DOI: https://doi.org/10.31686/ijier.vol10.iss4.3718

DETERMINANTS OF THE DEGREE OF INNOVATION IN THE INDUSTRIES LISTED ON THE B3

Rafael Sales Almendra (Corresponding author)
Federal University of Sergipe, São Cristóvão, Sergipe, Brazil
ORCID: https://orcid.org/0000-0003-3967-7193
Email: rafalmendra@gmail.com

Gésio de Lima Veras
Federal University of Sergipe, São Cristóvão, Sergipe, Brazil
ORCID: https://orcid.org/0000-0003-0730-5758
Email: gesio.veras@ifpi.edu.br

Ruthelle Maria de Carvalho Sousa
Federal Institute of Education, Science and Technology of Piauí, Campo Maior, Piauí, Brazil
ORCID: https://orcid.org/0000-0001-9414-1477
Email: ruthelle.carvalho@ifpi.edu.br

Alisson Araújo Andrade Silva
Federal University of Paraíba, João Pessoa, Paraíba, Brazil
ORCID: https://orcid.org/0000-0002-2847-0480
Email: alisson.andrade@ifpi.edu.br

Mário Jorge Campos dos Santos
Federal University of Sergipe, São Cristóvão, Sergipe, Brazil
ORCID: https://orcid.org/0000-0002-7481-3982
Email: mjkampos@gmail.com

Denise Santos Ruzene
Federal University of Sergipe, São Cristóvão, Sergipe, Brazil
ORCID: https://orcid.org/0000-0002-1550-6341
ruzeneds@hotmail.com

Daniel Pereira Silva
Federal University of Sergipe, São Cristóvão, Sergipe, Brazil
ORCID: https://orcid.org/0000-0002-2266-4428
silvadp@hotmail.com

Abstract

The study aims to identify the determinants of the degree of innovation of industries listed on the Brazilian Stock Exchange - B3. To this end, it used as sample 129 industries that trade their shares on the B3. From the principal component analysis, it was found that the innovation indicators are combined into two distinct factors. Therefore, it can be said that the degree of innovation of the firms takes into account the combination of indicators referring to the innovation strategies of exploitation and exploration, and, by encompassing two distinct factors, it is valid to mention that the degree of innovation has a two-dimensional character, suggesting the existence of a synergy between the innovation strategies.

Keywords: Exploitation; Exploration; Synergy.

1. Introduction

In emerging markets, innovation emerges as a source of competitive advantage, where innovative strategies implemented by managers meet market demands, providing sustainable growth for firms (Anning-Dorson, 2018).

In this context, a renewal in the organizations is necessary, leading managers to seek new sources of growth for the organization, through investments, especially those linked to innovation. However, such investments direct corporate strategies and the classical literature identifies two generic types: exploitation and exploration. While exploration focuses on generating new opportunities, knowledge, and competencies, exploitation takes advantage of opportunities, knowledge, and competencies already existing in the company (Levinthal & March, 1993; March 1991).

Since the seminal work of March (1991), it has been observed that these two strategies compete for the same set of scarce resources, which often results in the favoring of one strategy over the other. Therefore, the challenge faced by business managers and researchers is to figure out how to leverage a firm's capabilities in a way that allows it to succeed by using both types of innovation strategies simultaneously.

It should be noted that there are arguments in the literature in favor of the interaction of exploration and exploitation innovation strategies because, in this case, their combination can provide a superior competitive advantage compared to when each strategy is used in isolation, emphasizing the importance of better understanding this interaction and its effects (Andriopoulos & Lewis, 2009; Lennerts, Schulze, & Tomczak, 2020).

In this scenario, one realizes the need for the combination of factors related to the exploitation and exploration strategies, creating a degree of innovation. Given the above, the following question arises: which indicators are deterministic of the degree of innovation in industries listed on the Bolsa Brasil Balcão (B3)?

The objective of the present study was, therefore, to identify the determinants of the degree of innovation of industries listed on the B3. It is noteworthy that the sample of 129 industries listed on B3 was intentionally selected since the industrial sector has great relevance for the country's economy. Furthermore, the industry presents a relationship with technology that makes it a pioneer in the use of innovation strategies to obtain a competitive advantage.

Another relevant point of the study was the increase in knowledge about the degree of innovation, from the combination of factors of the indicators related to the strategies of innovation, exploitation and exploration. Added to this is the fact that, in view of the literature review, no studies were identified on the deterministic factors of this degree. Thus, the results presented here can provide answers and possibilities of more concrete actions by managers facing a decision-making process.

2. Literature review

2.1 The innovation strategy exploitation and intangible assets

According to March (1991), the exploitation strategy focuses on themes such as refinement, choice, production, efficiency, selection, implementation, and execution. Furthermore, the exploitation strategy emphasizes increasing returns to the resources invested, as well as incremental improvement in existing products to satisfy consumer needs through the development of existing knowledge in the company (Barbosa, Dantas & Cajaiba-Santana, 2020).

Concerning investments allocated for the execution of the exploitation strategy, Jia (2018) mentions that these capital investments aim at predictable returns in the short term, since in this type of strategy there is an emphasis on successful approaches, and in this case, there is more information about this type of innovation, which reduces risk. However, the author emphasizes that by limiting this strategy to incremental improvements, companies may fail to obtain greater returns.

The goal of the exploitation strategy is to improve and expand organizational skills, routines, and capabilities. Routines are improved by building on existing experience and knowledge to increase efficiency, reducing activities related to problem-solving, and eventually achieving incremental innovation (Andriopoulos & Lewis, 2009). In this way, the repeated use of a certain set of concepts and procedures can enable a company not only to understand it better, but also to identify, connect, and combine knowledge in the best possible way (Bauer, Strobl, Dao, Matzler & Rudolf, 2018).

Considering that knowledge is an intangible asset, which, according to its characteristics - rarity, valuable, inimitable, and irreplaceable - is present as an essential resource in companies, where by being used to achieve corporate objectives it generates competitive advantages (Kayo, Kimura, Martin & Nakamura, 2006).

Thus, it is perceived that the search for competitive advantage is related to the application of intangible resources, mainly because innovations are created, initially, by investments in this type of assets, highlighting the intangible assets of innovation (Lev, 2001). Teh, Kayo and Kimura (2008) corroborate this idea by stating that innovation is an important intangible asset because it generates competitive advantages, which enable the construction of barriers against market threats.

Intangibles are increasingly perceived as essential factors in the creation of knowledge, innovation, and economic growth. According to Eustace (2000), these assets are means that contribute or are expected to generate future economic benefits for companies and their stakeholders.

Therefore, organizations in the Knowledge Era need to be in a constant process of change, and the use of intangible assets is a primary issue in this context because as these assets come from knowledge and

skills, they create resources that guide the company to growth and competitive differential, facts that ensure the sustainability and elevation of the firm's market value (Rezende, Correia & Gomes, 2017).

The literature points out different classifications/typologies for intangible assets, highlighting the one proposed by Kayo et al. (2006) for the fact that these authors elaborate a non-exhaustive classification of these assets, distributing them into human assets, innovation assets, structural assets, and relationship assets. To measure the innovation strategy exploitation, the present study adapt such typology, because one of the components of innovation assets in the study of Kayo et al. (2006), the investments in research and development (R&D), are characterized by the literature as being a radical innovation of long term, besides that it aims at new learning to generate new knowledge and have higher risk and uncertain return (Lampert & Kim, 2019), characteristics that are compatible with the innovation strategy exploration.

2.2 Innovation strategy exploration and R&D investments

Characterized as the act of experimenting with new technologies or approaches and continuous efforts to achieve breakthrough inventions, the innovation exploration strategy implies a business behavior defined by experimentation and risk-taking. The returns associated with this method are systematically less certain, more variable, and more distant in time, making the firm's earnings more volatile and less predictable by experimentation (March, 1991).

Exploration innovation involves moving away from existing knowledge and experimenting with new technologies and new ways of thinking and acting, to generate inventions, imposing a greater information gap between the company and its stakeholders to protect itself from the unwanted competition, because once such a strategy is successful, it can generate greater growth through these new categories of products and services, resulting in a greater competitive advantage when compared to incremental innovations, which are the result of the exploitation strategy (March, 1991).

However, although companies adopt the exploration innovation strategy to create and maintain competitive advantage, they also need to understand how to manage the level of uncertainty and risk involved in innovation activity (Barbosa et al., 2020), moreover, such typology is present in the innovation strategies of companies committed to investments focused on Research and Development (R&D) (D'Este, Marzucchi & Rentocchini, 2018).

According to Fabris, Camargo, Russo, & Zayas-Castro (2015), R&D are activities that differ in their purpose, knowledge bases, people involved, and management styles. The authors emphasize that research activity is understood as an instrument or tool for the discovery of new basic knowledge or applied knowledge, while development activity is oriented toward the application of new knowledge to obtain practical results.

In this context, R&D investments are related to the innovation capacity of firms, since the accumulation of this capacity occurs through corporate learning mechanisms, providing feasibility of innovation projects that the company aims to develop, and, consequently, increase its sales and boost the company's economic results (Ramos & Zilber, 2015).

By investing in R&D, companies enhance expertise in fields that represent new opportunities and contribute to the development of internal competencies aimed at developing new products and processes, which contributes to a radical departure from the organization's current knowledge base focusing on the

long term (D'Este et al., 2018). Thus, scientific knowledge is the one who serves as a resource for the implementation of the exploration strategy, as it can increase the effectiveness in the search for innovative and valuable solutions, helping researchers to experiment with new skills and technologies besides avoiding unnecessary efforts (Geiger & Makri, 2006).

That said, the literature suggests that the use of both strategies, exploitation and exploration, may be the key to achieving the benefits expected by firms. Thus, the studies by Chen (2017), Bauer et al. (2018), Luger, Raisch & Schimmer (2018), Solís-Molina, Hernández-Espallardo & Rodríguez-Orejuela (2018), Severgnini, Galdamez & Vieira (2019), and Lennerts et al. (2020) analyzed the interaction of exploitation and exploration innovation strategies as a means by which firms come to ensure their long-term survival and prosperity.

2.3 Exploitation and exploration in previous studies

This section presents a brief overview of the interaction between exploitation and exploration based on recent studies about the themes, and finally presents the study hypothesis.

Chen (2017) when examining the relationship between exploitation and exploration, evaluates the difficulties of combining both innovation strategies and identifies that there is a way to maintain a balance between the strategies. Thus, the control of radical innovation (exploration) with incremental innovation (exploitation) is achieved as a new way to overcome these difficulties, besides that by helping companies to manage both strategies, they ensure the sustainability of the business.

With a sample of 101 European small and medium-sized enterprises, Bauer et al. (2018) also performed the same relational analysis between exploitation and exploration, concluding that there is a synergistic effect between the two, where the demand for continuous strategic renewal indicates that firms need to balance activities that may be conflicting for resource allocation, competencies, and learning mechanisms of the two innovation strategies.

The study by Luger et al. (2018) analyzed the evolution of investments in firms' exploitation and exploration strategies and their long-term performance outcomes. The authors found that the dynamic exploitation-exploration balance combines capability building processes with capability change processes and warn that firms benefit from such a relationship thereby achieving superior performance.

In Solís-Molina et al. (2018), the exploitation and exploration relationship is analyzed in 281 manufacturing firms in Colombia, understanding that the combination of both strategies is important to raise the performance of firms.

Through a survey of 227 Brazilian software development companies, Severgnini et al. (2019) also concluded that the convergence of both strategies extends the organization's results. The authors suggest verifying the exploitation and exploration balance through a degree of innovation.

Lennerts et al. (2020) argue that the interaction of exploitation and exploration is a source of competitiveness, pointing out that both strategies are equally important for a firm's long-term growth and survival, but stress that maintaining a proper balance in the use of these strategies is crucial to raising the firm's performance.

Given this empirical evidence, the research hypothesis is presented: the innovation strategies of exploitation and exploration are determinants of the degree of innovation in the Brazilian industries listed on B3.

3. Methodology

The study gathers a population of 129 industries listed on B3. For the data survey, the years from 2013 to 2019 were considered, which include the previous and subsequent three-year periods, taking into account the New Legal Framework for Science, Technology and Innovation - Law no. 13,243/2016. It should be noted that the triennium 2017 to 2019 corresponds to the most current one at the beginning of this research. Therefore, the study comprised the analysis of 903 observations.

Considering the literature review on the subject, Chart 1 presents the main indicators related to innovation modalities, their operationalization, and data sources.

It is noteworthy that this study adapts the classification of intangibles proposed by Kayo et al. (2006), considering R&D expenditures as a long-term radical innovation, for having higher risk and uncertain return (D'Este et al., 2018; Jia, 2018; Lampert & Kim, 2019; Solís-Molina et al., 2018). Thus, in this study, the indicators patents and trademarks measure the exploitation innovation strategy, while the Innovation Index is a proxy for the exploration innovation strategy.

Through the descriptive statistics it is presented the sample characteristics, taking into account the aforementioned indicators, as well as is analyzed through the Multiple Correspondence Analysis - MCA the association between the indicators related to the innovation modalities. According to Fávero, Belfiore, Silva, & Chan (2009), the MCA is a technique that displays the associations between a set of non-metric categorical variables in a perceptual map, thus allowing a visual examination of any pattern or data structure.

Chart 1 - Firms innovation indicators

Indicator	Operationalization	Data Source	Theoretical basis
Trademarks (INOV_QMAR)	Natural logarithm of the total number of registered trademarks in the analysis period	INPI *Website*	Kayo, Teh & Basso (2006); Sandner & Block (2011); Teh *et al*. (2008)
Patents (INOV_QPAT)	Natural logarithm of the total number of patent applications in the analysis period	Espacenet *Website*	Albuquerque Filho, Freire, Luca & Vasconcelos (2020); Kayo *et al* (2006b); Póvoa (2010); Teh *et al*. (2008)
Innovation Index (INOV_P&D)	Ratio of R&D expenditures to net sales revenue	CVM - DFP - Explanatory Notes	Blazsek & Escribano (2016); Hsu, Lien & Chen (2015)

Source: made by the authors.

To this end, categorizations were created based on the quartiles of the indicators referring to innovation, thus resulting in three categories or levels: low, medium, and high, as presented in Chart 2.

Chart 2 - Categorization of innovation indicators

Quartile	Intervals	INOV_QPAT	INOV_QMAR	INOV_ P&D	Categorization / level
1st and 2nd	Minimum value to the 50th percentile	0	0	0	Low
3th	51st percentile to 75th percentile	Above 0 to 0.6931472	Above 1 to 1.098612	Above 0 to 0.002672	Medium
4th	Above the 75th percentile to the maximum value	Above 0.6931472	Above 1.098612	Above 0.002672	High

Source: Prepared by the authors based on survey data.

It is noteworthy that in the 1st and 2nd quartile indicators the maximum value is zero, so both quartiles made up the low-level categorization.

Then, to identify the deterministic factors of the degree of innovation of the companies, the statistical technique Factor Analysis was used, which through the method of Principal Component Analysis (PCA) identifies the explanatory factors of the relationship of a set of variables (Corrar, Dias Filho & Paulo, 2014).

The technique applied considered as the number of significant correlations between the variables at least 0.30 and the Measure of Sampling Adequacy (MSA) greater than or equal to 0.50 in all variables. In the general model, the Kaiser-Meyer-Olkin (KMO) test was used to measure 0.50 for all variables, including the correlation matrix (Bartlett's Test). In the end, the number of factors extracted was based on the eigenvalue of each factor, where factors with an eigenvalue greater than one unit were considered, and to identify the variables that explain the factors, the factorial loads with an absolute value greater than 0.50 with factors rotated using the varimax method were considered.

4. Results and discussion

First of all, the study sample is characterized by the innovation indicators of annual patents, trademarks, and R&D, as shown in Table 1.

Table 1 - Companies and innovation modality

Innovation	2013	2014	2015	2016	2017	2018	2019	Average
Patents	29.45%	28.68%	30.23%	22.48%	24.03%	24.80%	26.35%	26.58%
Trademarks	27.90%	30.23%	31.00%	31.78%	30.23%	39.53%	33.33%	32.00%
R&D	35.65%	37.20%	39.53%	37.98%	37.20%	36.43%	35.65%	37.10%
Average	31.00%	32.04%	33.59%	30.75%	30.49%	33.59%	31.78%	31.89%

Source: Research data.

In Table 1 presents the percentage of companies studied that made use of each mode of innovation. Given its results, on average, the innovation modality most used by companies in the period under analysis occurred through R&D, as 37.10% of the companies analyzed made such investments. In 2015 and 2018 were the years in which companies made the most use of innovation, since, on average, 33.59% of the firms adopted some modality of innovation in their context. The modality via patents stood out in 30.23% of the companies in 2015, while innovation through trademarks stood out in 2018, where 39.53% of the firms in the sample used such modality. Taking into account the New Legal Framework for Science, Technology and Innovation - Law No. 13,243/2016, only in 2018, there was an increase in the number of companies that adopted one of the innovation modalities, with the trademarks being the most prominent. After the publication of the New Legal Framework, there was a decrease in the number of firms that used the R&D strategic typology. The opposite behavior was observed in innovation via patents, but with lower percentages about the periods before the New Framework, a fact that can be justified by the gain in the robustness of Brazilian legislation regarding the development of innovative activities. It follows, then, that about innovation, there is a preference in companies for the exploration strategy practice, aiming at the development of new products and processes, focusing on the long term (D'Este et al., 2018).

The Figure 1 shows the number of registered trademarks and patent applications in the analyzed period.

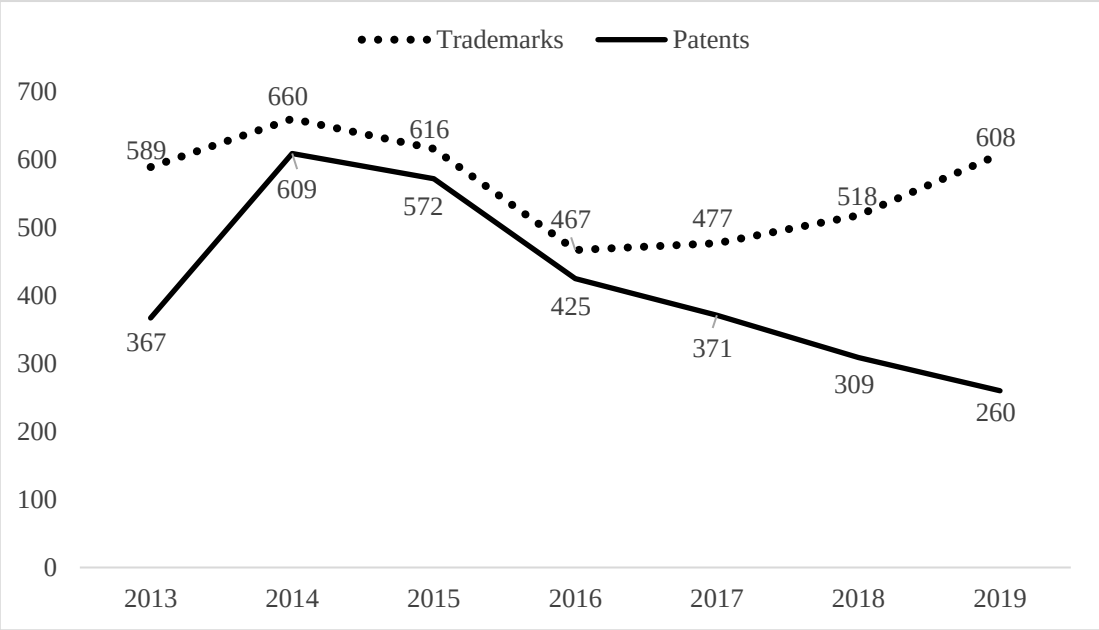

Figure 1 - Number of trademarks and patents

Source: Research data.

It can be seen that the number of registered trademarks was higher than the number of patent applications, especially before the advent of the New Legal Framework for Science, Technology and Innovation. As of 2016, the number of patent applications fell year by year, the opposite situation to that which occurred with trademark registration. Thus, one can see the importance that companies give to trademark registration as a way to improve their marketing strategies by focusing, for example, on incremental improvement of the existing product line with the purpose of satisfying consumer needs,

typical of the innovation strategy exploitation (Barbosa et al., 2020). Another important difference concerns the duration of registration because patents are granted for a certain period (usually 20 years), while trademarks are, in principle, granted for an unlimited time, since the trademark holder keeps the trademark by paying renewal fees every 10 years.

Despite the New Legal Framework for Science, Technology and Innovation in Brazil, which changes important rules aiming at creating a more dynamic innovation environment, it brings with it the dilemma of bureaucracy, which is also a factor for the reduction in the number of patent registrations.

In turn, Figure 2 contains the investments in research and development by the sample companies in the analyzed period. It can be seen that R&D investments were increasing until the year 2016, demonstrating the interest of firms in improving their ability to develop new products and processes in addition to improving existing ones (Cui, Ding, & Yanadori, 2019). The decline in this type of investment in the year 2017 may be linked to the reduction of government resources passed on to research funding agencies, as well as the enactment of the New Legal Framework for Science, Technology and Innovation in the country. However, it can be seen that firms have resorted to investments in R&D as a way to stand out and remain in the market through the exploration type of innovation strategy.

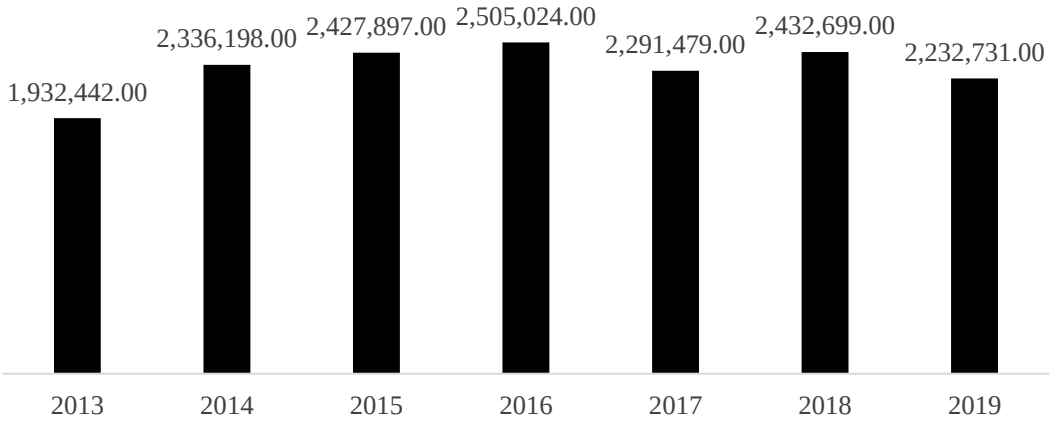

Figure 2 - R&D Investments (in thousands of Reais-BRL)

Source: Research data.

It is notable in Figure 3 the association of the three innovation indicators at a low level. It can also be seen that innovation via trademark registration and innovation via R&D are associated at a high level, while innovation via patent application at a high level is associated with innovation via R&D at a medium level. Thus, the associations demonstrate a greater interest of companies in investing high volumes in R&D to expand their product line, meet consumer needs and strengthen their trademarks. It is noteworthy that these results corroborate the studies of Chen (2017) and Bauer et al. (2018), which suggest a synergy between exploitation and exploration innovation strategies.

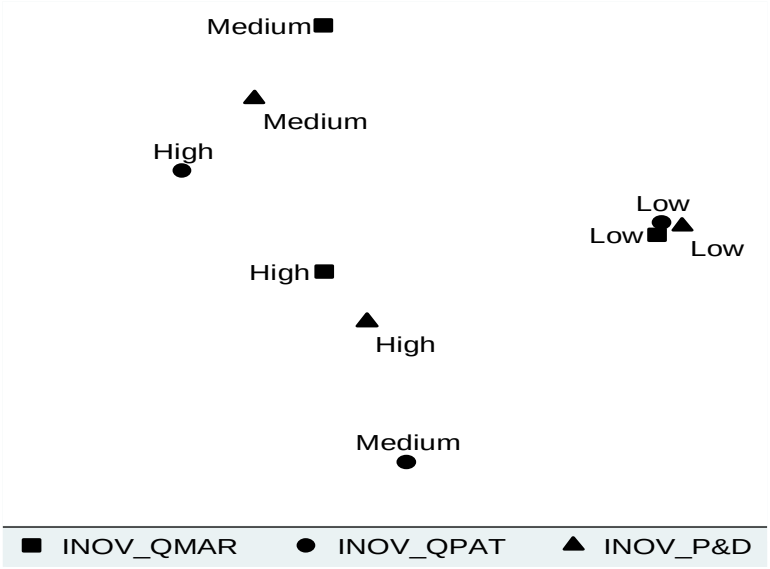

Figure 3 - Association between the categories of innovation indicators

Legend: INOV_QMAR - categorization of the indicator Trademarks; INOV_QPAT - categorization of the indicator Patents; INOV_P&D - categorization of the innovation index. Levels: Low; Medium; High.

Source: Research data.

Next, the descriptive statistics analysis was performed to verify the behavior of the survey data relative to the sample companies, Table 2.

Table 2 - Descriptive statistics of the study indicators

Indicator	Obs.	Average	Standard Deviation	Coef. of Variation (%)	Minimum	Maximum
INOV_QPAT	903	0.4520	0.9453	209.13	0	5.4026
INOV_QMAR	903	0.6698	1.1410	170.34	0	4.7449
INOV_P&D	903	0.3506	9.5319	2,718.74	0	285.8058

Source: Research data.

As shown in Table 2, the indicator INOV_QMAR has the highest average, but the variable INOV_P&D presents data with greater dispersion about the average, with a standard deviation equal to 9.5319, in addition to having more heterogeneous data, because it presents a coefficient of variation of 2,718.74%.

Subsequently, Spearman's correlation analysis was performed, since the Kolmogorov-Smirnov test indicated that the study variables do not have a normal distribution. Table 3 presents the results concerning the existence of correlation among the indicators of this research.

Table 3 - Spearman's Correlation

Indicator	INOV_P&D	INOV_QPAT	INOV_QMAR
INOV_P&D	1		
INOV_QPAT	0.3094***	1	
INOV_QMAR	0.2347***	0.3320***	1

Note: (***) Significant at the 1% level.

Source: Research data.

Table 3 shows that the innovation indicators are positively related with statistical significance at the 1% level. These results are indications of synergy between exploitation and exploration innovation strategies.

To meet the general objective of the research and test the research hypothesis, the factor analysis is carried out. A priori, it is important to highlight that, according to Corrar et al. (2014), the Principal Components Analysis method does not restrict the sample to the requirement of a normal distribution.

The anti-image correlation matrix among the innovation indicators revealed the first indication of data adequacy to factor analysis. According to this analysis, it was possible to raise the values of the measure of sample adequacy (MSA) for the study indicators. The MSA considers that values below 0.5 indicate that the variable does not fit the structure of the other variables and should therefore be eliminated. However, in this study, all indicators presented MSA with values greater than 0.5.

The communalities values represent the total variance explained by the factors in each variable. Initially, the communalities are 1 and after the extraction process, they start to vary between 0 and 1, being closer to 0 when the common factors explain low or no variance of the variable and 1 when all the variance is explained by all the factors. In this study, from the output resulting from the factor analysis processing by the statistical software, the communalities were greater than 0.666.

Bartlett's test of sphericity, used to verify the hypothesis that the matrix of correlations is the identity matrix, pointed to the rejection of the hypothesis, that is, the matrix of correlations can be the identity matrix, revealing the existence of correlations among the variables and indicating the suitability of the data for the application of factor analysis (Sig. 1%).

The KMO statistic ranges between 0 and 1 and compares the simple correlations with the partial correlations observed between the variables. According to the KMO statistic of the surveyed sample (0.500), the application of factor analysis becomes reasonable, allowing its use (FÁVERO et al., 2009). It is noteworthy that two factors were retained that can explain 77.54% of the variance of the original data.

The rotated component matrix, as shown in Table 4, presents the values of the loadings that correlate the variables with the factors after orthogonal rotation and has the objective of extreme the values of the loadings, in such a way that each variable is associated with a factor.

Table 4 - Rotating Component Matrix

Indicator	Component		Factor and designation
	1	2	
INOV_P&D	0.0034	0.9967	Factor 1 - Exploration
INOV_QPAT	0.8141	-0.0668	Factor 2 - Exploitation
INOV_QMAR	0.8127	0.0727	

Note: Extraction method: Principal Component Analysis. Rotation method: Varimax with Kaiser normalization.

Source: Research data

From Table 4, it is understood that the indicators or variables of innovation are combined into two distinct factors, where the first factor encompasses the indicators INOV_QPAT and INOV_QMAR, and the second factor comprises the indicator INOV_P&D. Thus, it can be said that the degree of innovation of the firms takes into account the combination of indicators related to the strategies of innovation, exploitation and exploration, and by encompassing two distinct factors it can be said that the degree has the characteristic of being two-dimensional, exactly in the dimensions of exploitation and exploration.

After performing the factor analysis, followed by the definition of the influencing factors, the factor score values were tested through Pearson's correlation, resulting in a zero value for the factors found, since the varimax rotation method generates factors that are orthogonal to each other.

Thus, the finding in this research is in line with other studies on the topic such as in Severgnini et al. (2019), Luger et al. (2018) and Lennerts et al. (2020), where the authors suggest a balance between exploitation-exploration since the combination of capability building processes with capability change processes leads firms to benefit from such a relationship obtaining a superior result.

Therefore, the hypothesis of this study is confirmed, that the innovation strategies of exploitation and exploration are determining factors of the degree of innovation of the Brazilian industries listed on B3, since the combination of radical innovation (exploration) with incremental innovation (exploitation) is a way to overcome difficulties, helping companies to manage both strategies to ensure the sustainability of the business.

5. Conclusion

The objective of the present research was to identify the determinants of the degree of innovation in industries listed on B3. It was decided to use the indicators patents, trademarks and R&D as proxies of innovation strategies, proceeding with a quantitative analysis through descriptive statistics and multiple correspondence analysis to characterize the sample and factor analysis through the method of principal component analysis to identify the factors that make up the degree of innovation.

The results showed that the innovation modality most used by companies in the period under analysis occurred through R&D investments since 37.10% of the companies making such investments. Nevertheless, the number of registered trademarks was higher than the number of patent applications, especially before the advent of the New Legal Framework for Science, Technology and Innovation. As of 2016, the number of patent applications fell year by year, the opposite situation to that which occurred with

trademark registrations. It can be seen, then, that there is a preference among companies for the practice of the exploration strategy, aiming at the development of new products and processes, in addition to obtaining prominence and permanence in the market, focusing on the long term.

It was verified through multiple correspondence analyses the association, at a high level, of innovation via trademark registration with innovation via R&D, while innovation via patent application at a high level is associated with innovation via R&D at a medium level. It can be seen then that the associations demonstrate a greater interest of companies to invest high volumes in R&D to expand their product line, meeting the needs of consumers and strengthening their trademarks. Through Spearman's correlation, it was found that the innovation indicators are positively related with statistical significance at the 1% level. Thus, the findings described here suggest the existence of a synergy between the innovation strategies of exploitation and exploration.

The innovation indicators or variables were combined into two distinct factors. Thus, it can be said that the degree of innovation of firms takes into account the combination of indicators referring to the innovation strategies of exploitation and exploration. Thus, by encompassing two distinct factors, one can say that the degree of innovation has the characteristic of being two-dimensional, exactly in the dimensions of exploitation and exploration.

The findings of this research contribute to the literature by increasing the relative knowledge about the degree of innovation, from the combination of factors related to the innovation strategies of exploitation and exploration, since no studies were identified on the deterministic factors of this degree. The results can provide answers and possibilities for more concrete actions by managers in the decision-making process, since innovation is a strategic factor of the first order in companies.

Despite the methodological rigor adopted, the results were obtained from an intentional sample. Therefore, a deeper investigation with a larger universe of companies is suggested, thus considering the analysis of all companies listed on B3. It is also noteworthy the possibility of a comparative analysis of the degree of innovation of companies from developing countries and companies from developed countries since the latter has more developed capital markets and technologies.

6. Acknowledgement

The authors acknowledge financial assistance from the Brazilian research funding agencies as CAPES (Coordination for the Improvement of Higher Education Personnel) under Finance Code 001, a Brazilian foundation within the Ministry of Education (MEC); CNPq (National Council for Scientific and Technological Development), a Brazilian foundation associated to the Ministry of Science and Technology (MCT); Federal Institute of Education, Science and Technology of Piauí (IFPI); and FAPITEC/SE (Support Foundation for Research and Technological Innovation of the State of Sergipe).

7. References

Albuquerque Filho, A. R., Freire, M. M. A., Luca, M. M. M., & Vasconcelos, A. C. (2020). Influence of Internationalization and Innovation on Business Competitiveness. InternexT - Revista Eletrônica de Negócios Internacionais da ESPM, 15(1), 1-18.

Andriopoulos, C., & Lewis, M. W. (2009). Exploitation-exploration tensions and organizational ambidexterity: Managing paradoxes of innovation. Organization science, 20(4), 696-717.

Anning-Dorson, T. (2018). Innovation and competitive advantage creation: The role of organizational leadership in service firms from emerging markets. International Marketing Review, 35(4), 580-600.

Barbosa, S. D., Dantas, D. C., & Cajaiba-Santana, G. (2020). Different strategies for different fields? Exploration, exploitation, ambidexterity, and the performance of self-employed musicians. Journal of Small Business Management, 1-34.

Barney, J. (1991). Firm resources and sustained competitive advantage. Journal of management, 17(1), 99-120.

Bauer, F., Strobl, A., Dao, M. A., Matzler, K., & Rudolf, N. (2018). Examining links between pre and post M&A value creation mechanisms-Exploitation, exploration and ambidexterity in central European SMEs. Long Range Planning, 51(2), 185-203.

Blazsek, S., & Escribano, A. (2016). Patent propensity, R&D and market competition: Dynamic spillovers of innovation leaders and followers. Journal of Econometrics, 191(1), 145-163.

Chen, Y. (2017). Dynamic ambidexterity: How innovators manage exploration and exploitation. Business Horizons, 60(3), 385-394.

Corrar, L. J., Dias Filho, J. M., & Paulo, E. (2014). Análise multivariada: para os cursos de Administração, Ciências Contábeis e Economia. Atlas Publishing House.

Cui, V., Ding, W. W., & Yanadori, Y. (2019). Exploration versus exploitation in technology firms: The role of compensation structure for R&D workforce. Research Policy, 48(6), 1534-1549.

D'Este, P., Marzucchi, A., & Rentocchini, F. (2018). Exploring and yet failing less: learning from past and current exploration in R&D. Industrial and corporate change, 27(3), 525-553.

Eustace, C. (2000). The intangible economy: Impact and policy issues. Report of the European high level expert group on the intangible economy.

Fabris, J. P., Camargo, M. E., Russo, S. L., & Zayas-Castro, J. (2015). Technological Innovation, R&D Activities and Innovation System between Organizations. Systemics, Cybernetics and Informatics, 13(6), 87-90.

Fávero, L. P., Belfiore, P., Silva, F. L., Chan, B. L. (2009). Data analysis: multivariate modeling for decision making. (4. ed.). Rio de Janeiro: Elsevier.

Geiger, S. W., & Makri, M. (2006). Exploration and exploitation innovation processes: The role of organizational slack in R & D intensive firms. The Journal of High Technology Management Research, 17(1), 97-108.

Hsu, C. W., Lien, Y. C., & Chen, H. (2015). R&D internationalization and innovation performance. International business review, 24(2), 187-195.

Jia, N. (2018). Corporate innovation strategy and stock price crash risk. Journal of Corporate Finance, 53, 155-173.

Kayo, E. K., Kimura, H., Martin, D. M. L., & Nakamura, W. T. (2006). Intangible assets, life cycle and value creation. Journal of contemporary management, 10(3), 73-90.

Kayo, E. K., Teh, C. C., & Basso, L. F. C. (2006). Intangible assets and capital structure: the influence of trademarks and patents on debt. Journal of management, 41(2), 158-168.

Lampert, C. M., & Kim, M. (2019). Going far to go further: Offshoring, exploration, and R&D performance. Journal of Business Research, 103, 376-386.

Lennerts, S., Schulze, A., & Tomczak, T. (2020). The asymmetric effects of exploitation and exploration on radical and incremental innovation performance: An uneven affair. European Management Journal, 38(1), 121-134.

Lev, B. (2001). Intangibles: management, measurement, and reporting. Washington: Brookings.

Levinthal, D. A., & March, J. G. (1993). The myopia of learning. Strategic management journal, 14(S2), 95-112.

Luger, J., Raisch, S., & Schimmer, M. (2018). Dynamic balancing of exploration and exploitation: The contingent benefits of ambidexterity. Organization Science, 29(3), 449-470.

March, J. G. 1991. Exploration and exploitation in organizational learning.

Organization Science, 2(1), 71-87.

Póvoa, L. M. C. (2010). Should the university patent its inventions? Revista Brasileira de Inovação, 9(2), 231-256.

Ramos, A., & Zilber, S. N. (2015). The impact of investment on firm's innovative capacity. RAI Journal of Management and Innovation, 12(1), 303-325.

Rezende, J. F., Correia, A. A., & Gomes, B. A. (2017). The intellectual capital and the creation of value in research units linked to the Brazilian Ministry of Science Technology and Innovation. RAI Journal of Management and Innovation, 14(3), 199-215.

Sandner, P., & Block, J. (2011). The market value of R&D, patents, and trademarks. The Valuation of Intangible Assets. Research Policy, 40(7), 969-985.

Severgnini, E., Galdamez, E. V. C., & Vieira, V. A. (2019). The Effects of Exploration, Exploitation, and Ambidexterity on Software Firm Performance. RAC-Revista de Administracao Contemporanea, 23(1), 111-135.

Solís-Molina, M., Hernández-Espallardo, M., & Rodríguez-Orejuela, A. (2018). Performance implications of organizational ambidexterity versus specialization in exploitation or exploration: The role of absorptive capacity. Journal of Business Research, 91, 181-194.

Teh, C. C., Kayo, E. K., & Kimura, H. (2008). Trademarks, patents, and value creation. RAM. Journal of Mackenzie Administration, 9(1), 86-106.