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METHODOLOGY FOR ASSESSING RISK IN INNOVATION INVESTMENTS

METODOLOGIA DE AVALIAÇÃO DO RISCO EM INVESTIMENTOS DE INOVAÇÃO

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ABSTRACT

The aim of this research is to analyze a theoretical method for measuring the business risk of investments in innovation proposed by Basso and Kimura (2010). The bases of the conceptual model relate the risk of investments in innovation at the firm level to the risk of the sector. In an analogous way, this study measures the sectorial risk of the different Brazilian industries with the added risk of investments in innovation, and then shows the risks of the companies listed on B3 (the São Paulo Stock Exchange) that exhibited all the necessary information for the model. This is an exploratory study with a quantitative approach, based on descriptive statistical methods and the proposed empirical model. The materials that support the research were taken from the five available editions of the Technological Innovation Survey – PINTEC (2000, 2003, 2005, 2008 and 2011) and from the standardized financial statements of the selected companies. The results of the research confirmed the possibility of using the proposed methodology, with the use of weighted factors that – in this study – were guided by the Brazil Innovation Index. Thus, it was possible to measure the level of risk of each sector of Brazilian industry and of 85 companies.

Keywords: Capacity to Innovate, Brazilian Industry, PINTEC, Volatility.

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RESUMO

O objetivo desta pesquisa é analisar um método teórico para mensuração do risco empresarial dos investimentos em inovação proposto por Basso e Kimura (2010). As bases do modelo conceitual relacionam o risco dos investimentos em inovação ao nível da firma com o risco do setor. De forma análoga, este estudo mensura o risco setorial das diferentes indústrias brasileiras com o risco agregado dos investimentos em inovação e na sequência são evidenciados os riscos das empresas listadas na BM&FBOVESPA que apresentaram todas informações necessárias para o modelo. Trata-se de uma pesquisa exploratória com abordagem quantitativa, a partir de métodos estatísticos descritivos e o modelo empírico proposto. Os materiais que suportam a pesquisa foram retirados das cinco edições disponíveis da Pesquisa de Inovação Tecnológica – PINTEC (2000, 2003, 2005, 2008 e 2011) e das demonstrações financeiras padronizadas das empresas selecionadas. Os resultados da pesquisa confirmaram a possibilidade do uso da metodologia proposta, com a utilização de fatores ponderados que neste estudo foi balizado pelo Índice Brasil de Inovação. Sendo assim, foi possível aferir o nível de risco de cada setor da indústria brasileira e de 85 empresas.

Palavras-chave: *Capacidade de Inovar, Indústria Brasileira, PINTEC, Volatilidade.*

1. INTRODUCTION

The search for market leadership, based on investments in innovative practices, is increasingly recurrent in the organizational context, due to the high degree of competitiveness present in the various segments of industry (BRITTES, SALLES-FILHO & PFITZNER, 2015; STAL, 2010).

In this regard, it is through the implantation of technological innovations and innovative actions that companies manage to create new expectations and needs in consumers, in addition to making them stand out from other competitors (RAIMUNDO, BATALHA & TORKOMIAN, 2017) (FLORIANI, BEUREN & MACHADO, 2013). Therefore, it is possible to characterize innovation as a fundamental element for the development of growth strategies at companies (PORTER, 1998).

However, it is not enough just to invest in innovation; it is necessary to analyze the impacts of this strategy on the company's performance, by verifying the risks involved in this action (SANTOS, BASSO et al., 2014). Nonetheless, one of the main challenges of finance theory is precisely to measure the risk of investments (DANTHINE & DONALDSON, 2005).

This difficulty can be understood by the theoretical complexity of providing models capable of capturing investment risk, especially when returns cannot be clearly dimensioned by reason of technological, commercial and logistical uncertainties, as well as variables exogenous to the firm (MARCELINO-SÁBADA, PÉREZ-EZCURDIA et al., 2014).

Basso and Kimura (2010) claim the concept of an organizational resource for innovation, by considering that the results of these investments are a function of the management of the organizations; in effect, the risk is endogenous and its measurement depends on the distribution of probability of occurrence of non-expected results. However, there is a latent difficulty in defining parameters that discriminate the variations of the results in a comparative way.

An alternative for resolving the issue identified by Basso and Kimura (2010) is to consider sectorial variation; thus, when it is understood that the current results of the company are effects of the choices made in the past, the risk and return will always be assessed based on market and or industry standards, i.e., the risk of the firm when considered individually does not explain its level of competitiveness within the sector, and it is necessary to establish a relationship between the firm and the sector (BOWERS & KHORAKIAN, 2014).

Thus, companies with the same degree of innovation may present different risks as a function of the sectorial volatility of this resource (WU, KEFAN et al., 2010), or even their internal volatility at the firm level (BASSO & KIMURA, 2010), since each sector has its peculiarities that will

condition the intensity and the process of technological development of that sector (RAIMUNDO, BATALHA & TORKOMIAN, 2017).

In view of this, two questions motivated this research: i) which sectors of Brazilian industry present the biggest and smallest risks for investments in innovation?; ii) is it possible to assess the risk of innovation, at the firm level, based on the risk of its sector?

In order to better delineate the innovation resource, the typology proposed by Santos, Basso & Kimura (2012) is taken into account, which classified Brazilian innovation efforts into three types of capital: human, internal and relational. Human capital is associated with the quantity and characteristics of people dedicated to innovation within companies. Internal capital brings together the investments made by organizations in innovation research and development; while relational capital comprises investments in the acquisition of innovation or knowledge developed outside the company.

Thus, this research analyzes, in an exploratory way, the risk assessment model of the innovation resource proposed by Basso & Kimura (2010), based on the structure of the innovation resource developed by Santos et al. (2014) for the Brazilian industrial reality, considering the period from 2000 to 2011.

Analytically, the specific objectives for the development of this study are: a) to verify the evolution of the most innovation-intensive sectors in Brazil; b) to evaluate possible changes over the course of time, both from the distribution of risk in innovation in the sectors as well as investments in innovative activities; and c) to assess the risk of investment in business innovation in the period from 1998 to 2011.

2. LITERATURE REVIEW

In this section, we discuss the theoretical bases that support the analysis model as well as the empirical studies that contribute to the analysis of the results that will be presented after the third section, which discusses the methodological procedures of this research.

2.1 Business innovation

Innovation is considered to be an essential factor to obtain a competitive advantage, and the incorporation of innovative practices in the strategies adopted by the companies is common (BESANKO, DRANOVE et al., 2006). An organization with market knowledge and a focus on innovative activities expands its opportunities to develop new solutions that can extend its competitive advantage and create new business opportunities (MENEZES et al., 2011). According to Dosi (1988) when the issue of innovation is discussed from the perspective of firms, one can affirm that this company strategy is associated with the search, discovery, experimentation, development, imitation and adoption of new products, processes and/or forms of organization (CONCEIÇÃO, 2000) (DOSI, FREEMAN et al., 1988).

In the Oslo Manual, innovation is any good or service (either new or significantly improved), process or method of transformation, or a new organizational practice, aimed at achieving market superiority (OCDE, 2005). Thus, innovation constitutes a strategic element and one of the most valuable for companies (BESANKO, DRANOVE et al., 2006; SHAFIQUE, 2013). The theory of innovation is a specific field of research, leveraging contributions mainly in the area of knowledge, from organizational and economic studies, which are fundamental for the formation of a solid theoretical foundation. Different researchers using quantitative and qualitative meth-

odologies through multiple approaches have studied the relationship between innovation and performance (SANTOS, BASSO et al., 2014).

However, there is a theoretical–practical gap in the studies in this topic, because, although the literature recognizes the importance of innovation for economic development and business competitiveness, when this relationship is evaluated at the firm level, the results are controversial regarding the hypothesis of positive influence of innovation on business performance (SHAFIQUE, 2013; SANTOS, BASSO and KIMURA, 2018). It is likely that risk variables and sectorial differences of strategies and innovation outcomes will affect firms differently (DOSI et al., 1988; BASSO and KIMURA, 2010).

The literature indicates risk as one of the factors that contribute to the formation of this 'black box' that is investment in innovation (SHAFIQUE, 2013) (BASSO and KIMURA, 2010). Innovation is a complex phenomenon whose activities are directed towards 'extraordinary' profits (rents) (GRUPP, 1998), involving technical and economic opportunities not yet exploited, making risk a key element in the management of innovative practices (IBGE, 2013).

The process of innovation at companies presents a certain complexity, since it involves high risk, needs extensive involvement of several company departments, and requires constant monitoring of the environment, in addition to involving the allocation and management of resources of high value for the organization (TIDD, BESSANT & PAVITT, 2008).

Accordingly, organizations need to establish innovation at the company as a whole, and to manage the entire process of innovation, since it will be through the processes, methods, principles and knowledge that integrate it, that those responsible will take advantage of the innovations created more efficiently (TIDD, BESSANT & PAVITT, 2008) (TIGRE, 2006).

Companies that operate in competitive markets need to continuously invest in the acquisition and development of innovative capabilities, as these are the ones that ensure survival and drive business (BESANKO, DRANOVE et al., 2006). The immediate market trend, in identifying the success of an innovation, is imitation by the competition, forcing companies to maintain invests and constantly monitor their innovation (TIDD, BESSANT & PAVITT, 2008).

Investments in Research and Development (R&D), for example, are embedded in the company's capacity to innovate and are sometimes confused as the firm's own innovative effort (SANTOS, BASSO et al., 2014). However, the capacity to innovate is broader than R&D activity, considering that it encompasses all activities aimed at improving learning, leveraging the organization's performance as well as financial/economic results (RAMOS & ZILBER, 2015).

The importance of recognizing the capacity to innovate beyond investments in R&D is due to the very volume of corporate investments in this activity, since – according to the PINTEC 2011 Report – spending on innovation is mainly focused on process rather than product: approximately 51.96% of companies' expenditures on innovation occur in acquisition of machinery and 34.5% in R&D (IBGE, 2013).

Additionally, there is also the direct influence of economic factors on companies' decision to innovate: with respect to macroeconomics: inflation, exchange rate, interest rates, and times of crisis and/or economic instability intensify the risk of investing in new innovative practices, making the planning process costly and uncertain (RAMOS & ZILBER, 2015).

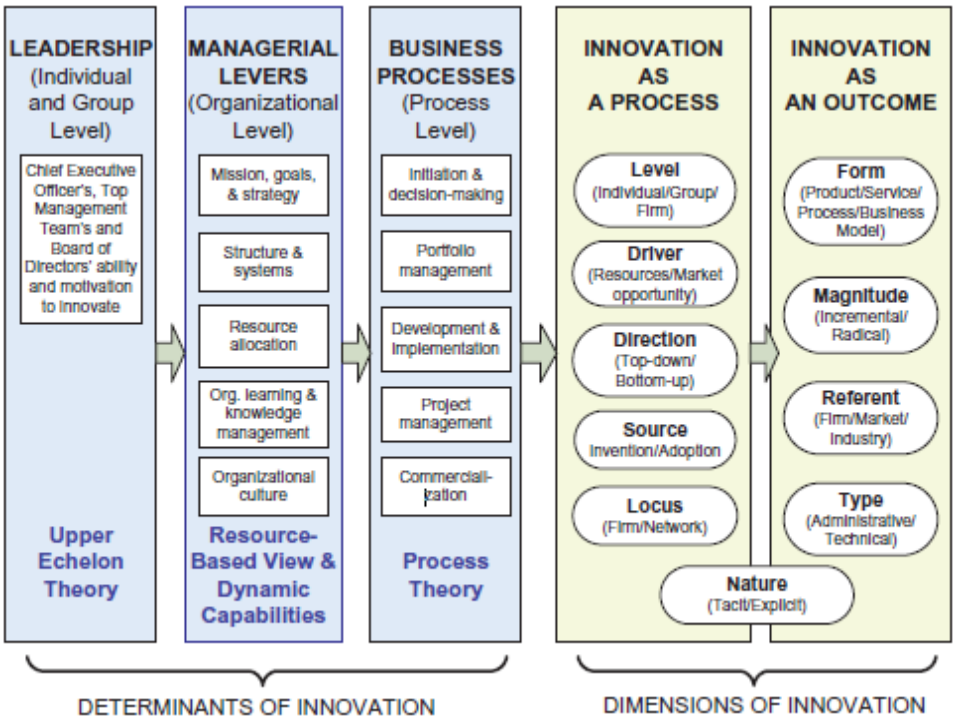
Regarding the microeconomic aspect, for Besanko et al. (2006), technology-intensive sectors with innovative business dynamics require that individual firms have innovation in their strategy, but for Ramos and Zilber (2015), the limited number of technology-intensive sectors in Brazil reduces the relevance of activities of R&D and, in fact, few companies have innovation as a business strategy.

It is necessary to consider that innovation strategy depends on the characteristics of the sector, the existing and perceived technological opportunities, and the previous accumulation of knowledge of many other factors both within and outside the company (MENEZES et al., 2011). Several studies recognize innovation as a dependent variable and not as a mediator for performance, in other words, the capacity to innovate influences a favorable performance for the organization, and it is the company's responsibility to manage this strategy (CROSSAN & APAYDIN, 2010).

Several studies have sought to present the determinants of the innovative behavior of companies. For example, Cabagnols and Bas (2002) found six guidelines in the literature that seek to explain firms' innovative behavior: characteristics of the firms' demand, conditions for appropriating the benefits of innovation, sources of technological knowledge, market structure, the firm's characteristics, and the firm's strategy.

Crossan and Apaydin (2010) present a systematic review of the literature regarding the understanding of the determinants and dimensions of innovation in business (Figure 1).

Figure 1: Determinants and Dimensions of Organizational Innovation



Source: Adapted by the authors based on CROSSAN & APAYDIN (2010, p. 1167)

According to Figure 1, Resource-Based View (RBV) is the main theory that supports the determinants of innovation at the organizational level, since it brings to within the firm the responsibility for performance vis-à-vis the management of the organization's internal resources, in which development and exploitation are analyzed based on the representativeness of the potential to generate and sustain the advantage (CROSSAN & APAYDIN, 2010; SANCHES and MACHADO, 2013).

In the studies by Barney (1991), Dierickx and Cool (1989), Grant (1991), Peteraf (1993), and Wernerfelt (1984), it is possible to verify that – based on RBV and on the initial studies by Penrose (1959) – each organization has a unique set of resources (tangible and intangible) that condition it in the quest for performance and success on the market in which it operates, and

innovation is an essential factor to sustain the advantages created by the members of the organization (ZEN, MACHADO et al., 2017).

In RBV, for Wernerfelt (1984) and Peteraf (1993), the source of competitive advantage arises, *a priori*, in the resources and competences developed and controlled by the organization and, *a posteriori*, in the structure of the sectors of which they are part (BARNEY & MACKEY, 2016).

The company's resources and capacities are central aspects in the formulation of a strategy, since – distributed in a heterogeneous way among the companies – they bring profitability through organizational identity and an adequate structure to exploit them (SANCHES & MACHADO, 2013). RBV emphasizes the role of strategic resources for the company, which are responsible for value creation and innovative practices (BASSO & KIMURA, 2010; LAZZAROTTI, MARCON and MELLO, 2014).

The capacity to innovate is defined based on the experiences and knowledge acquired during the firm's activities, and is responsible for differentiating the companies and driving their performance (RAMOS & ZILBER, 2015). The organizational form and the capacity of the firm's owners to understand the transformations within the sector, seeking to gain knowledge and to reach the opportunities, foster their performance (SANTOS, BASSO & KIMURA, 2012).

Accordingly, it can be said that the capacity to innovate results from the association of the internal, external and human resources present in the organization's environment, which, when harmonized, tend to significantly and positively influence financial performance, including in the long term, determining that the innovation process is characterized as a process of cumulative and variable interaction (SANTOS, BASSO & KIMURA, 2018).

However, investment in innovation, like any investment, is characterized by the expectation of future return and, in the specific case of this investment, there is a great probability of failure that is configured in the risk of the innovation process; i.e., there is risk if the resource is not capable of generating certain performance for its investors (SANTOS, BASSO & KIMURA, 2012).

2.2 Risk of the Innovation Resource

Understanding risk in finance is based on two main factors: (i) the investors' preference for liquidity; and ii) uncertainty about return on investment (DANTHINE & DONALDSON, 2005). The second factor represents the volatility of the organizational resource, which is shown to be different between the different sectors of the economy due to the technological complexity and exposure to the external variables that surround each industry, which integrate the systematic risk of each country (BOWERS & KHORAKIAN, 2014).

Innovation –the research and development process of which is intangible and characterized by endogenous and exogenous uncertainties to firms – is a current challenge for academics and market professionals involved in "Valuation and Project Finance" research and processes (WU, KEFAN et al., 2010) (ILEVBARE, PROBERT & PHAAL, 2014); the risk element is one of the determining factors in the performance of projects, as it ultimately influences both cash flow and discount rate (MIORANDO, RIBEIRO & CORTIMIGLIA, 2014).

One of the alternatives to work around this scenario of risk and uncertainty is the creation and use of risk assessment models in investments made in innovative practices, since through such models it would be possible to identify the result or the performance of the investment made in a certain area (BASSO & KIMURA, 2010).

Basso and Kimura (2010) consider the risk of an organizational resource as a function of the existing variation in its distribution of likelihood of occurrence; however, there is a latent difficulty in defining parameters of greater or lesser variation.

As a proposal for assessing the risk of innovation, there is the analysis of results in a manner based on market and/or industry standards, i.e., the firm's risk when considered individually does not explain its actual level of competitiveness, and it is necessary to establish a relationship between firm risk and sector risk (BOWERS & KHORAKIAN, 2014).

To do so, one must take into account the relative position of the company's essential resources, the risk of the resources, and the manager's attitude toward risk (in addition to incorporating theories from psychology and behavioral finance). For RBV, the company is considered a collection of heterogeneous resources that must be recombined when they receive a signal from the market that the result was lower than expected (BASSO & KIMURA, 2010). In this regard, the risk of a particular sector will be better understood if it is parameterized with the risk of the market that it is part of (HOECHT & TROTT, 2006). Therefore, the risk of a given resource must be analyzed at the firm level, sector level and industry level, since companies with the same degree of innovation may present different risks depending on the stage and dynamics of innovation that each sector presents (WU, KEFAN et al., 2010; BASSO and KIMURA, 2010).

3 METHODOLOGY

3.1 Materials

With the aim of identifying, interpreting and extracting data from studies by other researchers, the literature review method was used in this study, whereby it is possible to verify evidence found over time in the studied area (DRESCH, LACERDA & ANTUNES, 2015). The research of this article consists of a quantitative and explanatory analysis based on secondary financial data, i.e., this study is based on the use of statistical techniques to verify which factors influence a given reality (VERGARA, 2003).

The database that allows this study to be conducted covers the information published in the PINTEC/IBGE survey regarding the relative expenditures on investments in innovation in the following variables: i) Internal R&D activities; ii) External acquisition of R&D; iii) Acquisition of other external knowledge; iv) Acquisition of software; v) Acquisition of machinery and equipment; vi) Training; vii) Introduction of technological innovations on the market; and viii) Industrial design and other technical preparations for production and distribution. The human capital variable comprises the number of employees with master's degrees and PhDs dedicated to research and development.

The first eight variables are relativized by the revenue of the sector and the last one by the number of employees at the companies. This information allows us to reach the specific objectives "a," "b," "c" and "d," based on the method developed, which is demonstrated in the next subsection: methods.

The second stage of the research occurs after assessing the risk of investment in innovation for each sector, which serves as a parameter for the assessing investment risk at the firm level. To this end, deflated changes in the accounts of fixed and intangible assets, and spending on innovation mentioned in the administrative expenses of all the companies that presented the values needed to reach the objectives, are considered as investments in innovation.

This criterion provided a sample of 85 companies that are evaluated over a 13-year period (1998 to 2011), through the financial statements provided in the Economática® System; changes in the specific accounts (fixed assets, intangible assets, deferred charges and administrative expenses on innovation) are added on an equal basis to PINTEC, the published editions of which disclose the results of the previous three years.

Hence, the edition of the year 2000 totals up the sum of the values for 1998, 1999 and 2000; the 2003 edition computes the values of 2001, 2002 and 2003, and so on successively. This data collection effort provides a sample whose aggregate data allows us to evaluate the risk of the company's investments with the aggregate data of PINTEC.

We stress that it is not possible to exploit the model – at the firm level – of innovation risk by type of capital: human, internal and relational, But rather only the added value, since the companies do not disclose this information in their financial statements and the IBGE does not release the results of PINTEC at the firm level for the purpose of this research, along with the aggregated data; it is necessary to formally request the agency for specific access to the micro data. However, since this is an exploratory research that aims to evaluate a specific method for risk, we opted for the assessment with secondary data available in already consolidated databases.

It is worth noting that the data collection period took place between September 2015 and February 2016, so all the editions of PINTEC published by IBGE were used at the time of the research. The PINTEC edition that covered the period from 2011 to 2014 was only released in December 2016, when this research had already been finalized with its results discussed.

3.2 Methods

The firm risk and sector risk measurement should take into account not only the volatility of their expected results, but also the association thereof with the results and sectorial variance and the industry as a whole. Below, we present the model that serves as the basis for the others, as proposed by Basso and Kimura (2010).

The risk model for the innovation resource is built based on a simple concept up to a more complete formulation. The initial idea assumes that innovation is formed by a single variable, for example, total expenditures on internal R&D. In this regard, it would be possible to calculate the average longitudinal level of the innovation resource of the sector as the average of the total expenses in internal R&D in a given period. Formula (01) expresses the calculation:

$$\overline{NRS_i} = \sum_{t=1}^{N} \frac{NRS_t}{N} \qquad (01)$$

$\overline{NRS_i}$ = Average total R&D expenditure for period N in a given sector.
N = Number of periods

Likewise, it is possible to calculate the average level of innovation for the market as a whole, according to formula (02).

$$\overline{NRM} = \sum_{t=1}^{N} \frac{NRM_i}{N} \qquad (02)$$

Where, $\overline{NRM}$ = Average of total expenditure on internal R&D for the Brazilian industrial market.
N = Number of sectors in Brazilian industry.

In this way, the sector's risk can be calculated based on the following difference:

$$R_i = \frac{NRS_t}{\sigma_e} - \frac{\overline{NRm}}{\sigma_s} \qquad (03)$$

Where,

R_i = Risk of the sector

NRS_t = Internal R&D expenses of the sector in period t.

$\overline{NRM}$ = Average of internal R&D expenditures in Brazilian industry.

σ_e = Standard deviation of the sector's internal R&D expenses in period t.

σ_s = Standard deviation of internal R&D expenditures of Brazilian industry in period t.

However, innovation is formed by several variables, and is defined by Santos et al. (2014) as comprising the nine variables described in the Materials section. Thus, the capacity for innovation of each sector can be represented by formula 04:

$$Capacity\ for\ Innovation = \sum \frac{Variables_i}{\sigma_i} \times weig\square ts_i \quad (04)$$

It is also possible to calculate the standard deviation of each variable for a given period t, as well as the average of the total expenses for the sector and the industry as a whole. We can then attain a complex concept of innovation risk:

$$Risk\ of\ t\square e\ Sector = \frac{Invest_e}{\sigma_e} - \frac{Invest_s}{\sigma_s} \quad (05)$$

$$Risk = \left\{\left[a\left(\frac{\overline{NRS}_{x_t}}{\sigma_{ex_t}}\right) + b\left(\frac{\overline{NRS}_{y_t}}{\sigma_{ey_t}}\right) + c\left(\frac{\overline{NRS}_{z_t}}{\sigma_{ez_t}}\right)\right] - \left[a\left(\frac{\overline{NRM}_{x_t}}{\sigma_{xs_t}}\right) + b\left(\frac{\overline{NRM}_{y_t}}{\sigma_{ys_t}}\right) + c\left(\frac{\overline{NRM}_{z_t}}{\sigma_{zs_t}}\right)\right]\right\} \quad (06)$$

Where,

NRS = Innovation resource for each variable of each sector.

NRM = Innovation resource for each variable of Brazilian industry

σ_S = Standard deviation of the resource for the sector.

σ_M = Standard deviation of the resource for the industry.

a, b, c = Weights other than contribution to formation of the innovation resource provided in Santos et al. (2014).

x, y, z = Different variables that explain innovation, of which, in this case, there will be nine.

Santos et al. (2014) evaluated the impact of investments in innovation on company performance and, by extending the proposed conceptual model to the capacity to innovate, the authors identified the relative influence of each dimension on business performance. This evaluation contrasts a model proposed by the Brazil Index of Innovation carried out by Campinas State University, which is not currently being updated. The proposal suggests that the risk of the sector's innovation strategy takes into account the position of the innovation capacity level of each sector (divided by the standard deviation of the resource) in relation to the industry average (divided by standard deviation of the sector); the resource is calculated by the weighted average of the influence of each variable (Formula 06).

Thus, if the sector's capacity to innovate is greater than the industry's capacity, this means that the sector has an innovation risk lower than the average for Brazilian industry, since for each unit of standard deviation the company presents a higher value of investment in innovation (BASSO & KIMURA, 2010).

This same assessment structure is applied for this strategy at the firm level. However, variable-stratified results according to Formula 06 are not used, but the aggregate values for each sector are compared with the firms, just as in Formula 05, and the results for the sector will take over the position of the results for the industry, and the position of each company is measured according to the proposition for industry.

4. RESULTS AND CONCLUSIONS

The results shown in Tables 1 and 2 respectively indicate the sectorial analysis performed through the data provided by PINTEC/IBGE and the analysis at the firm level, based on the financial statements provided by the companies themselves, where the results are distributed on a scale with no upper or lower limits.

Due to the changes in the National Classification of Economic Activities (CNAE), it was sought to standardize the sectors among the five available editions of the survey, in order to obtain reliable results, close to reality. Thus, the sectors were organized according to the CNAE currently in force.

Table 1 lists Brazil's industrial sectors, in increasing order from the lowest to the highest risk by innovating. Effort in innovation comprises the capacity to innovate and human capital variable is the first and foremost variable responsible for determining whether a sector has a positive tendency to innovate.

Table 1: Measurement of Risk in Innovation (Sector and Market)

Brazilian Industry and sectors	Capacity to Innovate	Human Capital	Final Index of Effort in Innovation
Total (domestic industry)	2.85	2.77	2.83
Manufacture of electronic material and communications equipment	7.64	5.72	7.16
Manufacture of metal products	4.56	2.35	4.01
Preparation and manufacture of leather goods and footwear	4.47	2.74	4.03
Manufacture of apparel and accessories	4.28	1.55	3.60
Manufacture of rubber and plastic products	4.24	3.14	3.96
Manufacture of textile products	3.98	3.62	3.89
Manufacture of chemicals	3.35	4.72	3.69
Manufacture of furniture and miscellaneous industries	3.25	3.88	3.41
Manufacture of food products and beverages	3.23	3.16	3.21
Manufacture of machinery and equipment	3.23	4.00	3.42
Manufacture and assembly of vehicles, trailers and bodies	3.13	7.59	4.24
Manufacture of coke, petroleum refining, nuclear fuels and alcohol	2.69	3.88	2.99
Manufacture of other transportation equipment	2.58	2.81	2.63
Basic metallurgy	2.50	3.15	2.67
Manufacture of electrical machinery, devices and equipment	2.48	3.70	2.78
Manufacture of non-metallic mineral products	2.44	4.23	2.88
Manufacture of pulp, paper and paper products	2.43	3.61	2.72
Manufacture of wood products	2.03	2.62	2.18
Editing, printing and reproduction of recordings	1.50	1.32	1.46
Manufacture of tobacco products	1.47	4.90	2.33

Source: Prepared by the authors

According to this approach, the greatest differences present the lowest sectorial risks, since investments in innovation are relativized by risk, thus, for the same unit of risk, there is a greater investment in innovation. This is why, according to Formula 01, the biggest differences represent the lowest risks, since they report sectors that exhibit greater investments in innovation against the market standard for the same "unit" of risk. This procedure is comparable, for

example, to the Information Ratio used on the capital market for valuating financial assets with different return and risk standards (VARGA, 2001).

Based on Table 1, one can see that the electronic materials and communication equipment sector showed the lowest risk when innovating. On the other hand, the manufacturing and assembly of motor vehicles, trailers and bodies had the highest human capital index, but due to the weighting and combination of efforts in innovation, it did not stand out on PINTEC's list of sectors. In turn, it was shown to be one of the sectors with lowest risk among those analyzed in this study.

Through this methodology, the five sectors with the greatest risks were: non-metallic mineral product manufacturing; pulp and paper manufacturing; wood product manufacturing; publishing, printing and reproduction of recordings; and finally manufacture of tobacco products.

These sectors presented low values both in the item "investments in innovation" and in "participation of human capital in R&D" and also showed greater volatility in these variables, which reported a higher risk than the market. This is because when compared to the industry average, their values were the most distant (negatively) from the Brazilian industry average.

The results obtained in the exploratory model for measuring the risk in investment in innovation can be contrasted with some empirical evidence published for specific sectors.

For example, in the study by Bahia and Domingues (2010), the authors surveyed the automotive sector and identified that the greatest barriers to innovation in this sector are: the economic risks of the product not being accepted by consumers due to failure to meet their preferences, the cost to innovate, and the lack of adequate financing for this activity.

Each type of company in this sector suffers from specific adversities, for example: the battery sector suffers from lack of information about technology; the truck and bus sector suffers mainly from the lack of qualified personnel; and the automotive sector suffers from the economic risk and cost to innovate (BAHIA & DOMINGUES, 2010).

Notwithstanding, also with regard to the automotive sector, the study by De Negri and Lemos (2011) points out that investments in internal R&D are characterized by being less risky, since they have a high probability of generating positive results for companies due to the learning curve already carried out (DE NEGRI & LEMOS, 2011). Therefore, regardless of the sector in which the company operates, investments in innovation must be understood as an extremely important element for its growth on the market (PORTER, 1998). Another sector that stands out among academics is the chemical industry, which – in this study – showed average values of capacity to innovate and risk. In turn, different studies, such as those by Galembeck et al. (2007) and Avelar & Souza (2005), highlight the main risks suffered by this sector: process infrastructure (leakage of waste in the environment), and pharmaceutical/beauty products that cause side effects or do not meet consumer expectations. Accordingly, the main investments in this sector are aimed at control equipment and new technological processes, aiming to reduce the aforementioned risks.

The construction of sector indicators is fundamental to understand the aggregate and serves as parameters for organizations; however, do not express the individual results of each company. In this regard, the methodology was extended to companies that exhibited all the necessary data of each sector researched, in the interest of evaluating the risk of investment in innovation of these companies, associated with their respective sectors.

Through the formulas described in the Methodology section, it was possible to reach the results presented in Table 2, which shows the 10 companies surveyed that are positioned at the extremes of the model, i.e., the 5 with the lowest risks of innovation and the 5 with the greatest risks of innovation. The complete Table can be found in the Appendix to this study.

Table 2: Measurement of Risk in Innovation of 10 companies with the respective sectors

Company	Sector	(I) Company's tangible capacity to innovate	(2) Company's intangible capacity to innovate	Average between Tangible and Intangible	Risk of the Pertaining Sector	Difference between Company and Sector
Usiminas	Steel-making industry and basic industry of other metals	6.64	0.48	3.56	2.85	0.71
Portobello	Non-metallic mineral product Industry	4.90	1.06	2.98	2.44	0.54
Eucatex	Wood product industry	3.84	0.99	2.41	2.03	0.38
Melhor SP	Paper Industry	3.65	1.38	2.52	2.43	0.09
Marcopolo	Transportation equipment industry	5.41	0.96	3.18	3.13	0.05
Aliperti	Industry of metal products	1.66	0.57	1.11	4.56	-3.45
Mundial	Industry of metal products	1.78	0.42	1.1	4.56	-3.46
Vulcabras	Leather and related product industry	1.38	0.42	0.9	4.47	-3.57
Hercules	Industry of metal products	0.91	0.98	0.95	4.56	-3.61
Itau	Computer and electronics industry	1.85	0.61	1.23	7.64	-6.41

Source: Prepared by the authors

As the results were taken from the standardized financial statements, it was not possible to use the weighting provided for in Formula 06, because they are not stratified. Thus, our study considered investments in tangible and intangible resources, the arithmetic mean of which constituted the companies' capacity to innovate, related to the standard of volatility (standard deviation) that these investments occurred in time. It should be noted that all amounts were corrected for inflation (according to the IPCA index) for December 2015.

One can see that the tangible behavior of the companies is more representative than the intangible behavior, which confirms the preponderance of financial investments in the acquisition of machinery and equipment by Brazilian industry (SANTOS, BASSO et al., 2014).

The low intensity of investments and intangibles associated with higher volatility reflect a lower value for practically all companies compared to tangible investments. This context can be understood by the low qualification of Brazilian labor, the low number of companies with structured R&D activities, and the low insertion of postgraduate and academic research guided by and coordinated with the market (VERONESE, 2006).

However, some companies achieve more robust results due to the better management of their internal resources, and as there is a concentration of companies in certain sectors, the influence of these companies may represent a significant part of the sector (ZUCOLOTO, 2004), as is the case with Usiminas and Marcopolo.

On the other hand, in the cases of Eucatex and Melhor SP, which operate in extremely concentrated markets and (according to the methodology) the sectors of which presented greater risks than the market, one can see that these companies achieved a better positioning than the sector and the average of Brazilian industry.

It should be noted that all five companies that presented the lowest risks associated with innovation have already been the targets of studies in the specialized literature and confirm the importance of innovation as a major element in the business strategy, namely: Usiminas(-TURANI e TAIS, 2007; RODRIGUES and INÁCIO, 2010); Marcopolo (CARLOS and PADILHA, 2015;

STAL, 2010); Portobello (CORREIA, 2004); Eucatex (LEMOS, DOMINGUES, *et al.*, 2009); Melhor SP (SANTOS, 1999).

Regarding the companies that presented lower results than the sector standard, there are some companies that have outstanding performance in innovation, such as the case of Itautec (SANTOS JÚNIOR & ALVES FILHO, 2000), which showed the highest risk of investments in innovation among the companies studied, as well as other representative companies in the area of innovation in Brazil, such as Embraer(DE NEGRI and LEMOS, 2011; FERREIRA, SALERNO and LOURENÇÃO, 2011; STAL, 2010), Petrobras (PIRES, TEIXEIRA and HASTENREITER FILHO, 2012), Weg S.A. (COSTA and PORTO, 2011) and Whirlpool (DIETRICH, BRASIL and FRIO, 2013).

The evaluation of the quantitative results with the theoretical support and the articles that qualitatively discuss the specific cases of the companies suggest that the proposed methodology can measure the risk of investments in innovation as volatility of the investment standards; however, the analysis should be extended between the factors that make up the capacity to innovate (SANTOS, BASSO & KIMURA, 2012) and mainly the results of the efforts in innovation(ROVAI, JUNIOR and PLONSKI, 2013; MIORANDO, RIBEIRO and CORTIMIGLIA, 2014).

This proposition becomes important, since companies with offensive strategies for innovation are more exposed to risk in their investments (GRUPP, 1998); however, they tend to present higher and better conditions of business and financial performance (SANTOS, BASSO et al., 2014). Therefore, showing greater volatility of investments in innovation does not necessarily represent a limitation or undesirable characteristic of the organization; on the contrary, in certain cases, presenting a greater risk in innovation vis-à-vis the sector may suggest a strategy of the organization more offensive towards competitors (STAL, 2010).

It is worth noting that the risk indicator considers both the volatility and the average of investments. Therefore, a lower index may represent either a greater volatility of investment in innovation, a lower level of investment in innovation, or even both situations at the same time; so the analysis of the result must be carried out carefully and preferably be associated with the performance of the efforts in innovation.

6. FINAL CONSIDERATIONS

The aim of this study was to verify the evolution of expenditure on innovation both in sectors of Brazilian industry and at Brazilian companies, evaluating the risk involved in this type of investment, through an evaluation of the methodology created by Basso and Kimura (2010), which consists of a model for assessing the risk present in investments in innovation. This is a strategy composed of several variables and should be analyzed both at the industry level and at the firm level, in order for it to be analyzed in aggregate manner (AVELAR & SOUZA, 2005). Through the evidence found, it was possible to use the proposed methodology to classify all the Brazilian industrial sectors that were classified as a function of the capacity to innovate, which constitutes a weighted construct of the different variables required for innovation. It is believed that this is the first classification of this nature for the Brazilian reality, whose results report the sectorial differences in investments in innovation.

The study also verified that, at the firm level, it is possible to construct a risk indicator of investments in innovation, despite the limitation of greater comparisons, due to the aggregate characteristic of investments in innovation, and not stratified by activities as presented by the PINTEC survey. Hence, the theoretical model shows its effectiveness and consistency in the

methodological procedures to reach the results, which have shown to be consistent with several empirical studies that evaluated the innovation in a sectorial manner.

The discussions presented in this study also generate some managerial and academic implications, since it is possible to affirm that companies are mainly responsible for the way they manage their resources, and the performance acquired is a function of this management. Therefore, market and sectorial standards should be used as guides and not as objectives per se, as this depends on the strategy adopted by each company.

Moreover, it is understood that investment in innovation transcends R&D expenditure and, therefore, companies should consider – in their strategies and control over results – a more comprehensive assessment of companies' capacity to innovate. Associated with this issue, managers still have to worry about the volatility of investments, since this is a determining factor for the success of that strategy. Thus, the budget must be aligned with the strategy so that the projects launched are not constantly interrupted, thereby hindering the learning process.

In relation to methodological processes, the existence of a database with standardized information is fundamental, since it will be able to generate broader and comparative analyses, as well as the construction of models that allow a comparative analysis of the same issue (innovation) for different items (firm and sector).

However, some limitations were found during the research, such as the weights used in weighing the results that were taken from a comprehensive empirical research for the Brazilian reality, but that presented results limited to the first three editions of the PINTEC survey. Additionally, the volatility of the results of the capacity to innovate, plus the variations of investments in this organizational resource, were not included in this study. Therefore, this is a risk in the construction of the resource and not in the results thereof.

Also with regard to the limitations of the study, the data on companies were taken from the standardized financial statements, in such a way that the absence of specific accounts for innovation, with little information on innovation strategies, incurs major limitations in interpreting the results at the company level. It is worth noting that this limitation does not invalidate the proposal of the model, but rather the analysis of the results according to the quality of the primary information.

Due to the implications and limitations of this research, it is understood that new studies can be carried out: analyzing the risks of investments in innovation at the firm level, based on IBGE data; adding the volatility of investment results to the model proposed by Basso & Kimura (2010); establishing sectorial and market standards for risk in innovation considering an analysis among different countries; evaluating whether companies that adopt more highly structured models for reporting results, such as the framework of the International Integrated Reporting Council, show lower innovation risks due to less information asymmetry; and assessing whether variations in firms' capacity to innovate are influenced by or have an influence on business risk.

REFERENCES

AVELAR, A. C. M.; SOUZA, C. G. D. Desenvolvimento de produtos na indústria nacional de cosméticos: um estudo de caso. In: ENCONTRO NACIONAL DE ENGENHARIA DE PRODUÇÃO**,** 25, 2005, Porto Alegre, **Anais...** Porto Alegre: ABEPRO, 2005, p. 2782-2789.

BAHIA, L. D.; DOMINGUES, E. P. **Estrutura de inovações na indústria automobilística brasileira**. Brasília: IPEA, 2010.

BARNEY, J. B. Firm resources and sustained competitive advantage. **Journal of Management**, [S.l.], v. 17, n. 1, p. 99-120, 1991.

BARNEY, J. B.; MACKEY, A. Text and metatext in the resource-based view. **Human Resource Management Journal**, [S.l.], v. 26, n. 4, p. 369-378, 2016.

BASSO, L. F. C.; KIMURA, H. O conceito de risco na visão baseada em recursos (RBV): uma análise exploratória. **Revista de Administração do Mackenzie**, São Paulo, v. 11, n. 5, p. 82-105, 2010.

BESANKO, D.; DRANOVE, D.; SHANLEY, M.; SCHAEFER, S. **A Economia da Estratégia**. 3a. ed. Porto Alegre: Bookman, 2006.

BOWERS, J.; KHORAKIAN, A. Integrating risk management in the innovation project. **European Journal of Innovation Management**, [S.l.], v. 17, n. 1, p. 25-40, 2014.

BRITTES, J. L. P.; SALLES-FILHO, S. L. M.; PFITZNER, M. S. Avaliação do risco regulatório em pesquisa & desenvolvimento no setor elétrico brasileiro. **Revista de Administração Contemporânea**, Rio de Janeiro, v. 19, n. 2, p. 193-211, 2015.

CABAGNOLS, A.; LE BAS, C. **Differences in the determinants of product and process innovation:** The French Case. Innovation and Firm Performance, Palgrave, London 2002.

CARLOS, E. D. A.; PADILHA, P. Gestão da inovação e seus impactos no processo de internacionalização da Marcopolo S/A. **Revista Inovação, Projetos e Tecnologias**, São Paulo, v. 3, n. 2, p. 153-167, 2015.

CONCEIÇÃO, O. A. C. A centralidade do conceito de inovação tecnológica no processo de mudança estrutural. **Ensaios FEE**, Porto Alegre, v. 21, n. 2, p. 58-76, 2000.

CORREIA, G. S. **Avaliação do potencial da estrutura organizacional da cerâmica portobello para o desenvolvimento da criatividade**. 2004. 205f. Dissertação (Mestrado em Administração) – Centro Sócio-Econômico, Universidade Federal de Santa Caratarina, Florianópolis, 2004.

COSTA, P. R. D.; PORTO, G. S. Capacitação e inovação: aspectos do desenvolvimento interno e exteno nas multinacionais brasileiras. **REGE - Revista de Gestão**, São Paulo, v. 18, n. 3, p. 297-322, 2011.

CROSSAN, M. M.; APAYDIN, M. A multi-dimensional framework of organizational innovation: a systematic review of the literature. **Journal of Management Studies**, [S.l.], v. 47, n. 6, p. 1154-1179, 2010.

DANTHINE, J. P.; DONALDSON, J. B. **Intermediate financial theory**. 2nd. ed. San Diego: Elsevier, 2005.

DE NEGRI, J. A.; LEMOS, M. B. **O núcleo tecnológico da indústria brasileira**. v. 1, Brasília: IPEA, 2011.

DIERICKX, I.; COOL, K. Asset stock accumulation and the sustainability of competitive advantage. **Management Science**, [S.l.], v. 35, n. 12, 1989.

DIETRICH, J. F.; BRASIL, V. S.; FRIO, R. S. O processo de cocriação de valor entre empresas e consumidores: uma análise comparativa de dois casos da indústria de bens de consumo. **Revista de Administração IMED**, Passo Fundo, v. 3, n. 3, p. 221-238, 2013.

DOSI, G.; FREEMAN, C.; NELSON, R.; SILVERBERG, G.; SOET, L. **Technical change and economic theory**. London: Printer, 1988.

DRESCH, A.; LACERDA, D. P.; ANTUNES, J. A. V. **Design Science Research:** método de pesquisa para avanço da ciência e tecnologia. Porto Alegre: Bookman, 2015.

FERREIRA, V. D. L.; SALERNO, M. S.; LOURENÇÃO, P. T. D. M. As estratégias na relação com fornecedores: o caso Embraer. **Gestão & Produção**, São Carlos, v. 18, n. 2, p. 221-236, 2011.

FLORIANI, R.; BEUREN, I. M.; MACHADO, D. D. P. N. Processo de inovação em empresas brasileiras de capital aberto. **Revista de Administração da Universidade Federal de Santa Maria**, Santa Maria, v. 6, n. 4, p. 783-802, 2013.

GALEMBECK, F.; SANTOS, A. C. M.; SCHUMACKER, H. C.; RIPPEL, M. M.; ROSSETO, R. Indústria química: evolução recente, problemas e oportunidades. **Química Nova**, São Paulo, v. 30, n. 6, p. 1413-1419, 2007.

GRANT, R. M. The resource-based theory of competitive advantage. **California Management Review**, [S.l.], v. 33, n. 3, p. 114-135, 1991.

GRUPP, H. **Foundations of the Economics Innovation.** Theory, measurement and practice. Cheltenham: Edward Elgar Publishing, 1998.

HOECHT, A.; TROTT, P. Innovation risks of strategic outsourcing. **Technovation**, v. 26, n. 5-6, p. 672-681, 2006.

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

ILEVBARE, I. M.; PROBERT, D.; PHAAL, R. Towards risk-aware e roadmapping: Influencing factors and pratical measures. **Technovation**, [S.l.], v. 34, n. 8, p. 399-409, 2014.

LAZZAROTTI, F.; MARCON, R.; MELLO, R. B. D. Recursos para inovação e desempenho: uma análise da invariância de mensuração em firmas de setores de alta intensidade tecnológica no Brasil. **Revista de Administração e Inovação**, São Paulo, v. 11, n. 4, p. 33-57, 2014.

LEMOS, M. B. et al. **Relatório Setorial:** Indústria de Móveis, Madeiras e Artefatos. v. 4. Campinas: ABDI/UNICAMP, 2009, p. 1-78.

MARCELINO-SÁBADA, S.; PÉREZ-EZCURDIA, A.; LAZCANO, A. M. E.; VILLANUEVA, P. Project risk management methodology for small firms. **International Journal of Project Management**, [S.l.], v. 32, n. 2, p. 327-340, 2014.

MENEZES, U. G. D.; KNEIPP, J. M.; BARBIERI, L. A.; GOMES, C. M. Gestão da Inovação para o Desenvolvimento Sustentável: Comportamento e Reflexões sobre a Indústria Química. **Revista de Administração e Inovação**, São Paulo, v. 8, n. 4, p. 88-116, 2011.

MIORANDO, R. F.; RIBEIRO, J. L. D.; CORTIMIGLIA, M. N. An economic-probabilistic model for risk analysis in technological innovation projects. **Technovation**, v. 34, n. 8, p. 485-498, 2014.

OCDE. **Manual de Oslo**: Proposta de Diretrizes para Coleta e Interpretação de Dados sobre Inovação Tecnológica. Rio de Janeiro: FINEP, 2005.

PENROSE, E. **The theory of the growth of the firm**. New York: Oxford University Press Inc., 1959.

PETERAF, M. A. The cornerstones of competitive advantage: a resource based-view. **Strategic Management Journal**, [S.l.], v. 14, n. 3, p. 179-191, 1993.

PIRES, A. M. D. B.; TEIXEIRA, F. L. C.; HASTENREITER FILHO, H. N. Colaboração nas atividades de pesquisa desenvolvimento e inovação: O que nos ensina o modelo de centros de rede de excelência Petrobras / COPPE UFRJ? **Organizações & Sociedade**, Salvador, v. 19, n. 62, p. 507-526, 2012.

PORTER, M. Clusters and the new economics of competition. **Harvard Business Review**, Boston, v. 76, n. 6, p. 77-90, 1998.

RAIMUNDO, L. M. B.; BATALHA, M. O.; TORKOMIAN, A. L. V. Dinâmica tecnológica da indústria brasileira de alimentos e bebidas. **Gestão & Produção**, São Carlos, v. 24, n. 2, p. 423-436, 2017.

RAMOS, A.; ZILBER, S. N. O Impacto do investimento na capacidade inovadora da empresa. **Revista de Administração e Inovação**, São Paulo, v. 12, n. 1, p. 303-325, 2015.

RODRIGUES, M. D.; INÁCIO, R. D. O. Estudo da estratégia de compra e venda de tecnologia: o caso da Usiminas. In: ENCONTRO NACIONAL DE ENGENHARIA DE PRODUÇÃO, 30, 2010. São Carlos. **Anais...** São Carlos: ABEPRO, 2010, p. 1-14.

ROVAI, R. L.; JUNIOR, O. C.; PLONSKI, G. A. Gestão de riscos em projetos de inovação através da abordagem contingencial: análise conceitual e proposição de modelo estruturado para redução de incertezas em projetos complexos. **Revista de Administração e Inovação**, São Paulo, v. 10, n. 3, p. 269-295, 2013.

SANCHES, P. L. B.; MACHADO, A. G. C. Estratégias de inovação e RBV: evidências em uma empresa de base tecnológica. **Revista de Administração e Inovação**, São Paulo, v. 10, n. 4, p. 183-207, 2013.

SANTOS JÚNIOR, D. D.; ALVES FILHO, A. G. Padrões tecnológicos e processo de inovação de produtos: o caso da Itautec-Philco S.A. **Gestão & Produção**, São Carlos, v. 7, n. 2, p. 106-117, 2000.

SANTOS, D. F. L.; BASSO, L. F. C.; KIMURA, H.; KAYO, E. K. Innovation Efforts and Performances of Brazilian Firms. **Journal of Business Research**, [S.l.], v. 67, n. 4, p. 527-535, 2014.

SANTOS, D. F. L.; BASSO, L. F. C.; KIMURA, H. A Estrutura da Capacidade de Inovar das Empresas Brasileiras: uma proposta de construto. **Revista de Administração e Inovação**, São Paulo, v. 9, n. 3, p. 103-128, 2012.

SANTOS, D. F. L.; BASSO, L. F. C.; KIMURA, H. The trajectory of the ability to innovate and the financial performance of the Brazilian industry. **Technological Forecasting and Social Change**, [S.l.], v. 127, p. 258-270, 2018.

SANTOS, S. J. D. A Inovação de produtos no mercado editorial de dicionários. In: SEMINÁRIOS DE ADMINISTRAÇÃO DA USP, 4 , 1999, São Paulo. **Anais...** São Paulo: USP, 1999, p. 1-14.

SHAFIQUE, M. Thinking inside the box? Intellectual structure of the knowledge base of innovation research (1988–2008). **Strategic Management Journal**, [S.l.],v. 34, n. 1, p. 62–93, 2013.

STAL, E. Internacionalização de empresas brasileiras e o papel da inovação na construção de vantagens competitivas. **Revista de Administração e Inovação**, São Paulo, v. 7, n. 3, p. 120-149, 2010.

TIDD, J.; BESSANT, J.; PAVITT, K. **Gestão da Inovação**. 3. ed. São Paulo: Artmed, 2008.

TIGRE, P. **Gestão da Inovação:** a economia de tecnologia no Brasil. Rio de Janeiro: Elsevier, 2006.

TURANI, L. D. O.; TAIS, E. J. M. Marketing e Inovação: O impacto da gestão de desenvolvimento de novos produtos no sucesso das inovações na siderurgia brasileira. **Tecnologia em Metalurgia e Materiais**, São Paulo, v. 4, n. 2, p. 39-44, 2007.

VARGA, G. Índice de sharpe e outros indicadores de performance aplicados a fundos de ações brasileiros. **Revista de Administração Contemporânea**, Rio de Janeiro, v. 5, n. 3, p. 212-245, 2001.

VERGARA, S. C. **Projetos e relatórios de pesquisa em administração**. São Paulo: Atlas, 2003.

VERONESE, A. A busca de um novo modelo de gestão para a ciência, tecnologia e inovação na política do MCT (1995-2002). **Revista de Administração Pública**, Rio de Janeiro, v. 40, n. 1, p. 107-125, 2006.

WERNERFELT, B. A resource-based view of the firm. **Strategic Management Journal**, [S.l.], v. 5, n. 2, p. 171-180, 1984.

WU, D. D.; KEFAN, X.; HUA, L.; SHI, Z.; OLSON, D. L. Modeling Technological innovation risks of an entrepreneurial team using system dynamics: An agent-based perspective. **Techonological Forecasting and Social Change**, v. 77, n. 6, p. 857-869, 2010.

ZEN, A. C.; MACHADO, B. D.; LÓPEZ, A. I. J.; BORGES, M. C.; MENEZES, D. C. Rota da inovação: uma proposta de metodologia de gestão da inovação. **Revista de Administração Contemporânea**, Rio de Janeiro, v. 21, n. 6, p. 875-892, 2017.

ZUCOLOTO, G. F. **Inovação tecnológica na indústria brasileira**: uma análise setorial. 2004. 162f. Dissertação (Mestrado em Economia) - Faculdade de Economia, Administração e Contabildiade, Universidade de São Paulo, São Paulo, 2004.

APPENDIX

Company	Sector	Risk of the sector	Capacity to Innovate tangible	Capacity to Innovate intangible	Average between Tangible and Intangible	Company - Sector
Usiminas	Steel-making industry and basic industry of other metals	2.85	6.64	0.48	3.56	0.71
Portobello	Non-metallic mineral product industry	2.44	4.90	1.06	2.98	0.54
Eucatex	Wood product industry	2.03	3.84	0.99	2.41	0.38
Melhor SP	Paper Industry	2.43	3.65	1.38	2.52	0.09
Marcopolo	Transportation equipment industry	3.13	5.41	0.96	3.18	0.05
Coteminas	Clothing Industry	4.28	7.60	0.99	4.29	0.01
Wembley	Clothing Industry	4.28	7.56	0.99	4.28	0.00
Wetzel S/A	Transportation equipment industry	3.13	3.93	2.09	3.01	-0.12
Klabin S/A	Paper Industry	2.43	3.61	0.98	2.30	-0.13
Alpargatas	Leather and related product industry	4.47	8.03	0.57	4.30	-0.17
Sid Nacional	Steel-making industry and basic industry of other metals	2.85	3.86	1.45	2.65	-0.20
Mangels Indl	Industry of metal products	4.56	7.69	0.86	4.27	-0.29
Eternit	Non-metallic mineral product industry	2.44	3.10	0.99	2.04	-0.40
Springer	Electrical appliance, equipment and component industry	2.48	2.88	1.01	1.94	-0.54
Whirlpool	Electrical appliance, equipment and component industry	2.48	2.93	0.87	1.90	-0.58
COPEL	Electricity, gas and water company	2.85	4.11	0.41	2.26	-0.59
Ambev S/A	Beverage and tobacco industry	3.23	4.70	0.55	2.63	-0.60
Nadir Figuei	Non-metallic mineral product industry	2.44	2.72	0.76	1.74	-0.70
Chiarelli	Non-metallic mineral product industry	2.44	3.06	0.41	1.74	-0.70
Cedro	Yarn and fabric industry	3.98	5.44	1.10	3.27	-0.71
Crystal	Chemical industry	3.35	4.00	1.12	2.56	-0.79
DHB	Transportation equipment industry	3.13	2.71	1.79	2.25	-0.88
Ind Cataguas	Yarn and fabric industry	3.98	3.93	2.14	3.04	-0.94
Suzano Papel	Paper Industry	2.43	1.98	0.99	1.48	-0.95
Fibria	Paper Industry	2.43	2.12	0.49	1.31	-1.12
Ferbasa	Steel-making industry and basic industry of other metals	2.85	2.73	0.69	1.71	-1.14
Estrela	Other industries	2.85	2.72	0.51	1.62	-1.23
Celul Irani	Paper Industry	2.43	1.69	0.67	1.18	-1.25
Sansuy	Plastic and rubber product industry	4.24	4.78	1.10	2.94	-1.30
Embraer	Transportation equipment industry	3.13	2.12	1.51	1.82	-1.31
Inds Romi	Machinery Industry	3.23	3.31	0.49	1.90	-1.33
Metal Leve	Transportation equipment industry	3.13	2.99	0.60	1.79	-1.34

Baumer	Other industries	2.85	2.60	0.41	1.50	-1.35
Josapar	Industry of Food	3.23	2.24	1.45	1.85	-1.38
Elekeiroz	Chemical industry	3.35	3.14	0.77	1.96	-1.39
Bombril	Chemical industry	3.35	3.19	0.64	1.92	-1.43
Recrusul	Transportation equipment industry	3.13	2.62	0.75	1.68	-1.45
Plascar Part	Transportation equipment industry	3.13	2.68	0.68	1.68	-1.45
Minupar	Industry of Food	3.23	2.71	0.76	1.74	-1.49
Panatlantica	Steel-making industry and basic industry of other metals	2.85	2.28	0.41	1.34	-1.51
Elektro	Electricity, gas and water company	2.85	1.77	0.89	1.33	-1.52
Pet Manguinh	Oil and coal product industry	2.69	1.58	0.69	1.13	-1.56
Gerdau Met	Steel-making industry and basic industry of other metals	2.85	1.85	0.42	1.14	-1.71
Gerdau	Steel-making industry and basic industry of other metals	2.85	1.85	0.42	1.13	-1.72
Bardella	Machinery Industry	3.23	1.50	1.52	1.51	-1.72
Aco Altona	Steel-making industry and basic industry of other metals	2.85	1.74	0.41	1.07	-1.78
Fras-Le	Transportation equipment industry	3.13	2.23	0.47	1.35	-1.78
Petrobras	Extraction of oil and natural gas	2.69	1.29	0.49	0.89	-1.80
Cambuci	Leather and related product industry	4.47	3.93	1.39	2.66	-1.81
Schulz	Transportation equipment industry	3.13	2.00	0.54	1.27	-1.86
Iochp-Maxion	Transportation equipment industry	3.13	1.56	0.92	1.24	-1.89
Riosulense	Transportation equipment industry	3.13	1.53	0.94	1.24	-1.89
Inepar	Other industries	2.85	0.85	0.82	0.84	-2.01
Vale	Mining (except oil and gas)	2.85	1.17	0.45	0.81	-2.04
Braskem	Chemical industry	3.35	1.50	1.09	1.30	-2.05
Santanense	Yarn and fabric industry	3.98	3.25	0.58	1.91	-2.07
Randon Part	Transportation equipment industry	3.13	1.49	0.64	1.06	-2.07
Cia Hering	Clothing Industry	4.28	3.48	0.92	2.20	-2.08
Pettenati	Yarn and fabric industry	3.98	3.33	0.46	1.90	-2.08
Tectoy	Other industries	2.85	1.06	0.42	0.74	-2.11
Ultrapar	Chemical industry	3.35	1.77	0.56	1.17	-2.18
Karsten	Clothing Industry	4.28	3.73	0.42	2.08	-2.20
Teka	Clothing Industry	4.28	3.34	0.71	2.03	-2.25
Oderich	Industry of Food	3.23	1.25	0.60	0.93	-2.30
Weg	Machinery Industry	3.23	1.22	0.62	0.92	-2.31
Bic Monark	Transportation equipment industry	3.13	1.18	0.41	0.80	-2.33
Encorpar	Yarn and fabric industry	3.98	1.93	1.33	1.63	-2.35
Guararapes	Clothing Industry	4.28	2.31	1.51	1.91	-2.37
BRF SA	Industry of Food	3.23	0.96	0.48	0.72	-2.51

Schlosser	Yarn and fabric industry	3.98	2.33	0.41	1.37	-2.61
Fibam	Industry of metal products	4.56	3.16	0.60	1.88	-2.68
Tex Renaux	Yarn and fabric industry	3.98	1.97	0.50	1.23	-2.75
Forja Taurus	Industry of metal products	4.56	2.22	1.40	1.81	-2.75
Paranapanema	Industry of metal products	4.56	2.31	0.94	1.62	-2.94
Evora	Plastic and rubber product industry	4.24	1.28	1.20	1.24	-3.00
Tekno	Industry of metal products	4.56	2.00	0.64	1.32	-3.24
Kepler Weber	Industry of metal products	4.56	1.75	0.89	1.32	-3.24
Dohler	Clothing Industry	4.28	1.59	0.41	1.00	-3.28
Haga S/A	Industry of metal products	4.56	2.13	0.41	1.27	-3.29
Buettner	Clothing Industry	4.28	1.51	0.41	0.96	-3.32
Aliperti	Industry of metal products	4.56	1.66	0.57	1.11	-3.45
Mundial	Industry of metal products	4.56	1.78	0.42	1.10	-3.46
Vulcabras	Leather and related product industry	4.47	1.38	0.42	0.90	-3.57
Hercules	Industry of metal products	4.56	0.91	0.98	0.95	-3.61
Itau	Computer and electronics industry	7.64	1.85	0.61	1.23	-6.41

Contribution	[Author 1]	[Author 2]	[Author 3]
1. Definition of research problem	√	√	
2. Development of hypotheses or research questions (empirical studies)	√	√	√
3. Development of theoretical propositions (theoretical work)	√	√	√
4. Theoretical foundation / Literature review	√	√	
5. Definition of methodological procedures	√	√	
6. Data collection	√		
7. Statistical analysis	√	√	
8. Analysis and interpretation of data	√	√	
9. Critical revision of the manuscript			√
10. Manuscript writing	√		√
11. Other (please specify)			