes with performance or cost that alter the existing market or create new markets.

4.6.2.4 Impact degree. For Q1 and Q3 respondents, innovations are predominantly non-disruptive because they use new tools that optimize the business but do not change the company's business model (Q3). However, for the Q1 respondent, the telecommunications sector is one of the sectors with more disruptive changes, such as new digital media for communication.

For the Q2 respondent, in a particular way, the energy distribution sector is predominantly disruptive. He further notes that, for example, even though the first patent for flexible pipes has been registered in the USA in the first or second decade of the eighteenth century, the technology only reached reliability levels for use just over 20 years ago, using new production processes and product design. This whole process occurred through disruptive innovations and changed the business model of the companies.

4.6.2.5 Control degree. The innovations are mostly closed (Q1 and Q2) as the innovations development is concentrated within the R&D areas of the manufacturers themselves, and this development is highly controlled (Q2). However, relative openness can be observed when the activity of the company under analysis is approached. In the educational sector, for example, it is common to use partners for product development (Q3). In the telecommunication sector, it is also common the practice of observing the market and monitoring the innovations in startups communication companies for, if an opportunity is identified, an open development (Q1) is performed.

4.6.2.6 Transfer innovation. The predominance of one type over another is directly related to the company activity and the context in which it operates, as for as the innovation transfer is concerned. For the interviewee Q1, for example, the reverse transfer is the most common, justifying itself by the ease of globalization of the sector. For the respondent, only promotions or discounts are local. According to the respondent Q2, globalization encourages the opposite. The research centers are allocated by countries, where there is production for all market *players*. Thus, each consumer adopts his own standards and designs, so that the product is highly customizable.

Table XII summarizes the characteristics of the innovation process in the creative and high technology economy sector. This overview allows visualizing, jointly, the innovation process of the studied companies.

Table XII Summary of the sector of creative and high technology economy

Sector of creative and high technology economy	
Regulation	According to activity sector
Internationalization	According to activity sector
Competition	Few and large players
Growth	New market consolidation
Innovation	According to activity sector
Type of innovation	Predominantly technological
Resulting from innovation	Majority in products and processes
Novelty	Radical and incremental
Impact	Disruptive and non-disruptive
Control	Open and closed
Transfer	Mostly local

Source: Prepared by the authors (2018)

4.7 Comparative analysis among sectors

This section presents the comparative analysis across sectors, see Table XIII, focused on the characteristics of the innovation process and the characteristics of the sector.

The variable "regulation" presents different degrees, according to the sector of the economy analyzed. In general, the sectors present high regulation, mainly because the products must meet quality and safety requirements, as in the case of the pharmaceutical, banking, telecommunications and automotive sectors. As the consumer goods sector offers a portfolio of varied products for daily use, it presents a lower degree of regulation.

As for the internationalization degree, the organizations have trade agreements with other countries as most of the companies considered in this study are multinational. Thus, it was highlighted the role of product development, or at least part of the development carried out abroad in integration with R&Ds located in Brazil. Sectors such as banking and telecommunications, by the nature of services, need to be integrated globally.

The sectors, in general, present a high degree of competitiveness, although the consumer goods sector demonstrates that competitiveness is tied to the product portfolio, which in this sector has great breadth. The pharmaceutical sector is moderately competitive, as for in the pharmaceutical industry the competition is lower compared to the high competitiveness in retail, where there are disputes mainly for prices to end customers.

The Brazilian economic recession reflects in the growth performance of the sectors analyzed, and no sector shows a high degree of growth. The telecommunications sector, for example, remains in disarray with the foreign market, as domestic demand is sluggish. The banking sector shows that, despite being stable, growth is continuous.

The Program Innovation-Auto Incentive and the Law of Good, as well as the sector regulation, influence the variable "innovation". In addition, the innovation process is driven by imported technology or by the integrated development of R&D within and outside Brazil. The automotive, banking and consumer goods sectors have predominantly technological innovations, such as processes and products, both of which are typically incremental and non-disruptive, in addition to being closed innovations, where there is a dependence on the headquarters for their development. In turn, the telecommunications sector has technological and non-technological innovations that involve processes, products and marketing.

4.8 Sector innovation and knowledge management

Considering the different sectors of the economy analyzed, automotive, consumer goods, pharmaceuticals, telecommunications and the high-tech and creative economy, one can

Table XIII Comparative analysis among sectors

	Variables										
Sector	*Regulation*	*Internationalization*	*Competition*	*Growth*	*Innovation*	*Type of innovation*	*Resulting of innovation*	*Novelty*	*Impact*	*Control*	*Transfer*
BANKING	High level	High level, needs improvement if compared to domestic ecosystem	High level, few players with large market share	Constant and moderate	Influenced by the regulations of the Central Bank(BACEN)	Technological and non-technological	Majority in products and processes	Majority incremental	Predominantly non-disruptive	Open and closed	Majority local
AUTOMOTIVE	High level	Importation of technology to develop products domestically	High level	Lower growth owing to the economic crisis	Innovation in maturation, driven by the Incentive Program Innovation-Auto and competitiveness	Predominantly technological	Majority in products and processes	Majority incremental	Majority non-disruptive	Majority closed	Local and reverse
CONSUMER GOODS	Varied	Varied in response to the diverse product portfolio	High level	Stable	Constant	Technological and non-technological	Majority in products, processes and marketing	Majority incremental	Predominantly non-disruptive	Predominantly closed	Predominantly local
PHARMACEUTI-CAL	High level	Development of products integrated with foreign R&Ds	Moderate	Moderate	Evolves timidly	Technological and non-technological	Majority in products, processes and marketing	Majority incremental	Majority non-disruptive	Open and closed	Local and reverse
TELECOM-MUNICATIONS	High level	Low degree of internationalization, dependent on overseas development	High level	Moderate	Adaptations of products/ processes developed abroad	Technological and non-technological	Majority in products, processes and marketing	Majority incremental	Disruptive and non-disruptive	Majority Closed	Local and Reverse
ECAT	According to activity area	According to activity area	Few and large players	New market consolidation	According to activity area	Predominantly technological	Majority in products and processes	Radical and incremental	Disruptive and non-disruptive	Open and Closed	Majority Local

Source: Prepared by the authors (2018)

perceive that each one with its characteristics imprints innovation patterns in the dimensions analyzed: the types of innovation, divided in technological or non-technological innovations; the degree of innovation, radical or incremental innovations, the degree of impact; disruptive or non-disruptive innovations; and finally, the degree of control over the process of innovation, open or closed innovation.

Knowledge management is an administrative tool that supports multiple processes in organizations, in particular, innovation processes are strongly impacted by efficient and effective knowledge management. Thus, each stage of the process of knowledge management, definition, acquisition, dissemination, storage, application and evaluation of knowledge must be adjusted to better meet the peculiar characteristics of innovation in each sector of the economy.

A detailed analysis of the cross-referencing between innovation typology and the stages of knowledge management can offer a rich number of specific strategies to better manage each of the possible combinations, for example, technological innovations are related to changes in the products and processes, of the which will require partnerships with universities, research centers, startups and other knowledge centers, different from the partnerships demanded by non-technological innovations, oriented to changes in marketing activities and organizational activities, which require more partnerships with business consultancies, market research companies and business associations.

Without the pretension to exhaust the possible strategies of knowledge management, for each type of innovation are presented some strategies for the best knowledge management in the organization considering the innovation characteristic of its sector (Table XIV).

By way of presentation, it is observed, for example, that depending on the degree of control over the process of innovation, closed innovation or open innovation, it will define the decision to develop certain internal capabilities and competences. If the innovation is eminently closed, the organization should seek to develop internal capabilities to foster innovation within the organization, for example, the development of laboratories and the

Table XIV Type of innovation and knowledge management

Innovation	*Knowledge management strategies*
Type of innovation	
Technological	Definition of the type of knowledge
non-technological	Definition of the type of partnerships
Degree of novelty	
Radical	Assessment of the risks involved
Incremental	Product-focused knowledge
	Process-focused knowledge
	Management of information obsolescence
Degree of Impact	
Disruptive	Involvement with government
Non-disruptive	Consumer education
	Protection of intellectual property
Degree of control over the innovation process	
Open innovation	Development of internal capacities to innovate;
Closed innovation	Development competences to manage projects with third parties
Transfer of innovation	
Local	Identification of local demands or global demands
Reverse	Identification of the level of customization
	Identification of the level of standardization

Source: Prepared by the authors (2018)

hiring of professionals with a solid academic background. On the other hand, if the focus is open innovation, the organization will mainly seek to develop competences to manage projects, especially with third parties.

5. Conclusions

The main objective of this article is to analyze the innovation process of organizations representing the main sectors of the Brazilian economic activity. This research complies with the proposed objective as it characterizes the innovation process of the investigated companies and presents a comparative analysis regarding the sectoral standard for innovation.

With regard to the research methodology, it is observed that the first stage of the research is a descriptive–comparative analysis among companies of the same sector and the second stage is a comparative analysis among companies of the different sectors surveyed. Thus, on the basis of the results obtained, the description and characterization aim at analyzing the companies' innovation process and the comparative analysis aims to present the sectoral patterns of innovation. These stages of the research are, therefore, studied in the Brazilian economic context.

The main theoretical contribution consists in the development of a conceptual model that associates the characteristics of the innovation process in the organizations and the characteristics of the business sector that impact on the innovation process of the organizations. In the conceptual model, the following characteristics of the innovation process are highlighted: type of innovation, divided into technological or non-technological innovations; business area, divided into product, process, marketing or organizational; degree of novelty, divided into radical or incremental innovations; degree of impact, divided into disruptive or non-disruptive innovations; and degree of control over the innovation process, divided into developed open or closed. With regard to the characteristics of the business sector that impact on the innovation process of organizations the following characteristics are highlighted in the conceptual model: degree of regulation; degree of internationalization; degree of competition; degree of growth; and degree of innovation.

Regarding the managerial implications, we can highlight the comparative analysis of the innovation process of companies from six different business sectors, namely, banking, automotive, consumer goods, pharmaceuticals, telecommunications and economics creative and high-tech. For each business sector, it was presented the general information, presented the characteristics of the business sector that impact on the innovation process of organizations and the characteristics of the innovation process of the sector. As a result, the article presents a comparative analysis of the innovation process of the business sectors studied, in the form of a matrix with the characteristics of the innovation process arranged per line and the characteristics of the sector arranged by column. Additionally, considering the general characteristics of the innovation process, type of innovation; business area; degree of novelty; degree of impact and; degree of control over the innovation process; presented the main strategies involved in better knowledge management to foster innovation in organizations.

As a final consideration, this article also highlights the importance of innovation for the competitiveness of the organizations studied. The stages of the research affirm the importance of understanding the innovation process owing to its importance for the economic, technological and consequently social development in the contemporary domestic context.

Thus, the limitations of the research are the sectorial scope studied as six main business sectors were surveyed, with three companies participating in each one. In addition, the characteristics of the innovation process were limited to five characteristics. Likewise, the characteristics of the business sector were limited to five characteristics. It should be

noted that such characteristics may have temporal and geographical influence on their definitions.

Finally, we suggest future studies in validating the conceptual model through a quantitative study with managers of the companies of the main Brazilian business sectors. Of course, the qualitative or quantitative study could be replicated in other business sectors and in other countries. In addition, we also suggest the deepening of the analysis of knowledge management strategies to foster the process of innovation in organizations, considering their sectoral context.

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