

MACKENZIE PRESBYTERIAN UNIVERSITY

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IN BUSINESS ADMINISTRATION**

**THE IMPACT OF INNOVATION AND DIVERSITY ON THE
VALUE CREATION AND FINANCIAL PERFORMANCE OF
THE PHARMACEUTICAL INDUSTRY**

CARLOS HENRIQUE FIRMINO DE OLIVEIRA

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Ph.D. Thesis presented to the Graduate Program in
Business Administration of Mackenzie Presbyterian
University, as a partial requirement to obtain the title of
Doctor of Business Administration.

Advisor: Prof. Dr. Michele Nascimento Jucá
Coadvisor: Prof. Dr. Polona Domadenik Muren

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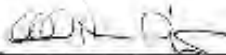
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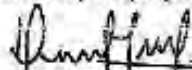
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Abstract: This thesis aims to investigate the effects of innovation and diversity on the value creation and financial performance of companies in the pharmaceutical industry. It is developed considering two related articles. The first one performs a bibliometric analysis and a systematic review of the scientific production published in the two main journal databases - Scopus and Web of Science. The bibliometric analysis performs a frequency count and identification of co-citations of documents, authors, journals and other objective data of the articles in the final sample. In turn, the systematic review seeks to identify knowledge gaps in order to suggest an agenda for future research related to the research topic. The second paper verifies what are the separate and grouped effects of innovation and diversity of the board of directors on the value creation and financial performance of the companies. To this end, it analyzes a sample of 92 publicly traded companies, located in 24 countries. The data is obtained between 2015 and 2022. The hypotheses arising from the objectives of the study are verified by means of a regression with panel data, both for the core and the robustness tests. This study contributes to policymakers and pharmaceutical firms by analysing the relation between innovation, diversity, value creation and financial performance. The results promote the enforcement of innovation, diversity and inclusion policies. It also provides useful insights by identifying the main proxies for measuring these concepts, encouraging emerging markets to evolve these topics. Moreover, it adds up to the existing academic literature by analyzing the independent and combined effects of innovation and board diversity on the value creation and financial performance of the global pharmaceutical industry

Keywords: Innovation, Diversity, Value creation, Financial performance, Pharmaceutical industry.

LIST OF FIGURES

Figure 1 - Distribution of articles over time	32
Figure 2 - Occurrence map among the main keywords.....	33
Figure 3 - Map of the thematic evolution of the main keywords	34
Figure 4 - Keyword cloud.....	34
Figure 5 - Collaboration between countries in the publication of articles.....	38
Figure 6 - Bradford's law on periodicals	39
Figure 7 - Total citations per journal - TC index.....	40
Figure 8 - Major affiliations	40
Figure 9 - Analysis of (sub)categories to identify knowledge gaps	45

LIST OF TABLES

Table 1 - Evolution of the sample of articles	27
Table 2 - Matrix of (sub) categorization.....	28
Table 3 - Frequencies of the main keywords.....	32
Table 4 - Goffman's T.....	36
Table 5 - Zipf's law	37
Table 6 - Total citations.....	38
Table 7- Dependent variable of value creation.....	75
Table 8 - Dependent variables of financial performance	78
Table 9 - Variable description	79
Table 10 - Descriptive statistics	81
Table 11 - Correlation matrix	82
Table 12 - Panel data results.....	86
Table 13 - Robustness tests	88
Table 14 - Compilation of hypotheses confirmation.....	89

LIST OF ABBREVIATIONS AND ACRONYMS

BCG	Boston Consulting Group
CIQ PRO	Capital IQ Pro
CSR	Corporate Social Responsibility
CVM	Brazilian Securities and Exchange Commission
DSCR	Board Diversity Score
EBIT	Earnings Before Interest and Taxes
ESG	Environmental, Social and Governance
GDP	Gross Domestic Product
JCR	Journal Citation Report
MBV	Market to Book Value Ratio
OECD	Organisation for Economic Co-Operation and Development
RBV	Resource-Based View of the Firm
RDT	Resource Dependence Theory
R&D	Research and Development
ROA	Return on Assets
ROE	Return on Equity
TC	Total Number of Citations
TOBQ	Tobin's Q Ratio
VAIC	Value Added Intellectual Coefficient
WOS	Web of Science

SUMMARY

1.	INTRODUCTION	11
1.1	Article 1.....	13
1.2	Article 2.....	14
1.3	References	16
2.	IMPACTS OF INNOVATION AND DIVERSITY ON THE VALUE CREATION AND FINANCIAL PERFORMANCE OF COMPANIES: A BIBLIOMETRIC ANALYSIS AND SYSTEMATIC REVIEW	19
2.1	Introduction.....	20
2.2	Literature review	24
2.3	Methodology	26
2.4	Analysis of the results	31
2.4.1	Bibliometric analysis	32
2.4.2	Systematic review.....	41
2.5	Conclusion	45
2.6	References	47
2.7	Appendix A - Summary of articles in the final sample.....	58
2.8	Appendix B - Classification of the (sub) categorization matrix	65
3.	INNOVATION AND DIVERSITY EFFECTS ON THE VALUE CREATION AND FINANCIAL PERFORMANCE OF PHARMACEUTICAL COMPANIES	66
3.1	Introduction.....	67
3.2	Literature review	69
3.2.1	Theoretical review and formulation of hypotheses.....	70
3.2.2	Empirical review	73
3.3	Methodology	78
3.3.1	Sampling	78
3.3.2	Tests	78
3.3.3	Equations and variables.....	79
3.4	Result analysis.....	80
3.4.1	Descriptive statistics and correlation analysis	80
3.4.2	Core regression tests	83
3.4.2	Robustness regression tests	86
3.5	Conclusion	89
3.6	References	91
3.7	Appendix C – Number of pharmaceutical companies for each country in the sample...	98
3.8	Appendix D – Board of directors’ diversity score	98
4.	CONCLUSION	100

1. INTRODUCTION

The increases in life expectancy seen in recent decades, as well as the Covid-19 pandemic crisis, place the pharmaceutical industry at the forefront of the current 5.0 industrial revolution. This industry is also at the center of innovative solutions to the main issues facing humanity in the twenty-first century (Malerba & Orsenigo, 2015; Schwab, 2016; Druedahl & Prince, 2021). Another contemporary phenomenon influencing the corporations is the pressure to promote diversity and inclusion of underrepresented social groups in leadership positions, which also applies to the companies in the pharmaceutical industry (Safiullah *et al.*, 2022; B3, 2023). In this context, knowing the possible impacts of both phenomena on business results matters. Thus, it is important to understand the relationships between innovation, diversity, value creation and financial performance of firms and how they influence each other. Since each industry may differ in the way that those constructs correlate, this study will focus on the pharmaceutical industry for its importance and characteristics (Li *et al.*, 2021, Saha *et al.*, 2022).

One of the main characteristics of the pharmaceutical sector is specialization, since its production chain requires specific knowledge and techniques (Euromonitor International. 2022; Saha *et al.*, 2022). The manufacture of medicines depends on the production of drugs that contain active ingredient - the substance responsible for the therapeutic effect in the body (Malerba & Orsenigo, 2015). However, some of the supplies used in the production chains of pharmaceutical industries come from different parts of the globe (Druedahl & Prince, 2021). As a result, production is highly dependent on international technology and is influenced by large pharmaceutical corporations that are embedded in complex value chains. This fact explains its prominence in the assimilation and development of technological innovations (Asad & Popesko, 2023; Dosi *et al.*, 2023)

Innovation, in turn, is both a cause and consequence of industry 5.0 revolution (Schwab, 2016; Ziatdinov *et al.*, 2024). Experimenting with different ways of making use of various technologies - physical, digital and emerging biotech – it changes the way society produces, consumes, interacts and meets sustainable development goals (BCG, 2023). In addition, interest in innovation is increasing due to its importance to brand value and other intangible assets, which are drivers of an organization's long-term business competitiveness (Schumpeter, 1934; Dosi *et al.*, 2023). Such aspects raise a positive relationship between innovation and company value (Li *et al.*, 2021; Keenan *et al.*, 2022; Dosi *et al.*, 2023).

However, there are developed and emerging economies in the world that concentrate the pharmaceutical industry - China, USA, Ireland, Switzerland, and Germany are the top five (Euromonitor International, 2022). In all of them, the issue of diversity is present. From a regulatory point of view, there are those who impose measures to accelerate this process (Safiullah *et al.*, 2022). Such policies are practiced not only by governments, but also by the market itself. In the case of publicly traded companies, the example is set by the board of directors (B3, 2023). Authors have found that the greater the diversity of the leadership, the greater the value of companies. Thus, it is interesting to understand the moderating effect of board diversity on innovation upon value creation and financial performance of pharmaceutical companies (Loh *et al.*, 2022; Hazaea *et al.*, 2023).

To this end, two articles are being developed. The first paper aims to identify existing knowledge and gaps on the topics of diversity, innovation, value creation and financial performance through a bibliometric analysis and systematic review of the literature. Its results drive the themes of the subsequent paper which analyzes the impact of innovation and board of directors' diversity on value creation and financial performance of pharmaceutical companies. Besides, it investigates how diversity moderates the effects of innovation on the value creation and financial performance.

This thesis contributes to the existing literature related to innovation, diversity, value creation and financial performance – in the context of multinational pharmaceutical companies. It also fills the literature gaps mentioned at the first paper. For example, Boiko, (2022) stresses the necessity to analyse what influences the decision to invest in innovation in specific industries. Thus, this work delves into the moderating effect of diversity on innovation for the pharmaceutical sector. In the same line, Sierra Moran *et al.* (2024) suggests to keep studying the relationship between board characteristics and innovation. More specifically, they address the recommendation to consider the effect of age diversity.

Furthermore, this paper offers evidence on how the capital markets perceive the importance of diversity and innovation, which is helpful information for policymakers. It also highlights the agency conflict that exists between stockholders and managers. The first ones consider future profits to be obtained by investment in innovation. On the other hand, the second are more concerned about the expenses resulting from these investments that can reduce the company's

current financial performance. As for company leaders and consultants, it offers evidence on the pros and cons of diversity, what stimulates the creation of a pipeline for leadership positions that takes diversity into account. By addressing these issues brought by the current economic and social landscape, this paper can assist businesses in achieving inclusive and sustainable growth.

The structure of the thesis is as follows: Chapter 1 is the introduction, showing the contextualization of the research problem, the study objectives, and the relationship among the two papers; Chapter 2 presents Article 1, Chapter 3 is about Article 2; Chapter 4 is the conclusion, containing the summary of the main findings of the research.

1.1 Article 1

This study aims to analyze the existing academic literature on the impacts of innovation and diversity on value creation and financial performance of companies through a bibliometric analysis and a systematic review. The execution of both methodologies considers the use of specialized software such as RStudio, Biblioshiny and Rank Words. The final sample consists of 34 articles obtained from the Web of Science and Scopus databases from 2017¹, to May 22nd., 2023. The bibliometric analysis also verifies the three main laws of bibliometrics - Zipf (1949), Bradford (1934) and Lotka (1926). As a result of the bibliometric analysis, the topic of this study has shown increasing interest over time. The keywords diversity and financial performance stand out from the rest. The most cited articles are those linked to institutions located in France.

As per the systematic review, the main findings suggest a research agenda for the following topics: i. the moderating effect of diversity in innovation on company results; ii. the use of regression with binary dependent variables and structural equations; iii. the analysis of alternative proxies for innovation, financial performance, value creation and diversity of boards of directors; and iv. the investigation of data from companies in Latin America with long time series. This study adds knowledge to the existing literature on this topic and sets itself apart

¹ The Web of Science and Scopus databases compile articles since 1945 and 1966, respectively. To obtain the sample for this study, it was not defined an initial cut-off year. However, after applying the filters mentioned in Table 1, the oldest article in the sample is from 2017.

from others by examining the effectiveness of innovation, intellectual capital, and diversity as predictors of firms' financial performance and value creation.

1.2 Article 2

Once the paths in Article 1 on the relationships between the constructs of innovation, value creation and financial performance have been identified, this information provides the basis for the analysis of the effect of innovation on value creation and financial performance. The main theory behind this relationship is the Resource-Based View (RBV) (Barney, 1991). It primarily classifies the resources available to the firm into physical, human and organizational capital. Recent studies point to the need for further research to prove the validity of this, among other corporate finance theories, in emerging markets and in specific industries with multi-country samples (Xu & Zhang, 2021; Farooq & Ahmad, 2023).

Thus, the objective of Article 2 is to analyze the impact of innovation and board of directors' diversity upon the value creation and financial performance of pharmaceutical companies, employing a panel data regression. The sample consists of firms from 24 countries (see appendix C). The data is obtained from the CIQ Pro database and Bloomberg, considering the period between 2015 and 2022. This period comprises the emerging and adoption of new technologies, representing the industry 5.0 (Ziatdinov *et al.*, 2024), which were deepened during the Covid-19 pandemic crisis. Besides, this is the time frame that allows the collection of the selected proxy for board of directors' diversity for a wider range of countries.

This study contributes to the literature about innovation, diversity, value creation and financial performance of multinational pharmaceutical companies - filling the gaps pointed out in article 1 - as well as those mentioned in other review articles (Boiko, 2022; Saha *et al.* 2022; Sierra Moran *et al.*, 2024). Moreover, it provides useful insights for researchers, policymakers, company managers and regulators. Addressing the opportunities and challenges of new economic scenario can help companies achieve sustainable and inclusive growth.

It does so by providing evidence to support the discussion about the issue of board of directors' diversity, which is a relevant topic to the contemporary world. Centuries of sex discrimination have led to gender gaps in wages, pensions and leadership positions in the present. In parallel, large migration movements increased the mixture of cultures and phenotypical characteristics

within contemporaneous societies. Nevertheless, the current corporate leadership in each society does not necessarily hold the same demography proportion, as the wider the population (Loh *et al.*, 2022; Pant & Ndugala, 2022).

This underrepresentation arouses demands for social justice that need to be addressed by companies, meeting all other stakeholders' expectations. In other words, it is essential to be a balance between labor force and leadership members, while maintaining innovation capacity and profitability. Therefore, there is a public interest in understanding how this situation impacts the companies' results (Hazaea *et al.*, 2023).

From a regulatory point of view, governments and market entities seek to accelerate the diverse representation in business leadership. There are examples of laws and market regulations that impose diversity rules on companies. In Brazil case, the racial quotas law requires state-owned organizations to reserve 20% of new hires for each position for black people. This law is applied to listed companies, including the largest one in the country - *Petróleo Brasileiro S.A – Petrobras* (Brazil, 2014).

Still considering Brazil's example, the local stock exchange - *Brasil, Bolsa, Balcão (B3)* - requires that publicly traded companies present a diverse governance. If they do not have the required level of diversity, B3 gives them a short period of time to comply with this norm (B3, 2023). Finally, at the firm level, there are companies that openly consider racial criteria in their new hiring. It means that candidates of different skin tones may not apply for some employment jobs. This policy has the purpose of increasing company's internal color diversity in leadership positions (Magazine Luiza, 2023).

However, despite all the sociological reasoning for those affirmative practices, there are second order effects that should be investigated. Among them is the necessity of verifying the effects of board of directors' diversity on companies' value creation or financial performance. Moreover, it is also relevant to investigate it's impact on companies' innovation since it proceeds from human intelligence hitherto (Loh *et al.*, 2022, Smriti & Das, 2022). It means that increasing the human diversity on the board of directors', it will influence the social dynamics of the group. As a consequence, this will impact the way decisions are made regarding strategic topics, such as innovation investments.

Therefore, article 2 contributes to the existing literature mostly by analyzing the moderating effect of board of directors' diversity in innovation, towards value creation and financial performance for the pharmaceutical industry. It also brings an unexplored proxy for board of directors' diversity, which mixes gender and age, as particular methodological contribution to previous works.

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2. IMPACTS OF INNOVATION AND DIVERSITY ON THE VALUE CREATION AND FINANCIAL PERFORMANCE OF COMPANIES: A BIBLIOMETRIC ANALYSIS AND SYSTEMATIC REVIEW

Abstract: This study aims to analyze the existing academic literature on the impacts of innovation and human diversity on the creation of value and the financial performance of companies through a bibliometric analysis and a systematic review. The execution of both methodologies considers the use of specialized software such as RStudio, Biblioshiny and Rank Words. The final sample consists of 34 articles obtained from the Web of Science and Scopus databases from January 1, 2017, to May 22, 2023. Included in the bibliometric analysis is the verification of the main laws of bibliometrics: Zipf (1949), Bradford (1934) and Lotka (1926). As a result of the bibliometric analysis, it appears that the topic of this study has shown increasing interest over time. The diversity keyword stands out from the rest. The most cited articles are those linked to universities located in France. In turn, the results of the systematic review suggest an agenda for future research on i. the moderating effect of diversity in innovation on company results; ii. the use of regression with binary dependent variables and structural equations; iii. the analysis of alternative proxies for innovation, financial performance, value creation and diversity of boards of directors; and iv. the investigation of data from companies in Latin America with long time series. This study contributes to the existing literature and distinguishes itself from the others by conducting a joint analysis of the proxies of innovation, intellectual capital, and diversity as determinants of companies' financial performance and value creation.

Keywords: *Innovation, Diversity, Value creation, Financial performance, Bibliometric analysis, Systematic review*

2.1 Introduction

The end of the 20th century marked the transition from traditional production models to the knowledge economy, in which intangible assets are the main sources of wealth. This transformation process evolved during the 21st century, giving rise to the fourth industrial revolution. In this phase, robotization and artificial intelligence occupy an even greater space in the production process, incorporating increasingly complex activities. In addition, there is an increase in interaction between humans and machines in the various links in the production chain, as well as with customers, suppliers, governments and financial intermediaries. Soon, the role of humans in organizations starts to focus on strategic and innovative activities. This fact allows people to dedicate themselves to value creation through the optimization of human knowledge (Schwab, 2016; Mudzar & Chew, 2022; Saha *et al.*, 2022)

In this revolutionary context, corporations need to adapt quickly to changes in the environment since their products and services must meet demand in a constant process of transformation. Elements of a portfolio can disappear abruptly. Some are because they were integrated into other products (ex: dedicated portable navigation devices based on the global positioning system (GPS) that were incorporated into smartphones and automobiles). Others have been completely replaced—ex: brick-and-mortar stores for the rental of videos succumbed to streaming platforms. Such changes are mainly motivated by the diversity of habits and characteristics of the new generations (Chopra & Veeraiyan, 2017; Kilkki *et al.*, 2018; Ringberg *et al.*, 2019).

It turns out that sizing a company's innovation capacity is a challenging task, due to the difficulty of identifying a metric that is capable of measuring it properly. Some studies consider as proxies for innovation the volume of investments in research and development (R&D) or in research, development and innovation (R&D&I), or even the number of patents or scientists within the companies. However, it is important to highlight that all these forms of representation of innovation and creativity originate from the intellectual capital of organizations in interaction with the environment and technologies (Santos *et al.*, 2018).

For Elberdin (2017), there is a relationship between intellectual capital and innovation. Nevertheless, it depends on relevant contextual elements of the companies, such as the business environment, size, location etc. For Najjari and Aamoun (2020), intellectual capital is an

unequivocal element in generating innovation. Through it, employees optimize the use of organizational resources, solve problems, make decisions and empower themselves. These studies analyze these relationships through intellectual capital proxies, such as the value-added intellectual coefficient (VAIC) - being obtained through the sum of the efficiency indices of the intellectual, structural and allocated capital (Pulic, 2000). This construct subsequently undergoes methodological improvements and criticism (Maji & Goswami, 2017; Marzo, 2022). The study by Li *et al.* (2021) also uses this same proxy and verifies the existence of a positive relationship between intellectual capital and the performance of the most innovative companies in the world.

As for the issue of diversity in organizations, it is also one of the determinants of value creation or improvement of their financial performance (Riaz *et al.*, 2019). The focus of this analysis is on boards of directors, above all (Basher *et al.*, 2022; Mgammal, 2022; Ponumareva *et al.*, 2022). Diversity on boards is understood as the variation in the demographic information of its members, such as age, gender, nationality, culture, ethnicity, language, etc. (Mgammal, 2022). Diversity broadens the spectrum of perspectives on the problems addressed by the council, which ends up strengthening its decision-making process. The results indicate that this plurality of visions contributes to the formation of the company's intellectual capital, positively impacting its reputation, social responsibility, financial results and value. There are different proxies for its measurement, and the one that is most easily obtained in secondary databases is the gender of the directors (Riaz *et al.*, 2019; Khatib *et al.*, 2020; Mgammal, 2022).

Another non-consensual theme in the literature is the distinction between metrics capable of measuring the creation of value and the financial performance of companies. The variety of results obtained stems from the complexity of defining value, which is linked to the observer's perspective. In the view of some shareholders, the company increases its wealth by increasing the distribution of dividends in the short term. For others, value creation depends on the company's ability to retain part of its profits to reinvest them in the future. This fact generates the expectation of resilience and a higher volume of dividends to be distributed in the long term. Examples of value creation or market-based performance metrics are market-to-book value, Tobin's Q ratio, etc. (Carton & Hofer, 2007; Hamdan, 2017).

In turn, there are metrics obtained from the financial statements that register the observed or historical result of the companies, not the expected or projected result. From an accounting

perspective, these measures can be interpreted as performance or financial performance. Due to the standardization of its measurement, such metrics are easily obtained and comparable, being preferred by financial analysts (Imam *et al.*, 2013), creditors (Carton & Hofer, 2006; Salehi & Zimon, 2021) and researchers (Marzo, 2022) - ex: return on assets (ROA), return on equity (ROE), etc. However, despite the capture of historical data, some authors consider them proxies for value creation (Salehi & Zimon, 2021; Moura *et al.*, 2022), which indicates that this topic is still subject to investigation.

Given the above, the research problem of this study consists of answering the following questions: i) What are the main metrics or proxies related to the creation of value and the financial performance of companies? ii) What are the metrics or proxies that best measure innovation, intellectual capital and diversity in companies? iii) What is the evolution of academic production on this topic? iv) What are the collaboration patterns between the main authors, institutions and countries in the sample? v) What are the articles, authors and journals that have the greatest impact on the topic of this research? and vi) What are the main connections between the sample documents?

Such answers are obtained through a bibliometric analysis and systematic review of the subject. The bibliometric analysis performs a frequency count and identification of co-citations of documents, authors, journals and other objective data of the articles in the final sample. The systematic review seeks to identify knowledge gaps in order to suggest an agenda for future research related to the research topic (Aria & Cuccurullo, 2017; Forliano *et al.*, 2021; Cicea *et al.*, 2022).

The final sample has 34 articles obtained between 2017² and May 22, 2023, from the Web of Science (WoS) and Scopus databases. The adoption of both methodologies requires the use of specialized software - RStudio, Biblioshiny and Rank Words. In addition, the verification of the main bibliometric laws, Lotka (1926), Bradford (1934) and Zipf (1949) is adopted.

Among the contributions of this study is the analysis of the following aspects, not verified by other studies with the same methodology on related topics (Elberdin, 2017; Isola *et al.*, 2019;

² The Web of Science and Scopus databases compile articles since 1945 and 1966, respectively. To obtain the sample for this study, it was not defined an initial cut-off year. However, after applying the filters mentioned in Table 1, the oldest article in the sample is from 2017.

Riaz *et al.*, 2019; Nejjari & Aamoum 2020; Basher, 2022; Mgammal, 2022; Paoloni *et al.*, 2022): i) joint analysis of innovation proxies, intellectual capital and diversity as determinants of financial performance and value creation of companies; ii) identification and distinction between value creation metrics and financial performance; iii) analysis of the most appropriate proxies for innovation, intellectual capital and diversity.

As a result, the bibliometric analysis points out that: i) the topic of this study shows a growing interest over time; ii) the keywords diversity and financial performance are the most observed; iii) the most cited articles are those linked to universities located in France; iv) the journal with the highest number of citations is "Business Strategy and the Environment"; and v) researchers linked to the University of Teramo publish the most.

The systematic review identifies the following main gaps for future research to address: i) incorporating value creation proxies in the models; ii) assessing whether there is an interaction between diversity and innovation and their joint correlation with financial performance or value creation; iii) selecting samples with global data or data from Latin American countries.

This study has the following structure: Section 2.2 brings a literature review, presenting the main constructs observed in the sample. Section 2.3 describes the methodologies employed both in the bibliometric analysis and in the systematic review. Section 2.4.1 presents the findings for the bibliometric analysis and section 2.4.2 brings the results of the systematic review. Section 2.5 is the conclusion. It highlights the main findings of the research.

This study contributes to the literature on innovation, diversity, value creation and financial performance and also on multinational pharmaceutical companies - in a particular setting of the industry 5.0 - as pointed by Olsson *et al.* (2024) and Ziatdinov *et al.* (2024). Moreover, it provides useful insights for researchers, policymakers, company managers and regulator – e.g: identifying the main proxies for measuring these concepts, encouraging emerging markets to mature these topics and pointing future avenues for investigating this topic. By addressing the opportunities and challenges of the actual economic and social scenarios, this paper can help companies to achieve sustainable and inclusive growth.

2.2 Literature review

The relationship between diversity and innovation with value creation is analyzed by different theories. The three most frequently cited are resource-based view, agency theory and upper echelon theory. According to the resource-based view, resources are assets, skills, processes, attributes, information and knowledge that are available and under the control of the company. Such resources must be used in the development and application of strategies that improve the efficiency and effectiveness of the organization (Barney, 1991). The theory identifies three main groups of capital: physical, human and organizational. It is important to mention that the human capital of a company is related to both diversity and innovation. More recently, studies have given greater emphasis to the analysis of the relationship between human capital and financial performance (Barney *et al.*, 2021).

As for the agency theory, it identifies that, in companies, the principals or owners delegate executive activities to their agents or managers. It happens that managers do not always act in accordance with the interests of the owners, generating an agency conflict. In order to mitigate this conflict, companies implement corporate governance structures. In them, legislative power rests with the board of directors – which represents the shareholders and has the power and duty to monitor management acts and define the organization's strategic directions (Jensen & Meckling, 1976; Fama & Jensen, 1983; Eisenhardt, 1989). The agency problem in the company can also occur between i) majority and minority shareholders and ii) shareholders and creditors (Panda & Leepsa, 2017).

As for the theory of senior management or upper echelons theory, it clarifies that the personal characteristics of executives - e.g. age, professional or academic background - can partially predict the strategies that the company tends to adopt as well as its financial performance (Hambrick & Mason, 1984). Despite being rational individuals, managers, eventually, can make decisions permeated by unconscious cognitive biases. Thus, it is important to understand which characteristics have the most (in)direct influence (White & Borgholthaus, 2022).

According to empirical studies, innovation and diversity are some of the most coveted assets by organizations, especially in the context of Industry 5.0 (Li *et al.*, 2021; Hussain *et al.*, 2022; Olsson *et al.*, 2024; Ziatdinov *et al.*, 2024). It is understood that they are associated both with the expectation of value creation in the future and with the improvement of financial

performance in the present. However, the analysis of this relationship is still subject to consensus in the academy. Some studies verify the existence of a positive relationship (Boadi, & Osarfo, 2019; Nawaz & Ohrlogge, 2022), while others point to an association without statistical significance (Ghafoor *et al.*, 2022; Cheikh & Noubbigh, 2019). Another controversial aspect is the definition of the metrics associated with these constructs, with research associating innovation with intellectual capacity (Li *et al.*, 2021; Nawaz & Ohrlogge, 2022).

For Nadeem *et al.* (2018), intellectual capital is a set of skills and relationships between people and technologies capable of generating wealth and producing solutions to business challenges. Thus, some authors understand that intellectual capital is linked to the innovative capacity of companies and is considered its main generator (Nejjari & Aamoun, 2020). On the other hand, others recognize the predominance of the company's operating context, so that there is effective innovation based on intellectual capital (Elberdin, 2017).

Regardless of this aspect, there is a relative consensus about the subdivisions of intellectual capital: human, structural and relational. The first represents the human intellect available to the organization. The second characterizes the organizational knowledge of the company. Finally, the third expresses his network of relationships (Quintero *et al.*, 2021). Concerning the latter approach, some researchers use the value-added intellectual coefficient (VAIC) as a proxy for intellectual capital (Pulic, 2000; Paoloni *et al.*, 2022). It is worth noting that, despite theoretical criticisms of the VAIC (Iazzolino & Laise, 2013; Marzo, 2022), empirical studies point to a positive relationship between the VAIC and the creation of value and/or financial performance of companies (Riaz *et al.*, 2019; Quintero *et al.*, 2021).

As for diversity, this is a widely investigated topic – specially in the analysis of business leadership. Diversity, in this case, is often considered as the composition of companies' board of directors. The investigated characteristics are the demographic ones, such as age, gender, nationality, ethnicity, etc. Those studies analyze the existence of a relationship - usually positive - between gender diversity on boards of directors and the (non) financial performance of companies (Riaz *et al.*, 2019; Mgamal, 2022).

Moreover, the cognitive bias that each director has also affect the important decisions made by the company board. Therefore, since risky investment decisions - such as in R&D - are made by the board, the personal peculiarities, beliefs and biases of the members will influence how they vote and how the discussion is made. So, board diversity ends up moderating innovation policy. However, the moderating and individual impact of board diversity and innovation - on the value creation and financial performance of companies - is not yet agreed. Thus, it is still relevant to deepen the analysis of those relations (Jhunjhunwala *et al.*, 2021).

Regarding the value creation, in finance, this concept is related to the expected return on shares, which, in turn, depends on the generation of cash flow and projected dividend distribution (Gordon & Shapiro, 1956). These positive prospects end up increasing the share price in the capital market. Concerning past results, the company's excess profit, which belongs to shareholders, is recorded in the equity group of the balance sheet. Thus, there are studies employing metrics considering market value - e.g.: Tobin's Q (Bouani & Hrichi, 2021) - and accounting information - ex.: ROE (Nawaz & Ohrlogge, 2022). In addition, there are some others that mix future and past results of companies – ex.: market to book ratio, price-to-income ratio, etc. (Imam *et al.*, 2013; Erkilet *et al.*, 2022).

2.3 Methodology

The objective of this study is to analyze the existing academic literature on the impact of innovation and diversity on the creation of value in companies, through a bibliometric analysis and systematic review. For this, 7 steps are implemented. Steps 1 to 5 are related to the bibliometric analysis, while the systematic review is developed in steps 6 and 7.

Step 1: Definition of the databases. The sample of articles is obtained from the Web of Science (WoS) and Scopus collections. These providers were chosen because they are two of the most important and globally recognized archives of academic research. In them, studies published in high-impact scientific journals can be identified, being classified in WoS by the Journal Citation Reports (JCR) index and in Scopus by the Citescore index.

Step 2: From initial to intermediate samples. The initial sample is obtained from keywords related to the topic of this research, combined with Boolean operators. Next, filters are applied to the WoS and Scopus databases regarding category, type of document and language of the

article. It is important to mention that the filter (econometr* OR determinan* OR "*dependent variabl*" OR regress*) is aligned to the purpose of finding the main variables and proxies employed in empirical models.

Step 3: From the intermediate to the final sample. At this stage, the databases are unified and duplicate articles are excluded via R Studio software. Among the main data presented in the unified file, the following stand out: authors' names (AU), authors' defined keywords (DE), keywords defined by WoS and Scopus, citations (CR), publication name (SO), abstract (AB), author's address (C1), Digital Object Identifier (DOI) (DI), article title (TI), year of publication (PY), funding agency and grant number (FU).

Step 4: Exclusion of articles not related to the defined theme of interest. Once the intermediate sample is defined, the abstract, introduction and conclusion of these articles are read. The final sample, then, is obtained by excluding those that are not aligned with the main theme of the study. In addition, it should be noted that the 34 articles in the final sample were obtained from the respective editors or through the following academic research bases: Science Direct, Sage, Wiley, Emerald, WoS, Cambridge, Oxford, Syarif, World Scientific and Blackwell. The evolution of the final sample is shown in Table 1.

Table 1 - Evolution of the sample of articles

Signal	Description	WoS	Scopus
(+)	Identification of the initial sample of articles, considering the following keywords in the fields "title, abstract, keywords" from Scopus and "Tópico" from WoS: ={"Intellect*" OR Innovati*} AND (diversity) AND ("value creation" OR "financial performance") AND (econometr* OR determinan* OR "*dependent variabl*" OR regress*)}	71	27
(-)	Exclusion of articles that do not consider the following categories: WoS - "Management, Business, Economics or Business Finance" Scopus - "Business, Management and Accounting" or "Economics, Econometrics and Finance"	14	9
(-)	Exclusion of articles not classified as "article"	6	3
(=)	Subtotal	51	15
(-)	Deletion of duplicate articles in the WoS and Scopus databases	11	
(=)	Intermediate sample	55	
(-)	Exclusion of articles whose econometric models have explanatory variables that are not related to the constructs of interest – e.g., diversity of strategies.	10	
(-)	Exclusion of articles whose econometric models have a dependent variable different from value creation, financial performance or innovation - e.g.: ESG index	6	
(-)	Exclusion of articles that address topics other than the interest of this research – e.g. macroeconomic growth, history of innovation etc.	5	
(=)	Final sample	34	

Step 5: Bibliometric analysis. The final sample file is imported into the R software and, from there, into the Biblioshiny software. The analysis of the articles' bibliometric analysis — countries, authors, keywords, institutions, etc.—is carried out for the elaboration and analysis of tables and relationship/co-citation maps. Additionally, the analyses are complemented by the verification of the main bibliometric laws: a) Zipf's (1949): regarding the frequency of words and keywords; b) Bradford's Law (1934): regarding the more relevant journals; and c) Lotka's Law (1926): identifying the researchers who have the highest frequency of production in the defined theme.

Step 6: Reading and coding the articles. Identification of the objectives, samples, methods, contributions and other characteristics of the articles. These are classified and coded into non-exclusive categories and subcategories (see Table 2). This means that the same article can be classified into more than one subcategory, which allows the sum of the frequency of the classifications to be greater than 100%.

Step 7: Systematic review. After coding the (sub)categorization matrix in Table 2 for the final sample, a frequency count of the subcategories is performed in order to enable the identification of knowledge gaps (Jabbour, 2013). These gaps are then compared with the subcategories of Category 11 (avenues for future studies) to obtain aspects amenable to further studies on the subject.

Table 2 - Matrix of (sub) categorization

Categories	Subcategoriess	Description
1. Main topic	A. Impact of diversity on business results	Analysis of the relationship between diversity and value creation or financial performance
	B. Impact of innovation or intellectual capital on business results	Analysis of the relationship between innovation or diversity and the creation of value or financial performance
	C. Impact of diversity on innovation	Analysis of the relationship between diversity and intellectual capital or innovation
	D. Moderating effect of diversity in innovation on business outcomes	Analysis of the moderating effect of diversity on innovation in relation to value creation or financial performance of companies
	E. Other	Other topics not mentioned in subcategories 1A to 1D
2. Theories	A. Resource-based view	Explanation of strategic behavior, based on the idea that the selection, obtaining and disposition of resources and development of unique skills - or difficult to imitate - result in differentiation and competitive advantage over competitors (Barney, 1991)

	B. Resource dependence theory	It starts from the assumption that decisions are made by the directors of the companies - directors and board of directors - and that they must always consider the environment in which they are inserted. It happens that the environment can be actively influenced by organizations, to modify it in the most convenient way possible for the creation of value (Pfeffer & Salancik, 1978)
2. Theories	C. Upper Echelon theory	Executives act on their personal interpretations of the strategic situations they face. These individualized interpretations stem from their experiences, culture, and personalities. Therefore, organizational outcomes are strongly influenced by the values and cognitive underpinnings of members of their senior leadership (Humbrick & Mason, 1984)
	D. Agency theory	It states that there is a conflict of interest between owners (shareholders) and agents (managers). Such conflicts are mitigated through agency costs - e.g. corporate governance mechanisms, indebtedness, reduction of the company's discretionary cash etc. (Jensen & Meckling, 1976)
	E. Stakeholder theory	It addresses the role of boards of directors before the stakeholders involved in the company's activities (Freeman, 1984).
	F. Stewardship theory	It attests that the company's managers always seek to maximize their profits and maintain a good relationship with their stakeholders. In addition, the theory states that directors are worthy of the role entrusted to them: to strategically manage the company's resources (Donaldson & Davis, 1994).
	G. Social identity theory	It clarifies that the human being expresses himself according to his social identity and that the heterogeneity among individuals can hinder decision-making (Tajfel, 1978).
	H. Not applicable	Articles that make no mention of a specific theory.
	I. Other	Other theories not mentioned in subcategories 2A to 2H.
3. Regression models	A. Cross-section or pooled regressions	Model in which the differences between individuals are analyzed at the same time. The time dimension is not considered
	B. Static panel regression	Model that considers a temporal and a spatial dimension. The same cross-sectional unit is followed over time
	C. Dynamic panel regression	Panel data model, whose dependent variable is also a time-lagged explanatory variable (Wooldridge, 2016).
	D. Regression with binary dependent variables.	The technique is employed when there is an interest in verifying the probability of occurrence of a phenomenon, being represented by a <i>dummy</i> variable (0 or 1) (Wooldridge, 2016).
	E. Structural equations	The multivariate statistical modeling technique is a combination of factor analysis and regression (Wooldridge, 2016).
	F. Other	Other econometric models not mentioned in subcategories 3A to 3E
4. Value creation proxies	A. Market to book value	The ratio between the market value of a company (quantity of shares * share price) and the book value of equity
	B. Tobin's Q	The ratio between the market value of the company and the replacement value of its assets.

4. Value creation proxies	C. Cash flow	Proxies based on the companies' cash flows – ex: cash flow from operations to total assets (CFOTA); past 5 years volatility of CFOTA etc.
	D. Price-to-earnings	The ratio of market price to earnings per share.
	E. Not applicable	Articles that do not use value creation proxies in their models.
5. Financial performance proxies	A. Growth of financial metrics	Metrics that analyze the variation in the financial performance of the current period, in relation to the previous one - e.g. sales growth, profit margin, number of employees, profit per share, etc.
	B. Return on assets	The metric that represents the ratio of the company's operating profit to its total assets
	C. Return on equity	The metric that represents the ratio of a company's net income to equity
	D. Profit	Metrics that consider the company's profit. profit before tax, earnings per share (EPS).
	E. Other	Other financial performance proxies not mentioned in subcategories 5A to 5D
	F. Not applicable	Articles that do not use financial performance proxies in their models.
6. Innovation proxies	A. Value added intellectual coefficient and its components	Metric based on the assumptions of the resource-based view, being obtained through the sum of the efficiency indices of the intellectual, structural and allocated capital. These indices are obtained from data from the financial statements of companies (Pulic, 2000).
	B. Extensions of value-added intellectual coefficient and its components	Metrics inspired by the value-added intellectual coefficient, but preserving its essence. They must consider other elements of value, such as the relationship capital of companies
	C. Patents	Quantity or variety of patents officially registered by companies
	D. Research and development	Expenses made by companies with research and development of new products and services
	E. Customized indexes	Quantitative indexes constructed by the authors - from (non) financial data - obtained from companies or research entities
	F. Other	Other innovation proxies not mentioned in subcategories 6A to 6E
7. Diversity proxies	A. Gender dummy	Presence of women on the executive board and/or board of directors of companies
	B. Gender index	Relationship between the number of women on the board of directors and the total number of directors
	C. Experience	Number of years of experience of the executives and/or members of the board of directors, performing this function in the company
	D. Education	Level of formal education - e.g. (post) undergraduate, Ph.D. etc. - or type of training - e.g. engineering, administration, accounting, technology etc., - of the executives and/or members of the board of directors of the companies
	E. Age	Age of executives and/or members of the board of directors of companies
	F. Other	Other diversity proxies not mentioned in subcategories 7A to 7D
8. Data origin	A. Global	Data from companies operating in countries located on several continents
	B. North America	Data from companies operating in the United States, Canada or Mexico

	C. Europe	Data from companies operating in Europe
	D. Oceania	Data from companies operating in Oceania
	E. Asia	Data from companies operating in Asia
	F. South or Central America	Data from companies operating in South America or Central America.
	G. Africa or the Middle East	Data from companies operating in Africa or Middle Eastern countries.
9. Analysis period	A. Up to one year	The sample period is up to one year
	B. From 2 to 5 years	The sample period of 2 to 5 years
	C. From 6 to 10 years	The sample period of 6 to 10 years
	D. From 11 to 15 years	The sample period of 11 to 15 years
	E. From 16 to 20 years	The sample period of 16 to 20 years
	F. Other	Other periods not mentioned in subcategories 9A to 9E
10. Results	A. New perspectives	Studies that expand the frontier of knowledge, through the presentation of a new theory, variable/proxy, research method or econometric model
	B. New conclusions	Studies that bring new conclusions on topics already discussed
	C. Conclusions similar to previous papers presented	Studies that do not present new perspectives
	D. Other	Other results not related to subcategories 10A to 10C
11. Future avenues	A. Sample expansion or regrouping	Expansion of the sample through the inclusion of different countries or extension of the analysis period. Regrouping the sample by industry types, (non)Islamic countries, etc.
	B. Moderating effect of governance or diversity	Analysis of the moderating effect of corporate governance or diversity on the innovation capacity of companies - e.g.: diversity of nationality, ethnicity, etc. in the company's boards of directors and senior management
	C. Analysis of alternative proxies of intellectual capital or innovation	Analysis of alternative intellectual capital proxies such as outdated spending on research and development, marketing, etc.
	D. Analysis of alternative proxies of financial performance or value creation	Analysis of alternative proxies of financial performance or value creation – e.g.: Economic value added (EVA).
	E. Use of other econometric methods	Use of other econometric methods - e.g.: Dynamic Panel, Structural Equations etc.
	F. Use of other theoretical or methodological approaches	Regression models with longitudinal data, qualitative methods, etc.
	G. Other	Other future avenues not mentioned in subcategories 11A to 11F

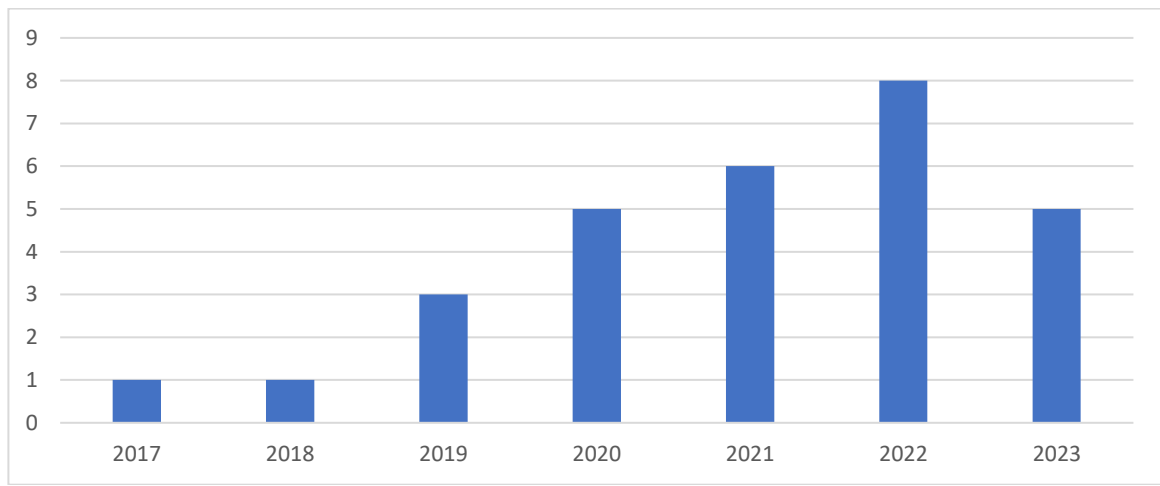
2.4 Analysis of the results

Item 4.1 presents the results of the analysis and the main bibliometric laws, mentioned in Steps 1 to 5. Item 4.2 contains the results of the systematic review, described in Stages 6 and 7 of this study.

2.4.1 Bibliometric analysis

The final sample consists of 34 articles: 33 from the WoS database and 1 from the Scopus database. Notwithstanding the fact that the collection period began in 1945 and ended on May 22, 2023, the oldest paper in the sample was published in 2017. Between 2017 and 2023, there is an increase in publications, with 8 articles published in 2022, as shown in Figure 1.

Figure 1 - Distribution of articles over time



Source: Biblioshiny

In turn, Table 3 presents the keywords that are repeated 5 or more times in the articles of the final sample, totaling 76 terms. Among them, the word "diversity" stands out with 14 (18%) occurrences. Subsequently, it is verified that "financial performance" and "impact" are reproduced 13 (17%) and 11 (14%) times, respectively.

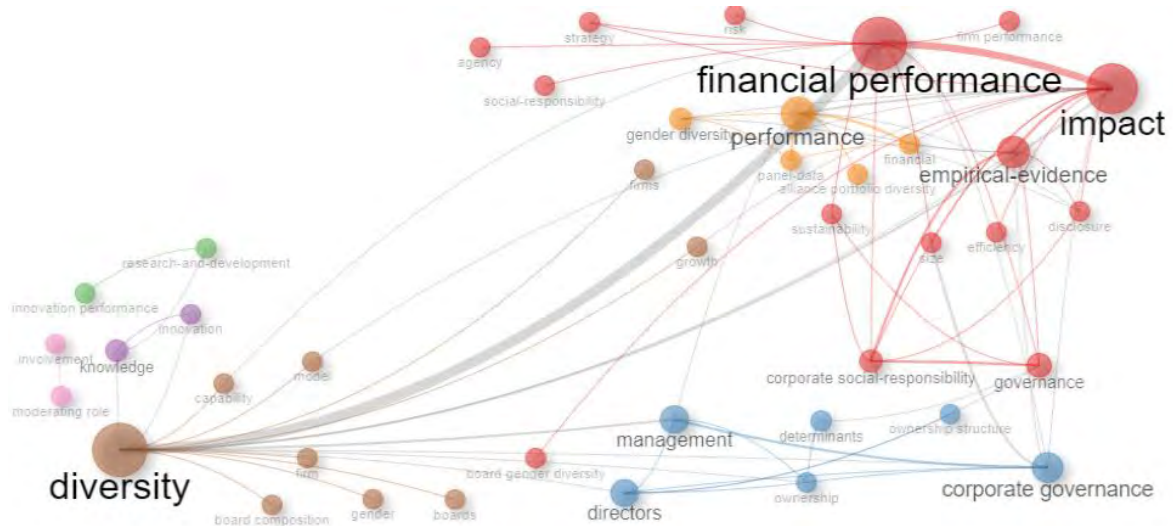
Table 3 - Frequencies of the main keywords

Keywords	Occurrences	Percentage
Diversity	14	18%
Financial performance	13	17%
Impact	11	14%
Corporate governance	6	8%
Empirical-evidence	6	8%
Performance	6	8%
Directors	5	7%
Gender diversity	5	7%
Innovation	5	7%
Knowledge	5	7%
Total	76	100%

Source: Biblioshiny

These same keywords stand out from Figure 2 as being the most representative of their thematic groupings or clusters. It is also verified that "financial performance" and "impact" belong to the same cluster.

Figure 2 - Occurrence map among the main keywords

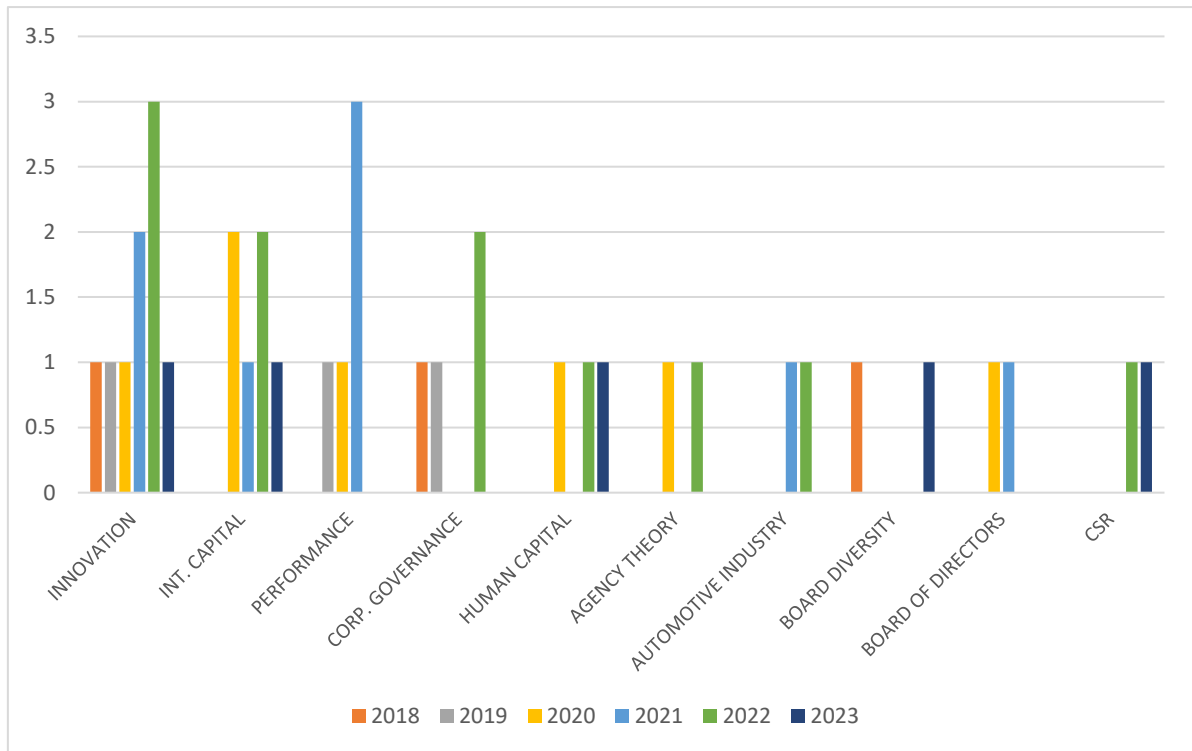


Source: Biblioshiny

Note: The diameter of each node represents the relevance of the respective term. The density of a line represents the intensity of the connection between the nodes united by it. Finally, each colour represents a thematic group of related terms (cluster).

Moreover, Figure 3 presents the timeline of the keywords mentioned by the article authors. "Innovation" and "intellectual capital" are those that appear with greater increasing frequency. In turn, "performance" peaks in 2021. On the contrary, "corporate social responsibility (CSR)" will occur only in the years 2022 and 2023.

Figure 3 - Map of the thematic evolution of the main keywords



Source: Developed by the authors based on data obtained via Biblioshiny

Still regarding the keywords, Figure 4 also highlights the terms "diversity", "financial performance" and "impact". With less visibility are mentioned "corporate social responsibility", "corporate governance", "performance", "directors", "innovation", "knowledge" and "management". Regarding the theories of finance and methodologies, "agency" and "panel data" are highlighted, respectively.

Figure 4 - Keyword cloud



Source: Biblioshiny

As for bibliometric laws, Zipf's Law (1949) analyzes and quantifies the distribution of words in a given text. For this, it is considered the principle that there is a tendency for minimal use of words that have a high frequency of occurrence. Zipf's first law is represented by Equation 1.

$$r \times f = C \quad (1)$$

Where:

r = series order

f = frequency of occurrence

C = constant for any text

In turn, for words with low frequency, Zipf proposed a second law, modified and revised by Booth (1967). For the author, in a given text, several words with low frequency of occurrence have the same assiduity – see Equation 2:

$$I_n = 2I_1 / n (n+1) \quad (2)$$

Where:

I_1 = number of words that have frequency 1

I_n = number of words that have frequency n

n = Goffman point or place of transition from low to high-frequency words

Zipf's laws define the ends of the word distribution list of a given text. Thus, between these extreme points, there is a transition region from high to low-frequency words. For Goffman (1971), the existence of a transition point between the words of higher and lower frequency represents the semantic content of a given text more adequately. Pao (1978) presents Goffman's transition point formula – see Equation 3.

$$T = (-1 + \sqrt{1 + 8I_1}) / 2 \quad (3)$$

Where:

T = Goffman's transition point

I_1 = number of words that have frequency 1

The identification of Goffman's T point occurs through the descending ordination of the words in the Rank Words software. Next, those repeated only once in each text are counted for calculating Goffman's T point in each article. Then, the words above the classification indicated

by that point are identified. For the final sample of 34 articles, the maximum and minimum frequencies of word repetition vary between 53.30 and 32.15, respectively.

Table 4 presents the first 10 articles in descending order of Goffman's T point. In it, the transition point of the words varies between 53.30 and 41.48, and its average is 45.19. In the case of the article by Garcia-Sanches *et al.* (2020), for example, there are 1447 words whose frequency of repetition is equal to 1 - e.g. "usefulness", "Tobit", "sensibility". The calculation of Equation 3 results in a value of $53.30 = (-1 + \sqrt{1 + 8 * 1447}) / 2$. The word that comes closest to that frequency is "directors".

The study by Garcia-Sanches *et al.* (2020) aims to identify the profile of board members who may be favorable to ecodesign and eco-innovation strategies, focusing on aspects of independence, gender diversity and environmental specialization. The high-frequency words (repetition above Goffman's T point) identified in the text are: "eco", "innovation", "environmental", "strategies", "design", "companies" and "directors". Not by chance, these words coincide with those defined as keywords by the authors, being: "board of directors", "CSR committee", "eco-design", "eco-innovation", "environmental innovation", "environmental policy", "female directors" and "independent directors".

Table 4 - Goffman's T

N°	Author	Goffman's T
1	Garcia-Sanches <i>et al.</i> (2020)	53,30
2	Hoskins and Carson (2022)	47,42
3	Smriti & Das (2022)	45,61
4	Dai <i>et al.</i> (2022)	45,48
5	Prencipe <i>et al.</i> (2023)	45,11
6	Zhang <i>et al.</i> (2022)	44,80
7	Nicolò <i>et al.</i> (2023)	43,53
8	Gangi <i>et al.</i> (2022)	43,32
9	He <i>et al.</i> (2023)	41,88
10	Farooq and Ahmad (2023)	41,48
Média		45,19

Source: Rankwords

Subsequently, an analysis of the region in which the most frequent words related to the main theme are located was conducted for each of the 34 articles in the final sample. Rank Words sorts words in descending order of repetition. Those not relevant to the study are excluded, e.g. articles, prepositions, adverbs and pronouns. Of the remaining words, the most frequent ones are identified.

Table 5 presents the first 10 articles in descending order of the word with the highest repetition in each study. For example, He *et al.* (2023) cite the word "generation" 278 times. For these 10 articles, the most frequent words add up to 1,939. "Generation" represents 14.34% (278/1.939) of this total, being the word that is most repeated in this subsample. He *et al.* (2023) investigate whether the presence of members from generation "X" as members of the board of directors has a positive relationship with the company's performance.

Table 5 - Zipf's law

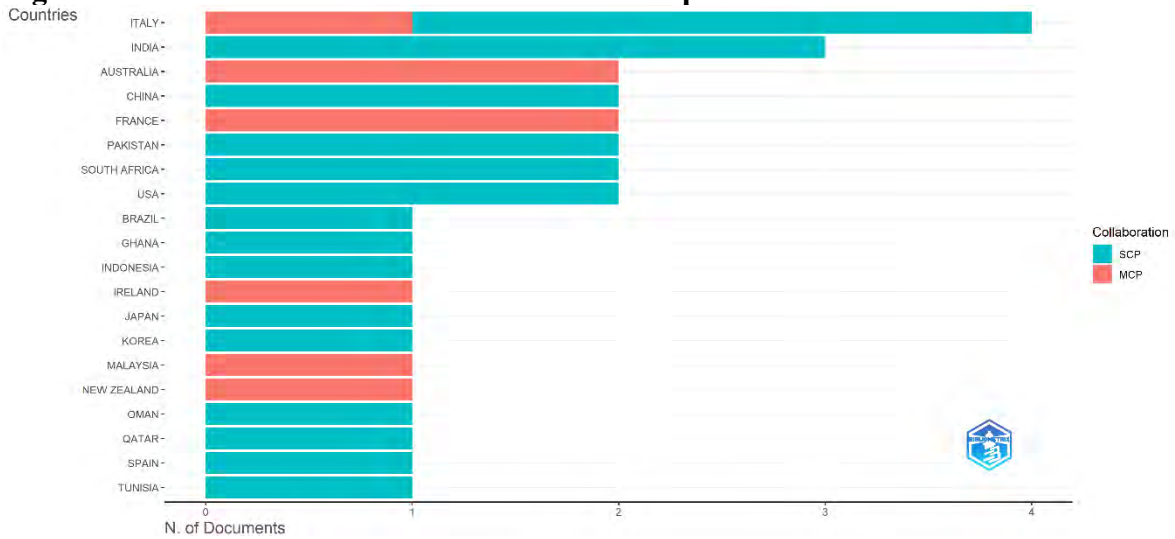
N°	Author	Word	Quantity	Frequency
1	He <i>et al.</i> (2023)	Generation (GEN)	278	14,34%
2	Azeem <i>et al.</i> (2022)	<i>Innovation</i>	233	12,02%
3	Hoang <i>et al.</i> (2020)	<i>Environmental</i>	199	10,26%
4	Zhang <i>et al.</i> (2022)	<i>University-industry alliance portfolio (UIAP)</i>	196	10,11%
5	Farooq and Ahmad (2023)	<i>Board</i>	196	10,11%
6	Vincenzi and Cunha (2021)	<i>Innovation</i>	184	9,49%
7	Dai <i>et al.</i> (2022)	<i>Entrepreneurial</i>	179	9,23%
8	Oware and Appiah (2023)	<i>Innovation</i>	159	8,20%
9	Smriti and Das (2022)	<i>Board</i>	158	8,15%
10	Garcia-Sanches <i>et al.</i> (2020)	<i>Ecological (ECO)</i>	157	8,10%
Total			1.939	100,00%

Source: Rankwords

As for the analysis of the authors, all of them present a single article in the final sample. This fact makes it impossible to investigate Lotka's Law (1926), which states that a small number of authors produce many articles and that the production obtained by this small number of researchers is equal in quantity to the performance of the others.

However, Figure 5 shows the collaboration between the host countries of the universities to which the authors are linked. It is observed that there is collaboration between authors from a single country (single country publications, SCP) as well as between authors from different countries (multiple country publications, MCP). In it, Italy stands out with four publications, including a single one with international collaboration. Following is India, with three publications, with only those linked to institutions located in the country as authors.

Figure 5 - Collaboration between countries in the publication of articles



Source: Biblioshiny

Table 6 analyzes the articles with more than 20 citations in the final sample. Of the total of 257 citations, 47 (18.3%) come from articles prepared by authors associated with institutions located in France. Spain also stands out with 46 (17.9%) of the citations. In the line "Others", 34 (13.2%) means the countries that develop articles on the theme of this research; however, they present less than 10 citations, making a total of 14 countries in addition to those listed in Table 6.

Table 6 - Total citations

Country	Total citations	Frequency
France	47	18,3%
Spain	46	17,9%
Malaysia	38	14,8%
Italy	25	9,7%
Oman	21	8,2%
New Zealand	18	7,0%
Australia	15	5,8%
India	13	5,1%
Others	34	13,2%
Total	257	100%

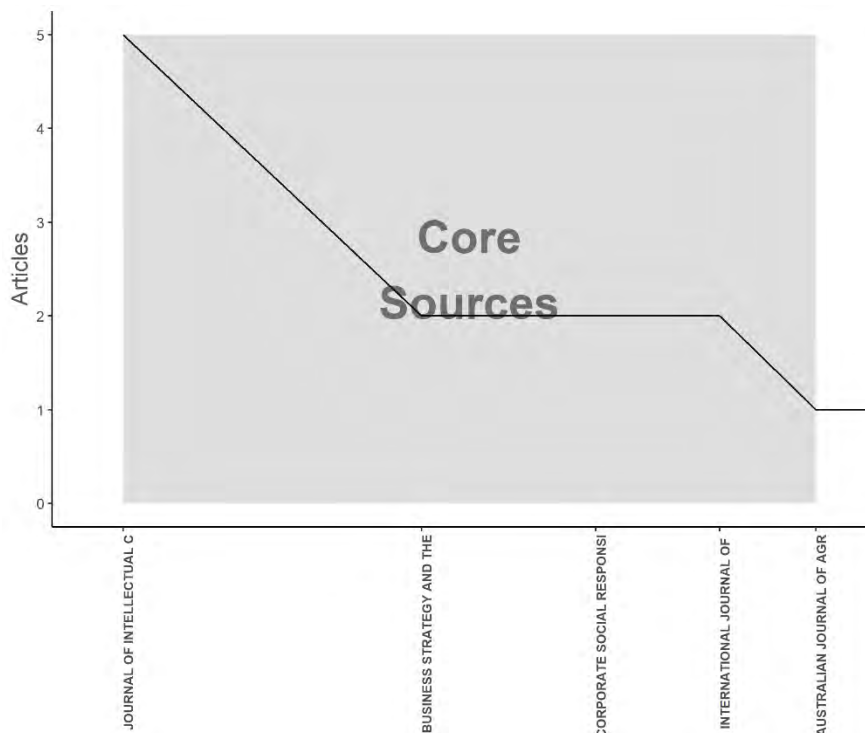
Source: Biblioshiny

Figure 6 presents the application of Bradford's Law (1934) on journals – few journals produce many articles and many journals that produce few articles on a given topic. Brookes (1969) cites that Bradford's Law estimates the degree of relevance of academic journals in specific areas of knowledge. Thus, if the journals are classified in descending order of productivity,

they can be distributed in zones with variation in the ratio 1: n: n² and so on. These zones are formed by dividing the total number of published articles by three.

Thus, in zone 1 – out of a total of 34 articles and 27 journals – 4 (14.8%) journals publish 11 (32.3%) articles. In it, some journals publish from 2 - Business Strategy and the Environment, Corporate Social Responsibility and Environmental Management, International Journal of Innovation Management - to 5 articles - Journal of Intellectual Capital. In turn, zone 2 is confused with zone 3 because all the other journals in the sample published only one article each.

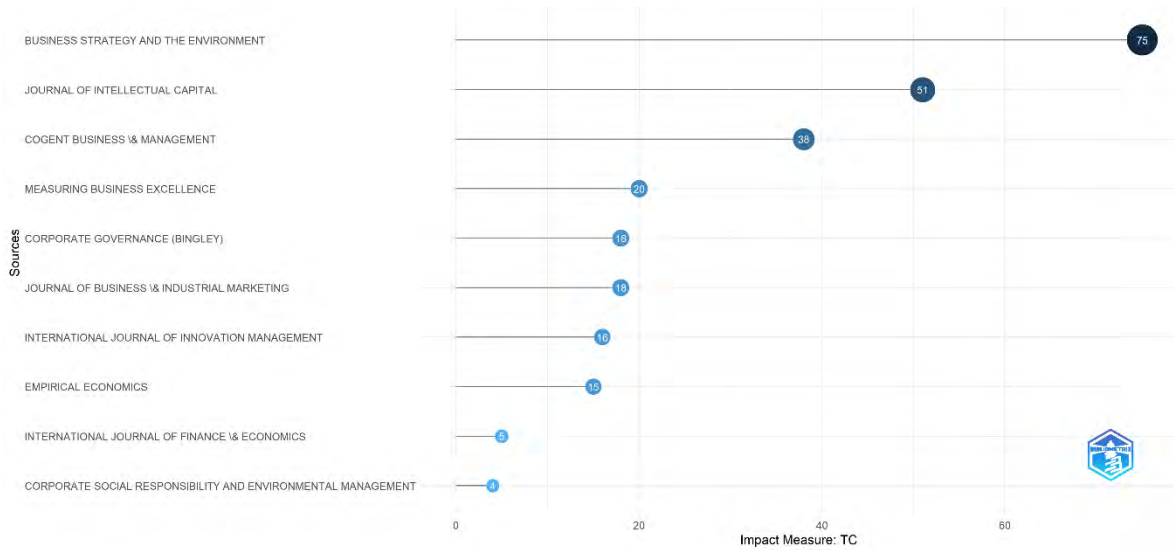
Figure 6 - Bradford's law on periodicals



Source: Biblioshiny

In turn, Figure 7 shows the total number of citations (TC) obtained by a given journal. These citations – also called global citations – correspond to the total number of citations that an article – included in the final sample – has received from other articles indexed in the WoS and Scopus bibliographic databases. For the 10 most cited journals, there are a total of 260 citations. Among them, the “Business Strategy and the Environment” (75 or 28.8%), “Journal of Intellectual Capital” (51 or 19.6%) and “Cogent Business & Management” (38 or 14.6%) stand out.

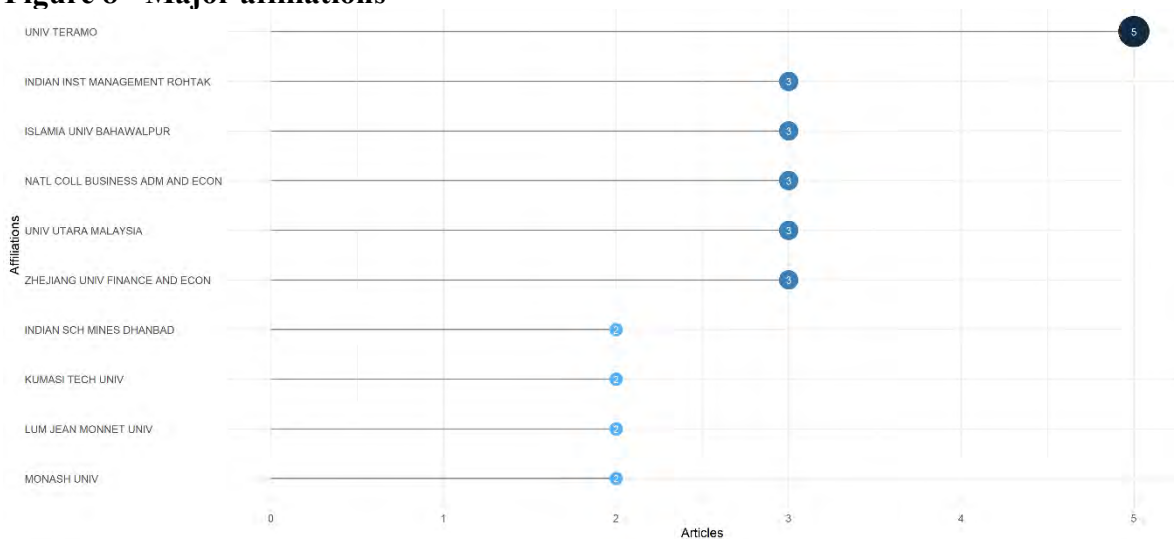
Figure 7 - Total citations per journal - TC index



Source: Biblioshiny

Figure 8 shows the institutions with two or more published articles. The top 10 universities add up to 28 author affiliations. Teramo University – in Italy – stands out with 14.7% or 5 of these 34 published articles. Secondly, there are five institutions with 3 published articles, or 8.8% of the sample each. They are “Indian Institute of Management-Rohtak” in India, “Islamia University of Bahawalpur” and “National College of Business Administration and Economics” in Pakistan, “Universiti Utara Malaysia” in Malaysia and “Zhejiang University of Finance and Economics” in China.

Figure 8 - Major affiliations



Source: Biblioshiny

2.4.2 Systematic review

The systematic review aims to identify knowledge gaps and point out future avenues for the evolution of a given research theme. In the case of this study, the aspects to be deepened are related to the theme of the impacts of innovation and diversity on the creation of value and financial performance of companies. To this end, Steps 6 and 7 of item 3 from Methodology clarify that, initially, there is a definition of a matrix of categorization (see Table 2). From the reading of the 34 articles in the final sample, they are classified and coded into non-exclusive categories and subcategories. Each article can be sorted into up to three subcategories per category. Subsequently, the frequency count of the subcategories is performed. The least frequent combinations of subcategories are those that potentially point to knowledge gaps. Figure 9 summarizes these results.

Category 1 presents the main themes of the articles. Subcategory B - Impact of innovation or intellectual capital on business results - has the highest frequency 41.2% (14/34), followed by C - Impact of diversity on innovation - with 32.4% (11/34). Among the subcategories of lower frequency are A - Impact of diversity on company results - with 26.5% (9/34) and D - Moderating effect of diversity in innovation on company results - being present in only 11.8% (4/34) of the articles. This indicates that there is academic interest in the analysis of the interaction between the constructs of innovation, diversity and performance, which means a research opportunity (Khan *et al.*, 2019).

In turn, category 2 analyzes the theories that support the hypotheses of the studies. Subcategory A - Resource-based view - stands out in 32.4% (11/34) of the studies, followed by subcategories D - Agency theory - (29.4% or 10/34) and B - Resource-dependence theory - (26.5% or 9/34). Other theories have a lower frequency, ranging from 14.7% to 8.8% - subcategories C - Upper echelon theory, E - Stakeholder theory, F - Stewardship theory and G - Social identity theory. This analysis reveals a pulverization of the theories of corporate finance associated with the theme of this study. High-level and agency theories are associated with corporate governance mechanisms, while the resource-based view and resource dependence theory relate board characteristics to value creation for companies (Garcia-Sanches *et al.*, 2020; Nawaz & Ohrlogge, 2022).

Category 3 deals with the econometric models used by the articles. In it, the subcategories B - regression with static panel data - and A - Cross section or pooled regression are the most cited by the authors to test their hypotheses - with 38.2% (13/34) and 32.4% (11/34), respectively. This suggests that, despite the natural organization of the data in a panel format, the authors resort to non-temporal regression as a viable alternative in terms of methodology. In some cases, both methodologies are considered (Churchill *et al.*, 2017; Dalwai & Mohammadi, 2020). In turn, subcategory C - regression with dynamic panel data - also presents a high frequency, being present in 23.5% (8/34) of the articles. As for the subcategories with the lowest incidence of 5.9% (2/34) in the articles, D - Regression with binary dependent variable - and E - Structural equations stand out. These percentages indicate that it is promising to identify the determinants of the chances of occurrence or simultaneity of an event – high or low probability of value creation or profitability (Prencipe *et al.*, 2023).

As for category 4 - Value creation proxies - it is noteworthy that the variable that is most repeated in the articles - 20.6% (7/34) - is the subcategory B - Tobin's Q. In fact, the versatility of this proxy is ratified by incorporating market expectations about the analyzed company (Dai *et al.*, 2022). The other proxies represented by the subcategories A – Market to book value with 5.9% (2/34), C – Cash flow, and D – Price to earning with 2.9% (1/34) are much less considered in the articles of the final sample. The data reveal that the simple use of value creation proxies is already a differential since most articles consider measures of an exclusively accounting nature. Only 20.6% (7/34) of the studies in the final sample employ value creation proxies in conjunction with those of accounting financial performance (Faroouq & Ahmad, 2023).

Concerning category 5, it identifies the most commonly used financial or accounting performance proxies. Subcategory B - Return on assets - appears in 44.1% (15/34) of the articles, followed by C - Return on equity - with 23.5% (8/34). Subcategories A - Growth of financial metrics - and D - Profit - with 8.8% (3/34) each. Thus, the growth of financial measures is a proxy that can be investigated in future research (Zhang *et al.*, 2022).

In turn, category 6 analyzes innovation proxies. There is a balance between the variables, and the most frequent are the subcategories C - Patents with 23.5% (8/34), E - Customized Indexes with 20.6% (7/34) and D - Development Research with 17.6% (6/34). The subcategories A - Value added intellectual coefficient and its components and B - Extensions of the value added intellectual coefficient and its components - are repeated 11.8% (4/34) and 14.7% (5/34) times

in the articles, respectively. These results indicate that there is no hegemony in the use of patents as a proxy for innovation since companies can focus on other approaches – e.g. industrial secrecy (Hoskins & Carson, 2022). In this sense, intellectual capital efficiency models are versatile as a representation of the company's intangible resources (Mardini & Lahiani, 2020).

Category 7 presents the proxies of board diversity. Subcategories B – Gender Index and A – Gender Dummy – are present in 38.2% (13/34) and 26.5% (9/34) of the articles in the final sample. The subcategories C - Experience - and D - Education have a frequency of 8.8% (3/34). Finally, subcategory E – Age – occurs in only a single article (2.9%). This means that while the issue of gender is extremely relevant to the discussion of diversity, there are other aspects to be tested. Thus, different age groups and biographies of counselors can bring new perspectives to the analysis of the theme (Dalwai & Mohammadi, 2020; Dai *et al.*, 2022).

Category 8 identifies the source of the sample data from the articles in the final sample. 38.2% of them (13/34) analyze Asian companies – subcategory E. The other subcategories that stand out are G - Africa and the Middle East (17.6% or 6/34), C - Europe (14.7% or 5/34) and A - Global (11.8% or 4/34). Therefore, an opportunity to investigate data from companies in subcategories F - Latin America (5.9% or 2/34) and D - Oceania (2.9% or 1/34) stands out. The analysis of these regions is relevant because they have growth potential, enjoy institutional stability and are increasingly embedded in global value chains (Azeem *et al.*, 2022; Moura *et al.*, 2022).

In turn, category 9 shows the period considered in the sample of articles analyzed. The most frequent period is from 6 to 10 years – subcategory C (29.4% or 10/34), followed by intervals of 2 to 5 years – subcategory B (23.5% or 8/34) and from 11 to 15 years – subcategory D (17.6% or 6/34). Longer panels between 16 and 20 years old – subcategory E and cross-section data within a single year – subcategory A – are present in only 11.8% (4/34) of the studies. This fact reveals that researchers prefer to work with data range longer than five years. This is justified to enable an adequate number of observations to support econometric studies, especially when considering the temporal effect.

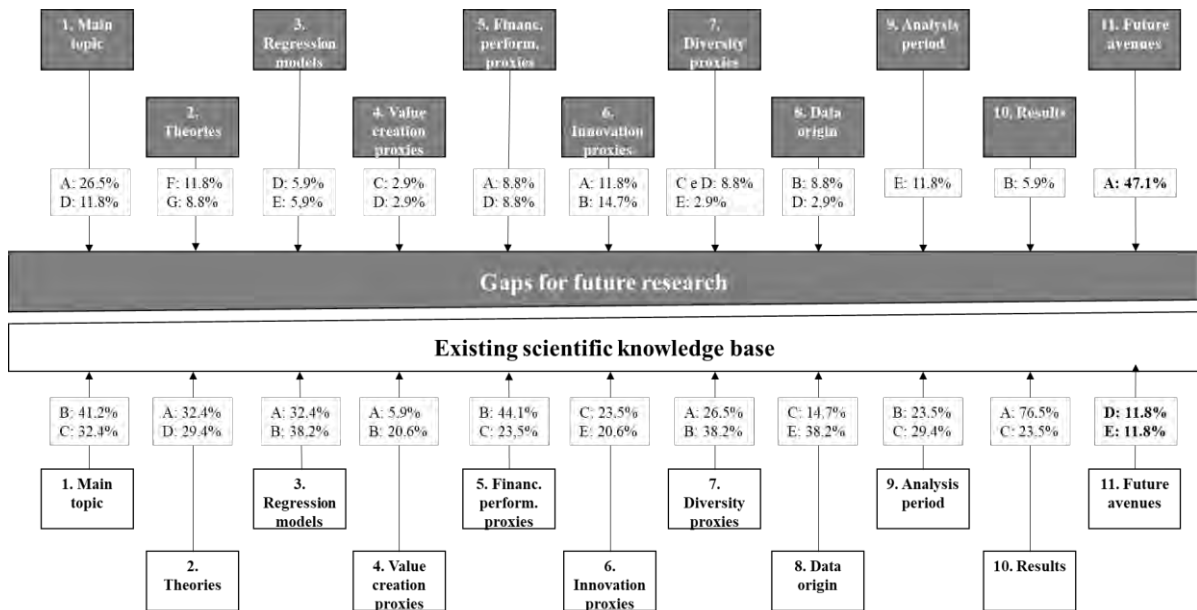
Category 10 analyzes the contribution potential of each article. The subcategory that is most repeated is the one that presents new research perspectives – A (76.5% or 26/34). In contrast, 23.5% (8/34) of them – subcategory C – have their conclusions similar to previously presented

works. This result exposes the opportunity for research testing different methodologies, samples, proxies, etc. (Steyn & Bruin, 2020; Hermanto *et al.*, 2021).

Finally, category 11 reflects on the authors' recommendations for future studies on the subject of their investigations. The most frequent suggestion refers to the expansion or regrouping of the sample – subcategory A (47.1% or 16/34). This result corroborates what was found in category 8, where the concentration of studies in samples from a single country of the Asian continent (8E) is verified (Boadi & Osarfo, 2019). On the contrary, few studies are conducted with companies located in Latin America (8F), Oceania (8D) or with global data (8A). Some authors recommend the analysis of alternative proxies of intellectual capital or innovation – subcategory 11C (23.5% or 8/34). This suggestion is in line with that observed in category 6 since such variables are intangible in nature and any representation has limitations (Prencipe *et al.*, 2023).

Finally, there is the incentive for studies on moderation variables, involving governance or diversity – subcategory 11B (17.6% or 6/34) and the use of other theoretical or methodological approaches – subcategory 11F (14.7% or 5/34). These results corroborate those observed in subcategory 1D, which points to a few studies that analyze the interaction between both explanatory variables. Moreover, the subcategories 3D and 3E indicate the low frequency of regression models with binary dependent variables and structural equations, respectively (Churchill *et al.*, 2017; Gangi *et al.*, 2022).

Figure 9 - Analysis of (sub)categories to identify knowledge gaps



Note: The subcategories at the top are those with the lowest frequency and are amenable to future analysis by researchers – except **category 11 – Future avenues**. In this case, the most frequent subcategories are those that suggest avenues for a future agenda.

2.5 Conclusion

The challenges of the twenty-first century impose on companies that they must be profitable but surrounded by an environment with high speed of innovation and demand for diversity in their leadership. Thus, this study investigates the relationship between value creation, innovation and diversity, through a bibliometric analysis and systematic review. To this end, 34 articles are analyzed – which make up the final sample. They are obtained in the period from January 1, 2017 to May 22, 2023, from the Web of Science and Scopus databases.

The first methodology refers to a quantitative analysis, being developed by counting frequencies and co-citations via RStudio, Biblioshiny and Rank Words software. It also verifies the main bibliometric laws - Lotka (1926), Bradford (1934) and Zipf (1949). The second methodology refers to a qualitative analysis of the texts, to identify knowledge gaps - addressing an agenda of relevant themes for future studies.

Among the results obtained by the bibliometric analysis, it is verified that: i. the theme of this study presents a growing interest over time; ii. the keywords diversity and financial performance are the ones that are most observed; iii. None of the authors stands out in terms of publication because each of them presents only one article in the final sample; iv. the most cited

articles are those linked to institutions located in France; v. the journal with the highest number of citations is *Business Strategy and the Environment*; and vi. researchers linked to the University of Teramo are the ones who publish the most.

In turn, the results of the systematic review indicate that the following issues are the most investigated: i. Impact of innovation or intellectual capital on the results of companies; ii. The most cited theory is the Resource-based view; iii. The most used regression model is the static panel; iv. The main proxy for value creation is Tobin's Q; v. The most frequent financial performance proxy is the ROA; vi. The most present innovation proxy is the patent base; vii. The most observed diversity proxy is the one that considers the proportion of women on the board of directors; and viii. The most common geographic region in the samples is from countries in Asia.

On the contrary, the themes that suggest a future research agenda are: i. To analyze the moderating effect of diversity in innovation on the results of companies; ii. Explore the premises of social identity theory to support the hypotheses of the studies; iii. Verify the hypotheses through regression models with the binary dependent variable and structural equations; iv. Choose alternative proxies for value creation, financial performance, innovation and for diversity in the board; and v. Analyze data from companies in Latin America with long time series.

This study contributes to the existing literature and distinguishes itself from the others by performing a joint analysis of the proxies of innovation, intellectual capital and diversity as determinants of the financial performance and value creation of companies. Regarding its limitations, the results presented refer to the set of articles from journals that meet the established selection criteria and the databases used – WoS and Scopus. In addition, the analysis of articles - exclusively with empirical tests - may have excluded the examination of studies with mathematical modeling, research and essays that also have relevant contributions.

Therefore, for the evolution of this research, it is suggested the analysis of articles that consider qualitative research methodologies, other bases of academic articles distinct from WoS and Scopus, comparison between pre and post-Covid-19 pandemic periods, analysis of specific industries with different degrees of technological influence and samples from developing countries.

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2.7 Appendix A - Summary of articles in the final sample

Appendix A presents a brief description of the objectives and results, as well as the total citations of the 34 articles in the final sample. The number of citations (NC) was obtained from the Web of Science and Scopus databases, totalling 275 citations.

No.	Reference	Summary	NC
1	Arun <i>et al.</i> (2020)	The paper investigates the relationship between gender diversity and innovation, supporting its hypotheses with the approaches of liberal feminist theory and institution-based view. The hypotheses are tested using Poisson regressions. In their model, the representation of the dependent variable of innovation was created by the authors from questionnaires. The independent variable is represented by the gender of the person who holds the main position in the company. The sample includes Indian companies in the period 2010-2014. Finally, the authors report that their findings differ from previous studies conducted in samples from developed countries.	11
2	Azeem <i>et al.</i> (2022)	The paper investigates the relationship between innovation and performance, basing its hypotheses on attention-based theory. This theory states that the focus of attention of managers is the main resource of a firm. Therefore, grouping companies that focus on a particular activity (innovation) can explain the performance of these companies. The method of study is the dynamic panel, having as performance proxy the sales growth. The innovation proxy is generated from questionnaires. The sample includes Australian companies from 2007 to 2011. The authors report that their findings are in line with previous studies and suggest that future studies address aspects related to collaboration networks, comparative studies and regulatory interventions.	0
3	Boadi and Osarfo (2019)	The paper investigates how the educational diversity of directors affects the financial performance of firms in the banking sector in Ghana. The authors support their hypotheses on six theories: agency, upper echellons, resource dependence, convergency theory (or catch up effects), stewardship theory and social identity theory. The first five suggest a positive relationship, while the last one suggests an inverse relationship between the constructs. As an econometric method, the dynamic panel was chosen. The dependent variable is financial performance with accounting proxies, while educational diversity - among directors - was chosen as a proxy for diversity (undergraduate, master's and doctorate). The sample covers banks headquartered in Ghana from 2001 to 2016. For future studies, the authors suggest expanding the sample to multiple countries, controlling for local differences.	18
4	Bouani and Hrichi (2021)	The paper investigates the relationship between diversity and performance, being based on cognitive theory. This theory states that the effectiveness of the board depends on the intellectual abilities of its members and that directors create value for the company by participating in internal committees. The dependent variable chosen is financial performance, represented by both accounting data and market value. The proxies for diversity are the percentage of women and foreigners, as well as members' experience in strategic positions and experience in politics. The sample contains data from Tunisian companies between the years 2012 and 2018.	0

5	Churchill <i>et al.</i> (2017)	The paper investigates the relationship between ethnic diversity and financial performance, being based on the empirical review of similar studies. The main econometric method is cross section regression and the robustness test is static panel. The dependent variable is performance. The explanatory variable is ethnic diversity, represented by the Herfindal index. The authors relate the results of companies with the ethnic composition of the region in which they operate. The data originate from China and cover the period 2001 to 2010. The authors conclude that firm performance is lower in more fragmented regions, which is in line with previous studies cited in the text. Finally, the authors suggest studying the factors that moderate the relationship between diversity and performance.	15
6	Dai <i>et al.</i> (2022)	The paper compares financial performance before and after IPO by firms that received venture capital investments. The theory that supports the hypotheses is the organizational learning theory, since the interaction between entrepreneurs and investors brings learning that is reflected in the creation of value for the company. The method employed is linear regression with static panel data. The dependent variable is represented by a metric based on market value. The independent variable is research intensity, represented by the ratio of research expenditures to firm turnover. The sample comprises Chinese firms in the period between 2009 and 2019. The authors suggest exploring the individual characteristics of entrepreneurs in future studies.	0
7	Dalwai and Mohammadi (2020)	The paper investigates the relationship between intellectual capital, financial performance and corporate governance. The theories that support the hypotheses are agency and resource dependence. The method used is panel data with fixed effects. The dependent variable is intellectual capital, while the explanatory variables related to the hypotheses are linked to elements of corporate governance. The sample is composed of companies in the financial sector of Oman in the period from 2012 to 2016. Finally, the authors suggest the use of other observable aspects of corporate governance and the individual characteristics of managers.	21
8	Farooq and Ahmad (2023)	The paper investigates the relationship between board characteristics, financial performance and intellectual capital. It supports its hypotheses on agency, resource dependence and resource-based view theories. The econometric method is static panel data. The dependent variable is performance, being represented by accounting data. The explanatory variables are the characteristics of the board, represented by size, independence, meetings and gender diversity. The moderating variable is intellectual capital. The sample gathers data from non-financial companies listed in Pakistan from 2010 to 2019. In the end, the authors suggest expanding the sample to multiple countries and considering other proxies for the dependent variable.	4
9	Gangi <i>et al.</i> (2022)	The article investigates the relationship between gender diversity and innovative environmental policies. The study draws on stakeholder theory and senior theory to establish the hypothesis that gender diversity on boards is related to banks' environmental innovation. The method is dynamic panel data. The study uses the gender inequality environment as a moderating variable. The innovation proxy is the environmental innovation score. The data were obtained from Refinitiv Eikon's Asset for banks - with global coverage in the period from 2009 to 2019. At the end, the authors suggest that future studies use new sustainability indices that may be developed.	0

10	Garcia-Sanches <i>et al.</i> (2020)	The article investigates the relationship between gender diversity and innovation. It relates the proportion of women on boards to the implementation of eco-innovation practices. The study supports its hypotheses in agency theories, resource-based view, top echelons and women's social identity theory - female leadership reflects the traditional care role played by them in society. The method is static panel data, using market value and accounting information as proxies for the dependent variable performance. As a proxy for innovation, the index calculated by the company Eikon is used, while the proxy for diversity is the percentage of women on the board of directors of companies. The sample contains data from 321 agri-food companies from around the world in the period 2002-2017. As a validation test, the article assesses value creation as a function of innovation and diversity. At the end, the authors suggest relating institutional factors to innovation, in addition to comparing the result of the model when applied to other industries.	1
11	Hani and Dagnino (2021)	The paper investigates the relationship between innovation, performance and cooperation networks. The theory that supports the hypotheses can be understood as the resource-based view, being tested under the panel data method with fixed effects. In this model, the dependent variable is performance, whose proxy is turnover. The explanatory variable is innovation, whose proxy is the number of patents. The sample includes global data from 2000 to 2014. At the end, the authors suggest complementing the methodology with qualitative studies, involving interviews with executives of the companies studied.	46
12	He <i>et al.</i> (2023)	The paper investigates the relationship between generational diversity on boards and firm performance. It considers generational theory to explain the existence of a group identity among the different members, while drawing a parallel with studies that analyze the relationship between gender diversity and performance. The dependent variable is performance with accounting and market value proxies. The independent variable is diversity represented by the generation and gender of board members. The demographic data of the directors were obtained from the Institutional Shareholders Service, formerly Riskmetrics. The sample includes data observed from 1996 to 2017 from companies in the United States.	18
13	Hermanto <i>et al.</i> (2021)	The paper investigates the relationship between performance, intellectual capital and governance. It tests the effect of intellectual capital on the performance and market value of state-owned enterprises. The study supports its hypotheses in the stakeholder theory which would be, according to the author, a variation of the signaling theory. The method is structural equations. The proxy for performance is both accounting and market value. It also verifies corporate governance variables, through indices calculated by the author. The sample comprises 16 state-owned companies listed in Indonesia from 2012 to 2017. Finally, the authors suggest testing the model in non-state-owned companies and using other proxies for performance.	0
14	Hoang <i>et al.</i> (2020)	The paper compares the impacts of environmental transparency and environmental performance on financial performance and value creation. It considers the patent base only as a sample selection criterion. That is, the study selects only companies that hold environmental patent registration and formulates its hypotheses based on the empirical review of previous articles. The dependent variable is performance, whose proxies are accounting and market value. The sample contains data from companies in the United States from 2007 to 2016. In the end, the authors suggest working with samples from other countries, using human capital as a factor of innovation, studying eco-innovation in a specific industry and using other ways of selecting the sample other than by green patents.	2

15	Hoskins and Carson (2022)	The paper examines the relationship between technological diversity (innovation) and performance. It supports its hypotheses in the resource-based view, knowledge-based theory and transaction cost economics. The method employed is static panel data. The study considers performance as dependent variable, while employing patent variety as explanatory variable. Research intensity is a control variable. The sample covers a period of 30 years of observations (1976 to 2006) in the United States, from the Compustat and NBER patent databases. In the end, the authors suggest: working on the contagion effect of innovation among firms and modeling trade secrets instead of patents.	29
16	Hussain <i>et al.</i> (2022)	The paper investigates the impacts of board diversity on firm performance. It supports its hypotheses from agency theory. The method employed to test the hypotheses is static panel data. The study considers the percentage of women as a proxy for the independent variable (diversity), while the proxies for the dependent variable (performance) have accounting origin. The sample includes companies in the Pakistani automotive segment from 2017 to 2020. The authors suggest investigating other segments and adding more control variables to strengthen the findings.	2
17	Iren and Tee (2018)	The paper investigates the impacts of diversity (explanatory variables) on innovation (dependent variable). It supports its hypotheses from resource dependency theory, upper echellons and agency. The method used to test the hypotheses is static panel data. The proxies for diversity are gender, years of experience and education level, while the proxy for innovation is calculated by the authors through the technology gap survey. The sample gathers data from 25 banks in the United Arab Emirates from 2012 to 2015. In the end, the authors suggest including more banks from the Middle East region, without limiting themselves to a single country, and comparing Islamic and secular banks.	1
18	Khan <i>et al.</i> (2019)	The paper investigates the relationship between governance and performance, mediated by innovation. It supports its hypotheses from resource dependency theory, agency, stewardship and stakeholder theories. The method employed to test the hypotheses is system of structural equations and uses questionnaire data to construct proxies for the variables. The data covers a period of 3 years and was provided by leaders of the textile sector in Pakistan. At the end, the authors suggest extending the study to other economic sectors and other geographic regions.	5
19	Kim <i>et al.</i> (2023)	The paper investigates the relationship between patents, research and financial performance. It supports its hypotheses in the resource-based view theoretical approach. The method used to test the hypotheses is dynamic panel. The proxy for the dependent variable is accounting in nature, while the proxies for the independent variables are the change in the number of patents and research expenditures. The sample includes South Korean technology firms, excluding local giants because they would bias the results. The observed period is from 2014 to 2018. In the end, the authors suggest looking at a sample of multiple countries or multiple industries.	38
20	Kok <i>et al.</i> (2021)	The paper investigates the relationship between board characteristics and the performance of South African companies. It supports its hypotheses from resource dependency theory and agency theory. However, the authors also mention behavioral and legitimacy theory (on the demand for ethnic diversity). The method for testing the hypotheses is logistic regression. The authors rank the firms according to the Sharpe ratio and assign a value of 1 to firms that are in the first quartile of their segment and zero to the others. The sample includes companies listed in South Africa from 2009 to 2015. In the end, the authors suggest exploring other performance or value creation metrics and extending the study to other segments of economic activity.	0

21	Mardini and Lahiani (2020)	The paper tests the hypothesis that financial performance and diversity relate to intellectual capital. It supports its hypotheses with agency theory and impression management theory. The method used to test the hypotheses is static panel data. The dependent variables are linked to intellectual capital. The independent variable is financial performance, being represented by accounting information and market value, while the diversity proxy is the percentage of women on the board. The sample includes data from companies in France from 2010 to 2017. In the end, the authors suggest examining the competitive disadvantage related to the disclosure of intellectual capital data.	1
22	Moura <i>et al.</i> (2022)	The paper investigates the relationship between (cultural) diversity and financial performance. It supports its hypotheses in the resource-based view. The dependent variable is financial performance, being represented by data of an accounting nature. Diversity is represented by cultural distance. Patents and research appear as moderating variables, being proxies for the construct of "absorptive capacity". The data analyzed are from Brazilian multinational companies that acquired other companies abroad in the period 1995-2015. In the end, the authors suggest using other dimensions of absorptive capacity.	7
23	Nadeem <i>et al.</i> (2019)	The paper investigates the relationship between board diversity and intellectual capital efficiency. It supports its hypotheses in the theoretical approaches of resource-based view and upper echellons. The method used to test the hypotheses is dynamic panel data. The dependent variable is intellectual capital efficiency, which is calculated from accounting data. The explanatory variable is diversity, which is represented by both a dummy for the presence of women and the Blau index. The sample includes data from UK companies from 2007 to 2016.	0
24	Nawaz and ohrlogge (2022)	The paper investigates the relationship between corporate governance, intellectual capital and financial performance. It supports its hypotheses on the resource-based view and agency theory. The method used to test the hypotheses is linear regression with time series. The dependent variable is financial performance, being represented by accounting data. The explanatory variables are intellectual capital and governance. The first is obtained from accounting information and the second is represented by diversity on the board. The sample includes data from a single company in the financial segment, based in Europe, observing a period of 30 years. In the end, the authors suggest longitudinal studies and the use of proxies that consider market value in addition to accounting information, as well as the use of other diversity characteristics.	18
25	Nicolò <i>et al.</i> (2023)	The paper investigates the relationship between gender diversity in corporate leadership and intellectual capital disclosures. It supports its hypotheses from stakeholder theory. The method used to test the hypotheses is cross section linear regression. The dependent variable is the level of disclosure of information on intellectual capital, being represented by an index elaborated from the analysis of the electronic pages of the selected companies. The independent variable is gender diversity, while financial performance assumes the roles of control and explanatory variable. The sample gathers information from Italian companies for a single year of observation. At the end, the authors suggest following the trend of the respective pages over time, cross country studies and analysis of the quality of the information disclosed.	5
26	Oware and Appiah (2023)	The paper investigates the relationship between gender diversity and innovation. The theories that support the hypotheses are the resource-based view and resource dependence theory approaches. The method used to test the hypotheses is linear regression with panel data. The dependent variable is innovation, represented by accounting information on research investments. Diversity is one of the independent variables, represented by the absolute number of women on boards. The sample is composed of Indian family firms in the period from 2009 to 2020. The authors suggest studies in multiple countries and the use of explanatory variables with time lags.	1

27	Pant and Nidugala (2022)	The paper investigates the relationship between diversity and value creation (as described by the authors). It supports its hypotheses from the resource-based view. The method of main tests is static panel data, while those of robustness is dynamic panel data. The dependent variable is value creation, being represented by accounting data. The independent variable is diversity among directors. The sample includes data from Indian banks from 2008 to 2017. In the end, the authors suggest employing more governance variables and investigating the existence of a non-linear relationship between the variables.	0
28	Prencipe <i>et al.</i> (2023)	The paper investigates the relationship between diversity and innovation. It supports its hypotheses from the resource dependence theory, upper echellons and critical mass theory. The latter theory refers to a minimum amount of people who would actually be able to influence a policy change in an organization. The method chosen to test the hypotheses is Poisson regression. The dependent variable is innovation, being represented by a dummy of value 1 - if the company has registered any patent in the observed year. On the other hand, the diversity of nationalities and genders on boards are the independent variables - having opposite effects to those expected. The sample gathers data from organizations based in Italy from 2008 to 2017. In the end, the authors suggest the use of other proxies for innovation than patents.	0
29	Raimo <i>et al.</i> (2020)	The paper investigates the determinants of intellectual capital disclosure and supports its hypotheses from agency theory. The method chosen to test the hypotheses is cross-sectional linear regression. The dependent variable is the human capital disclosure index, which is elaborated from the analysis of the information disclosed by companies in 2018. Diversity on boards appears as one of the explanatory variables of the model. The sample gathers global data for a single year. In the end, the authors suggest conducting longitudinal tests, analyzing the quality of the information provided, as well as the impacts on firm value.	3
30	Smriti and Das (2022)	The paper investigates the relationship between diversity and intellectual capital. It supports its hypotheses from resource dependence theory and agency theory. The method chosen to test the hypotheses is dynamic panel data. The dependent variable is intellectual capital, represented by the index calculated from accounting information. The proxy for diversity is the gender of the members. The sample gathers data from Indian companies in the period between 2007 and 2019. In the end, the authors suggest including the research component in the model.	20
31	Steyn and Bruin (2020)	The paper investigates the determinants of innovation and supports its hypotheses in systems theory. The authors argue that this theory is more appropriate than the resource-based theory. The method chosen to test the hypotheses is cross section linear regression. The dependent variable is innovation, whose proxy is constructed from data collected through questionnaires. The explanatory variable is gender diversity, which also appears as a moderating variable. The sample gathers information from South African companies for a period of one year. In the end, the authors suggest the use of structural equations.	2
32	Suto and Takehara (2022)	The paper investigates the relationship between social responsibility, innovation and firm value. It supports its hypotheses in the resource-based view and stakeholder theory. The method chosen to test the hypotheses is linear regression with panel data. The main hypothesis of the study establishes a relationship between the value of the company and its innovation capacity. For value proxies, measures based on market value are considered, in addition to two secondary proxies calculated by the author, based on cash flow. The proxy for innovation considers the company's patents. However, they are analyzed together with their economic value. The sample gathers data from Japanese companies in the period from 2006 to 2019. In the end, the authors suggest the use of other innovation metrics and analysis of individual motivation factors.	2

33	Vincenzi and Cunha (2021)	The paper investigates the relationship between innovation efforts and firms' financial performance. It supports its hypotheses on previous empirical studies. The method chosen to test the hypotheses is cross section linear regression. The proxy for innovation was developed from questionnaires answered by Brazilian firms. The proxy for performance is the ratio between turnover and number of employees. The sample gathers information from Brazilian firms for a single year. The authors suggest replicating the methodology for specific industries and other countries.	3
34	Zhang <i>et al.</i> (2022)	The article investigates the relationship between business growth and partnership with universities. It bases its hypotheses on an empirical review. The method chosen to verify the hypotheses is dynamic panel data. The dependent variable is financial performance, represented by sales growth. The independent variable is the partnership between companies and universities. The sample includes information from organizations based in China for the period between 2009 and 2013. At the end, the authors suggest inserting control variables for specific government subsidies for research and development.	2

Note: NC - Number of citations in Scopus and Web of Science databases on the date of collection - May 22, 2023.

2.8 Appendix B - Classification of the (sub) categorization matrix

Appendix B presents the result of the codifications and classification of the (sub)categories of each of the 184 articles in the final sample. In the classification of each article, the same category has up to 3 subcategories.

Article / Category	1	2	3	4	5	6	7	8	9	10	11
Arun <i>et al.</i> (2020)	C	I	A	E	F	E	A	E	B	B	G
Azeem <i>et al.</i> (2022)	B	I	C	E	A	E	G	D	B	AC	G
Boadi and Osarfo (2019)	A	CF G	C	E	BC D	G	D	G	E	AC	A
Bouani and Hrichi (2021)	A	I	B	B	BC	G	BC F	G	C	C	G
Churchill <i>et al.</i> (2017)	A	H	AB	E	BD	G	F	E	C	C	B
Dai <i>et al.</i> (2022)	B	F	AB	B	F	D	G	E	D	A	B
Dalwai and Mohammadi (2020)	B	BD	B	E	B	A	G	G	B	A	AB
Farooq and Ahmad (2023)	AD	AB D	B	E	BC D	B	A	E	C	B	AD
Gangi <i>et al.</i> (2022)	C	CE	C	E	F	F	AB	A	D	A	BF
Garcia-Sanches <i>et al.</i> (2020)	BC	AB G	B	B	B	F	B	A	E	A	AF
Hani and Dagnino (2021)	B	A	B	E	E	C	G	A	D	A	F
He <i>et al.</i> (2023)	AD	G	B	A	B	CD	AB E	B	F	A	AB
Hermanto <i>et al.</i> (2021)	B	E	E	B	B	B	G	E	C	A	AD
Hoang <i>et al.</i> (2020)	B	H	B	AD	BE	C	G	B	C	A	AC
Hoskins and Carson (2022)	B	A	B	E	C	C	G	B	E	C	C
Hussain <i>et al.</i> (2022)	A	D	B	E	BC	G	B	E	B	C	A
Iren and Tee (2018)	C	BC D	B	E	F	E	AC D	G	B	A	A
Khan <i>et al.</i> (2019)	BD	BD EF	E	E	E	E	F	E	B	A	A
Kim <i>et al.</i> (2023)	B	A	C	E	B	CD	G	E	B	A	A
Kok <i>et al.</i> (2021)	A	BD	D	E	E	G	BC D	G	C	A	AD
Mardini and Lahiani (2020)	E	DI	B	B	BC	A	B	C	C	A	D
Moura <i>et al.</i> (2022)	A	A	A	E	BC	CD	F	F	F	A	C
Nadeem <i>et al.</i> (2019)	C	AC	C	E	F	B	AB	C	C	A	AB
Nawaz and ohrlogge (2022)	AB	AD	A	E	BC	A	B	C	E	A	F
Nicolò <i>et al.</i> (2023)	C	E	A	E	B	E	A	C	A	A	AE
Oware and Appiah (2023)	C	AB	A	B	A	D	A	E	D	A	AE
Pant and Nidugala (2022)	C	A	C	E	F	AB	B	E	C	A	CE
Prencipe <i>et al.</i> (2023)	C	BCI	D	E	F	C	B	C	C	A	C
Raimo <i>et al.</i> (2020)	C	D	A	E	F	E	B	A	A	A	F
Smriti and Das (2022)	C	BD	C	E	F	B	B	E	D	C	C
Steyn and Bruin (2020)	D	F	A	E	F	E	A	G	A	C	E
Suto and Takehara (2022)	B	AE	A	BC	F	C	G	E	D	A	C
Vincenzi and Cunha (2021)	B	H	A	E	E	D	G	F	A	A	A
Zhang <i>et al.</i> (2022)	B	H	C	E	A	F	G	E	B	A	C

3. INNOVATION AND DIVERSITY EFFECTS ON THE VALUE CREATION AND FINANCIAL PERFORMANCE OF PHARMACEUTICAL COMPANIES

Abstract: The pharmaceutical industry has a business model associated with continuous innovation. In addition, it has an important weight in the capitalization value of relevant stock markets. Therefore, they are subject to corporate governance standards that encourage the inclusion of diversity in companies. The theory of economic development clarifies that investments in innovation are associated with the long-term continuity of organizations. On the other hand, the theories of resource-based view of the firm (RBV) and upper echelons point out that the diversity of human resources and, in particular, of their leadership contribute to the improvement of companies' results and value. It so happens that the impact of innovation, as well as the diversity within its boards, on the value creation and financial performance of companies is not yet consensual. Therefore, this study seeks to understand what are the separate and grouped effects of innovation and diversity of the board of directors on the value creation and financial performance of the global pharmaceutical industry. To this end, a sample of 92 publicly traded companies, located in 24 countries, whose data were obtained between 2015 and 2022, is considered. The hypotheses arising from the objectives of the study are verified by means of a regression with panel data, both for the core tests and for the robustness tests. The results indicate that: i. innovation positively (negatively) affects value creation (financial performance), ii. board diversity positively affects value creation, and iii. the moderating effect of diversity in innovation negatively affects value creation. This study differs from the others in that it analyzes the effects mentioned in the companies of the pharmaceutical industry on a global scale. In addition, it innovates by considering a diversity proxy that combines aspects of gender and age. He contributes to academia with the confirmation of the theories of finance that support the hypotheses. In addition, its results can help investors and pharmaceutical companies to better direct their investments in innovation, as well as in the composition of boards that are more appropriate to the industry's profile. Finally, regulators and governments are encouraged to evolve with the definition of policies aimed at research in cutting-edge technologies and diversity in the leadership of companies.

Keywords: Innovation, Board diversity, Value creation, Financial performance, Pharmaceutical industry

3.1 Introduction

The pharmaceutical industry is one of the most prominent in the world's capital markets. As of March 2024, it holds 7% of the main stock market index in the United States (S&P500) and Germany (DAX40), as well as 21% in Switzerland (SMI) (Capital IQ, 2024). Regarding wealth generation, the pharmaceutical industry accounted for about 2.5% of the world's gross domestic product (GDP) in 2022 (Euromonitor, 2023; World Bank, 2024). For the academic community and society, these industries collaborate with their ability to stimulate science and innovation through strategic partnerships with universities and research centers (Malerba & Orsenigo, 2015).

In addition, the pharmaceutical industry produces the main means for people to cure, treat and prevent diseases. This allows for an improvement in the quality of life and prolongation of the human life span. In fact, the pharmaceutical industry cooperated with the alteration in the age pyramid of populations throughout the twentieth century (Stegemann *et al.*, 2020; Lichtenberg, 2021). Specifically, on the Covid-19 pandemic crisis, it is important to highlight its fundamental role. The industry offered timely solutions to mitigate the harmful effects on people and markets by producing vaccines and equipment on a global scale (Druehl & Prince, 2021; Liu *et al.*, 2022). In short, the pharmaceutical industry is an important part of society and meets a perennial demand for new products. Such needs motivate increasing investments in the development of new drugs and treatments.

Consequently, some of the companies in this industry are among the most innovative in the world. The list disclosure by the Boston Consulting Group (BCG) ranks pharmaceutical companies among the 50 most important inventive ones (BCG, 2023). This characteristic is corroborated by the Organisation for Economic Co-operation and Development (OECD), which classifies it as high-tech (Sanad *et al.* 2023). As evidence of this propensity for innovation, in the twentieth century there is an expansion in the diversity of drugs, with a distinction between generations of medicines. There is an evolution from the search for isolated molecules to the implementation of even more complex biological processes. Currently, there are customized therapies at the individual level that use the patient's DNA as an input for production. On the frontier of the fifth industrial revolution, the pharmaceutical industry is a user and inducer of technological innovation (Stegemann *et al.*, 2020; Li *et al.*, 2021; Liu *et al.*, 2022)

In turn, the theme of diversity permeates all industries. Companies need to attract and retain talent of diverse ages, genders, cultures, and abilities. In other words, they need to adjust to the social contexts of their time, incorporating heterogeneity into their organizational structures – including top management. One feature of diversity is the male-female composition of the workforce – which can be directly observed and uniformly measured. Such gender aspect is more sensitive for governance bodies. In this way, the composition of company boards becomes a thermometer to measure the presence of women in the top corporate governance structures (Khuong *et al.*, 2022; Khan *et al.*, 2023).

In the case of publicly traded pharmaceutical companies, they must follow the same rules applied by the stock exchanges of capital market regulators. In Brazil, for example, the Brazilian Securities and Exchange Commission (CVM) approved the ESG Annex (B3, 2023). It is a document with the measures proposed by the Brazilian Stock Exchange (B3) to encourage gender diversity and the presence of underrepresented groups in senior leadership positions. Thus, the management of high volumes of investment directed to research must rely on the plurality of experiences and visions of the members of the board of directors. In addition, having women as members of the board of pharmaceutical companies can stimulate the hiring of other professionals in the various functions and hierarchical positions of these companies (Sanad *et al.*, 2023; Muhammed *et al.*, 2024).

Given the complexity and relevance of these issues, empirical studies are dedicated to analyzing the relationship between demographic diversity in leadership, innovation and financial performance of companies. Research identifies that both the plurality of board member characteristics and innovation affect the financial performance of companies. The work dynamics between people with different cultures, genders, and backgrounds can favor the constant renewal of processes, products and services through the formulation of strategies aimed at innovation (Jhunhunwala *et al.*, 2021). In addition, it is the primary role of board directors to act as encouragers and facilitators of this process. With this, the company seeks to achieve its objectives of better financial results and long-term continuity (Boiko, 2022; Khan *et al.*, 2023; Sierra-Moran *et al.*, 2024).

In fact, the studies by Wu *et al.* (2022) and Chen *et al.* (2023) identify a positive relationship between innovation and value creation and financial performance, respectively. On the other hand, Moura *et al.* (2022) do not verify statistical significance between innovation and

companies' financial performance. Regarding the effects of board diversity on financial performance and value creation, Farooq and Ahmad (2023), as well as Foster *et al.* (2023) point to a negative relationship and no statistical significance, respectively. Finally, Khuong *et al.* (2022), Chen *et al.* (2023) and Wu *et al.* (2022) find that the presence of women on the boards of directors of companies contributes favorably to their financial performance and value creation, respectively. It should be noted that these results were obtained for companies that do not necessarily operate in the pharmaceutical industry.

Given the lack of consensus on this topic, this study aims to analyze the effect of innovation and board diversity on the financial performance and value of pharmaceutical companies. To this end, 92 publicly traded pharmaceutical companies located in 24 countries are analyzed. The data is obtained from the databases of Capital IQ, Bloomberg and World Bank, during the period from 2015 to 2022. The hypotheses are tested through a panel data regression and confirmed via robustness tests.

This study adds to the literature by analyzing the relationships mentioned - focusing on companies in the pharmaceutical industry - which have innovation as a main driver in their business model. In addition, the sample considers companies operating in almost all continents, including emerging and developed countries. In addition, board diversity is measured through a score that combines gender and age characteristics into a single metric. Finally, this study differs from the others by testing the interaction between board diversity and innovation as determinants of value creation for the pharmaceutical industry in a global sample.

The results of this research contribute to academia through the empirical confirmation of the theories of resource-based view, upper echelons, and agency. Pharma, investors and the market can check the likelihood of the financial return or not of their investments in innovation and board diversity. Countries and regulators benefit from the findings presented by gaining a better insight into the assertiveness of policies that stimulate innovation and diversity on the boards of directors of these companies.

3.2 Literature review

In this section, the main theories and results of similar empirical studies that aim to support the hypotheses of this study are presented.

3.2.1 Theoretical review and formulation of hypotheses

The theory of economic development – presented by Schumpeter (1934) – clarifies that investments in research and development (R&D) are among the main determinants for the long-term survival of companies. Its occurrence signals an expectation of an increase in the future results of the companies, which ends up valuing their shares. However, the optimal level of investments in innovation cannot be obtained through a generic mathematical formula - applicable to any company. On the contrary, it stems from its strategic positioning, being influenced by the intuition of decision-makers (Coad & Rao, 2010). Moreover, the future outcome of innovation is not guaranteed. Actually, according to Ugur *et al.* (2016) and Ugur and Vivarelli (2021), the relationship between R&D and company survival presents an inverted U curve. This is due to the fact that companies, which operate in concentrated industries, have a higher chance of surviving. On the other hand, the scale effect of innovation decreases over time.

According to Lin *et al.* (2020) and Wu *et al.* (2022), R&D spending is a proxy for innovation investments made by companies because it represents a strategic decision by senior management. In addition, the relationship between investment in innovation and financial return depends on specific characteristics of the companies, such as: geographic location, size, age, technological intensiveness, type of industry, etc. According to Boiko (2022) this relationship is usually positive. However, the author highlights the existence of contradictory results. To better understand these divergences, he suggests that this investigation be segmented by type of industry, given the specifics of each business. In addition, the author recommends a comparative analysis between companies from developed and emerging countries. Consequently, the following hypotheses are formulated:

H1a - Innovation affects the value creation of pharmaceutical companies

H1b - Innovation affects the financial performance of pharmaceutical companies

On the other hand, the resource-based view (RBV) theory - highly cited by previous works according to Figure 9 - understands the company as an entity that holds (in)tangible resources, which are used for the purpose of developing its core activities (Barney, 1991). Among these resources, the human skills are at the service of the company, and particularly the human capital of the members of its high governance bodies. It means that, as leaders, their personal values

influence the way business are done and the company's relationship with the others stakeholders (Moura *et al.*, 2022; Farooq *et al.*, 2023).

It also dialogues with the theory of upper echelons, which suggests that the firm is a reflection of the individual and collective characteristics of its top management members (Hambrick & Mason, 1984). Thus, it is possible to relate the individual characteristics of these members to the results of the companies. Since board members are human beings, they are also susceptible to being influenced by cognitive biases. Therefore, their personal characteristics can be predictors of corporate decisions and subsequent outcomes (Sanad *et al.*, 2023).

Both theories suggest that gender diversity on the board can strengthen its capacity for oversight by contemplating the female perspective, in a traditionally structured environment with a male bias (Khan *et al.*, 2023). The presence of women incorporates typically feminine characteristics such as greater empathy, creativity, and greater consideration in the face of risky decisions (Wu *et al.*, 2022; Sierra-Moran *et al.*, 2024). However, Torchia *et al.* (2011) understand that the female presence is only capable of producing this counterpoint from a minimum number of women on the board. On the other hand, there are authors who argue that diversity in the board can excessively lengthen the discussions, making the collegiate untimely to the demands of the institution (Wu *et al.*, 2022).

Another concept associated with board diversity is the issue of age. Based on these same theories - RBV and Upper Echelons - it can be stated that the composition of the collegiate by members of different ages and generations also adds value to its deliberations (He *et al.*, 2023). Older members, a priori, have greater experience, resilience and capillarity of contacts than younger members. In addition, because they have experienced different economic scenarios and political contexts, their greater seniority allows the company to overcome recessionary cycles and institutional crises with greater serenity. Younger directors are likely to have a greater appetite for risk, while lacking a long-lasting reputation (yet) to preserve (Sierra-Moran *et al.*, 2024). Therefore, the arguments above support the construction of the following hypotheses:

H2a - Diversity affects the value creation of pharmaceutical companies

H2b - Diversity affects the financial performance of pharmaceutical companies

Agency theory affirms that governance instruments mitigate conflicts of interest between managers and owners (Jensen & Meckling, 1976). Executives tend to favor initiatives that deliver short-term results. It is because the positive impacts of short-time strategies will be reflected in the executives' current compensation, while long term strategies (if fruitful) will benefit another generation of executives instead (Shleifer & Vishny, 1997). On the contrary, other stakeholders are more interested in investing in projects that value companies and maintain their resilience in the long term. Thus, according to stakeholder theory (Freeman, 1984), senior governance has the power/duty to balance the company's short and long-term objectives, serving the interests of all stakeholders (Khuong *et al.*, 2022; Sierra-Moran *et al.*, 2024).

An example of potential divergences between stakeholders is the strategic allocation of resources to innovation (Honoré *et al.*, 2015; Sanad *et al.*, 2023). The conflict established between the parties arises from the following aspects: i. the expenses destined to innovation reduce the result of the year in which they occur. This restricts the remuneration and budget margin of managers and ii. shareholders, on the other hand, want investment decisions to occur under conditions of risk – such as expenses made in favor of innovation. Its expectation is that there will be continued appreciation of the shares in the long run. According to the theory of upper echelons, the negotiation to mitigate these conflicts depends on the intuition and cognitive bias of the company's decision-makers - managers and the board of directors (Hambrick & Mason, 1984; Coad & Rao, 2010).

It should be noted that formulating and monitoring corporate macro-strategies are the reason for the existence of a board of directors (Jhunjhunwala *et al.*, 2021). Among them is the policy of investments in innovation, for example. Therefore, the board can directly influence innovation activity through this channel (Wu *et al.*, 2022). Consequently, the diversity of individual demographic characteristics of its members is an aspect that affects how such decisions are made and how these investments translate into results (Coad & Rao, 2010; Coad & Grassano, 2019; Jhunjhunwala *et al.*, 2021; Wu *et al.*, 2022). The exposition of the facts presented suggests the following hypotheses:

H3a – Diversity moderates the effects of innovation on the value creation of pharmaceutical companies

H3b - Diversity moderates the effects of innovation on the financial performance of pharmaceutical companies

3.2.2 Empirical review

Tables 7 and 8 present a summary of the results of empirical studies comparable to this one. In Table 7, the dependent variables – value creation proxies – are Tobins' Q (TOBQ) and market to book value ratio (MBV). In Table 8, the variables dependent on financial performance are return on asset (ROA) and return on equity (ROE). TOBQ and ROA are considered in the main tests, while MBV and ROE are used in the robustness tests. The description of the variables is presented in Table 9.

In Table 7, of the six studies mentioned, two identify a positive and statistically significant relationship between innovation and value creation. Such results instigate the formulation of *H1a – Innovation affects the value creation of pharmaceutical companies*. However, regarding the relationship between board diversity and value creation in companies, there is only a single article which presents a statistically significant result. This supports the need for further research on *H2a – Diversity affects the value creation of pharmaceutical companies*. Finally, there is also only one research about the moderating effect of board diversity on innovation, which encourages the continuation of the research on *H3a – Diversity moderates the effects of innovation on the value creation of pharmaceutical companies*.

As for the study by Jhunjhunwala *et al.* (2021), they investigate the interaction between board diversity and innovation with value creation in companies. The sample is composed of Indian companies, whose data are obtained for the period from 2006 to 2017. The regression model used is the data panel model with fixed effects. The results point to a positive and statistically significant relationship between both explanatory variables and value creation alone. However, the moderation effect between diversity of boards and innovation is not statistically significant in relation to the dependent variable. In their conclusion, the authors highlight the importance of corporate governance and diversity in value creation. However, they warn of the risk of imposing a rigid governance model that is a mere regulatory checklist.

On the other hand, the article by Dai *et al.* (2022) analyzes, among other aspects, the relationship between innovation and value creation in companies in the year in which they carry out their public offering of shares (IPO). The tests are performed using a cross-section pooled regression. The sample is composed of Chinese companies, in the period from 2009 to 2019. As a result, the authors identify a positive relationship between innovation and value creation in companies. This relationship is even more pronounced in the case of startups. Such companies – because they are disruptive and incipient – usually raise funds via venture capital funds. The funds, in turn, expect the return on the capital invested at the time of the divestment or IPO. Given the nature of these companies, these resources are mainly intended for the development of innovative products and services. These findings could be useful to pharmaceutical startups. They are also financed via venture capital, obtained from large corporations in the sector that may later acquire them.

Regarding Foster *et al.* (2023), they test the relationship between diversity and value creation using different diversity *proxies*, with the aim of comparing them. One of them is the score assigned by Bloomberg to the diversity parameter in the composition of the board of directors. The sample is composed of North American companies from 2011 to 2018. The methodology applied is a regression with panel data. The authors did not identify statistical significance in the results. Among the possible reasons for this is the fact that corporate diversity – when observed only at the board level – may not be able to represent the company's overall efforts on this issue.

In turn, the study by Liew and Devi (2021) analyzes the relationship between the number of national banks with which companies engage and their value, considering whether they are family-owned or not. The issue of innovation is verified as a result of the ability of family businesses to be more favorable to its adoption than those that are not. The sample consists of 379 Malaysian companies, whose data are obtained between 2007 and 2009. Hypotheses are tested using a regression with fixed-effects panel data. The results were inconclusive, and the hypotheses were partially confirmed. The innovation proxy also did not show statistical significance. However, it turns out that the study was conducted for a small number of companies and during a period of global financial crisis.

Regarding the study by He *et al.* (2023), which tests the hypothesis that the arrival of members of generation X (people born between 1961 and 1981) on boards of directors impacts the value

creation of companies. The authors state that generational identity is the aspect that stands out the most among the demographic characteristics of the boards. The sample is composed of companies listed in the United States, whose data are obtained between 1996 and 2017. Hypotheses are tested using a regression with fixed-effects panel data. The study confirms that there is a positive relationship between Gen X board members and the value of companies. This relationship is even stronger in companies that invest in research and development and engage in patenting activities. In addition, the authors find that there is less resistance to women's access to leadership positions, which also contributes to value creation.

Finally, Ermawati and Soewarno (2024) test the relationship between gender diversity among board members and value creation. The methodology used is the data panel with fixed effects. The sample consists of manufacturing companies listed on the Indonesian stock exchange, whose data is obtained for the period from 2017 to 2021. The results (do not) present statistical significance in the aforementioned relationship, with the TOBQ value proxy (MBV) as the dependent variable. Among the limitations of the study, the authors highlight the analysis of companies in a single and developing country. Thus, they recommend that new research on this topic consider companies from several emerging and developed countries. In addition, there is a suggestion to adopt different proxies for financial performance (e.g., ROA and ROE) and value creation (e.g., MBV and TOBQ).

Table 7- Dependent variable of value creation

Variables	Tobin's Q						Market to Book Value					
	Jhunjunwa la <i>et al.</i> (2021) (b)		Dai <i>et al.</i> (2022)		Foster <i>et al.</i> (2023)		Liew and Devi (2021)		He <i>et al.</i> (2023)		Ermawati and Soewarno (2024)	
	Sign	SS	Sign	SS	Sign	SS	Sign	SS	Sign	SS	Sign	SS
RDS	n/a	n/a	+	1%	n/a	n/a	+	n/s	+	5%	n/a	n/a
DSCR (a)	+	1%	n/a	n/a	-	n/s	n/a	n/a	+	n/s	+	n/s
DSCR*RDS	-	n/s	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
SIZE	-	n/s	-	1%	+	1%	+	n/s	-	1%	+	5%
LEV	+	10%	-	1%	n/a	n/a	+	n/s	-	1%	+	n/s
AGE	-	n/s	+	1%	n/a	n/a	+	n/s	-	1%	+	5%
GDPG	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
WGI	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Notes: SS - Statistical significance; n/a - not applicable; n/s – no statistical significance; (a) The proxy for diversity used in these studies is the percentage of women - which is the main element in the composition of the DSCR. Foster *et al.* (2023) is the only one that uses the DSCR as defined in Table 9; (b) The proxy for innovation in this study is the Neperian logarithm of research and development expenses

In Table 8, of the six studies mentioned, two studies present contradictory results regarding the relationship between innovation and financial performance. These opposing results motivate

the investigation focused in one specific industry leading to the formulation of *H1b - Innovation affects the financial performance of pharmaceutical companies*. Likewise, regarding the relationship between board diversity (DSCR) and the financial performance of companies, two articles present positive and significant relationship for ROA while the study by Farooq and Ahmad (2023) shows a negative and statistically significant relationship between DSCR and ROE. The alternation of these results encourages the continuation of this research through *H2b - Diversity affects the financial performance of pharmaceutical companies*. Finally, there is only one study on the moderating effect of board diversity on innovation, confirming the importance of the analysis of *H3b - Diversity moderates the effects of innovation on the financial performance of pharmaceutical companies*.

The study by Khuong *et al.* (2022) verifies, among other questions, whether the diversity represented by the presence of women on the board is related to the company's financial performance. The methodology employed is the dynamic panel. The sample considers non-financial companies listed on Vietnam's stock exchanges, whose data are obtained for the period from 2015 to 2019. The results show that having women as directors improves the company's performance. According to the authors, women tend to act and make decisions more ethically, paying attention to the interests of the various stakeholders. In addition, their presence on the boards of directors is associated with innovation through investment in research and development, which can improve the company's performance. The study further suggests looking at other diversity proxies in future research, such as the age of board members.

Chen *et al.* (2023) analyze the impact of board innovation and diversity on companies' financial performance. The regression model used includes a two-stage analysis. The survey sample consists of non-financial companies, whose shares are traded on the Taiwan stock exchange. Data are obtained for the period from 1996 to 2017. The authors identify a positive and statistically significant relationship for both diversity and innovation. They highlight the especially positive effect for smaller companies, where the influence of the board can be better perceived.

On the other hand, Khan *et al.* (2023) test the impacts of various aspects of diversity – ethnicities, nationality and gender – on the financial performance of companies. They highlight the importance of governance bodies in countries with less consolidated state structures. The methodology employed is the data panel with fixed effects. The sample consists of non-

financial companies listed on the Pakistan stock exchange. Data are obtained for the period from 2009 to 2020. The results do not show statistical significance in the relationship between gender diversity on the board and companies' financial performance. The authors understand that this is due to the low presence of women in the top governance of Pakistani companies, making it difficult to test in domestic companies, as well as in other developing countries.

The aforementioned study by Jhunjhunwala *et al.* (2021) also investigates the relationship between board innovation and diversity with the financial performance of Indian companies. The results point to a positive relationship between innovation and performance; however, it is statistically insignificant between the diversity of the board and the financial performance of the companies. On the other hand, the moderation effect between board diversity and innovation has a negative relationship with ROE. The authors conclude that governance does moderate the relationship between innovation and performance. However, regulators should avoid imposing pre-defined parameters that are broad in scope. This takes away the necessary autonomy from companies to achieve their best possible performance.

About the research of Safiullah *et al.* (2022), they investigate the effects of innovation and board diversity on the financial performance of Spanish companies, among others determinants, for the period between 2013 and 2018. This period was chosen because - in 2015 - public companies had to “comply or explain” about their adherence to a governance code established by the Comisión Nacional del Mercado de Valores (CNMV). One of the main recommendations of CNMV is that all the listed companies should have at least 40% female representation on their boards. However, this guidance has not received adequate attention from most companies. The authors found that the presence of women on the board of directors does not affect companies' ROE. In authors' view, companies must change their biased perception that the simple fact of having women in top positions necessarily improves their performance measures. Moreover, they found a negative relationship between innovation and companies' financial performance.

Finally, the study by Farooq and Ahmad (2023) investigates, among other issues, whether gender diversity on the board of directors influences the financial performance of companies. The authors do this analysis using a regression model with panel data for non-financial companies listed in Pakistan. Data are obtained for the period from 2010 to 2019. The results indicate that there is a negative relationship between board diversity and company ROE. Among

the possible reasons for this is the fact that the inclusion of women in the boards of directors is seen as a mere compliance with the requirements of the legislation of that country. In other words, the presence of women among its members is not related to a thoughtful company strategy for improving the quality of board decisions.

Table 8 - Dependent variables of financial performance

Variables	ROA						ROE					
	Khuong <i>et al.</i> (2022)		Chen <i>et al.</i> (2023)		Khan <i>et al.</i> (2023)		Jhunjunwala <i>et al.</i> (2021) (b)		Farooq and Ahmad (2023)		Safiullah <i>et al.</i> (2022)	
	Sign	SS	Sign	SS	Sign	SS	Sign	SS	Sign	SS	Sign	SS
RDS	n/a	n/a	+	1%	n/a	n/a	n/a	n/a	n/a	n/a	-	10%
DSCR (a)	+	5%	+	1%	+	n/s	-	n/s	-	1%	+	n/s
DSCR*RDS	n/a	n/a	n/a	n/a	n/a	n/a	-	5%	n/a	n/a	n/a	n/a
SIZE	+	10%	+	10%	+	1%	+	10%	+	s/s	+	n/s
LEV	-	1%	n/a	n/a	+	1%	-	1%	-	1%	-	10%
AGE	-	s/s	+	1%	+	5%	-	1%	n/a	n/a	n/a	n/a
GDPG	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
WGI	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Notes: SS - Statistical significance; n/a - not applicable; n/s – no statistical significance; (a) The proxy for diversity used in these studies is the percentage of women - which is the main element in the composition of the DSCR. Farooq and Ahmad (2023) are the only ones that use a dummy for the presence of women on the board; (b) The proxy for innovation in this study is the Neperian logarithm of research and development expenses

3.3 Methodology

In this section, the sample and methods for verifying the hypotheses of this study are presented.

3.3.1 Sampling

The final sample of this study is composed of 92 publicly traded companies that belong to the pharmaceutical industry, located in 24 countries – see Appendix A. Data are obtained from the databases of Capital IQ, Bloomberg and World Bank for the period from 2015 to 2022. All companies have positive equity for yearly reports.

3.3.2 Tests

The data is analyzed by descriptive statistics and a correlation matrix. The hypotheses are verified through a regression with panel data, including fixed effects and a dummy of time, in order to overcome possible endogeneity problems (Barros *et al.*, 2020). The main regressions have Tobin's Q (TOBQ) and the return on asset (ROA) as dependent variables, as proxies for

value creation and financial performance, respectively. Robustness tests employ alternative proxies of market to book value (MBV) for value creation and return on equity (ROE) for financial performance.

3.3.3 Equations and variables

Equation 1 presents the study's econometric model, while Table 9 describes its variables.

$$Y_{it} = \beta_0 + \beta_1 RDS_{it} + \beta_2 DSCR_{it} + \beta_3 X_{it} + \beta_4 Z_{it} + u_{it} \quad (1)$$

In which:

Y = dependent variables value creation (TOBQ, MBV) and financial performance (ROA, ROE)

X = firm control variables (SIZE, LEV, AGE)

Z = country control variables (GDPG, WGI)

β_0 = the coefficient for the intercept term

β_1 to β_4 = the coefficient of explanatory variables

i = firm

t = year

u = error term

Table 9 - Variable description

Acron	Name	ES	Formula	Components	Source	Ref.
Dependent variables – Value creation						
TOBQ	Tobin's Q	n/a	TOBQ = (MV+TD) / TA	MV = Market value of equity = outstanding shares * share price of the last day of each calendar year TD = Total debt TA = Total assets	CIQ	(a)
MBV	Market to book value	n/a	MBV = MV / TE	MV = Market value of equity = outstanding shares * share price of the last day of each calendar year TE = Total equity	CIQ	(b)
Dependent variables – Financial performance						
ROA	Return on assets	n/a	ROA = EBIT/TA	EBIT = Earnings before interest and taxes TA = Total assets	CIQ	(c)
ROE	Return on equity	n/a	ROE = NI / TE	NI = Net income TE = Total equity	CIQ	(d)
Independent variable – Innovation						
RDS	Research and development over sales	+/-	RDS = R&D/REV	R&D = Research and development expenses REV = Operating revenue	CIQ	(e)
Independent variable – Board diversity						
DSCR	Board of directors' diversity score (*)	+/-	DSCR = It ranges between 0 and 10	DSCR score evaluates the company's aggregated performance and disclosure on the issue of board of directors' age and gender diversity.	BLO	(f)

Firm control variables						
SIZE	Size	+	SIZE = ln (TA)	ln = Natural logarithm TA = Total assets	CIQ	(g)
LEV	Leverage	-	LEV = TD / TA	TD = Total debt TA = Total assets	CIQ	(h)
AGE	Age of incorporation	+	AGE = ln(CY - YF)	ln = Neperian logarithm CY = Current year YF = Year founded	CIQ	(i)
Country control variables						
GDPG	Gross domestic product growth	+	GDPG = (GDP _t / GDP _{t-1}) - 1	GDP _t = Gross domestic product of the current year GDP _{t-1} = Gross domestic product of the previous year	WB	(j)
WGI	Worldwide Governance Indicator	+	WGI = It ranges between -2.5 and 2.5.	WGI index is derived from the average of six dimensional estimates: i. control of corruption, ii. government effectiveness, iii. political stability and absence of violence/terrorism, iv. regulatory quality, v. rule of law and vi. voice and accountability. The estimate gives the country a score for each dimension in units of a standard normal distribution.	WB	(k)

Notes: ACRON - Acronym; ES - Expected signal; REF - Reference; CIQ - Capital IQ; BLO - Bloomberg; WB - World Bank. (*) The board of directors' diversity score is provided by Bloomberg under the code SR006. For more information, see Appendix D.

References:

- (a) Dai *et al.* (2022); Foster *et al.* (2023); Khan *et al.* (2023)
- (b) Liew and Devi (2021); He *et al.* (2023); Ermawati and Soewarno (2024)
- (c) Khuong *et al.* (2022); Chen *et al.* (2023); Khan *et al.* (2023)
- (d) Khuong *et al.* (2022); Moura *et al.* (2022); Farooq and Ahmad (2023)
- (e) Dai *et al.* (2022); Wu *et al.* (2022); He *et al.* (2023); Khan *et al.* (2023)
- (f) Foster *et al.* (2023)
- (g) Dai *et al.* (2022); Moura *et al.* (2022); Foster *et al.* (2023); He *et al.* (2023)
- (h) Dai *et al.* (2022) Wu *et al.* (2022) Khan *et al.* (2023)
- (i) Dai *et al.* (2022); Wu *et al.* (2022); He *et al.* (2023); Khan *et al.* (2023)
- (j) Qureshi *et al.* (2020); Gerged *et al.* (2023)
- (k) Kaufmann *et al.* (2011); Gerged *et al.* (2023)

3.4 Result analysis

This item presents the results of the sample data analysis through its descriptive statistics and correlation matrix. Furthermore, it displays the results of hypothesis tests, carried out via regression with panel data, both for the main test and for the robustness one.

3.4.1 Descriptive statistics and correlation analysis

Table 10 shows the descriptive statistics of the final sample. Value creation proxies (TOBQ and MBV) have a wider range than financial performance proxies (ROA and ROE). This stems

from the high level of share price volatility, which projects an expectation of dividend distribution in the future – unlike historical accounting results. It is observed that, on average, the market value numerators exceed the accounting denominators by two (TOBQ = 2.7017) or four times (MBV = 4.4717). As for the average financial performance, it can be seen that the companies are profitable. Its operating return is 4.9% (ROA), while that of its shareholders is 9.4% (ROE).

Regarding the independent variables, the innovation proxy (RDS) indicates that, on average, pharmaceutical companies invest about 13% of their sales revenues in research and development, with those committing a maximum of 87%. It is noteworthy that this information lacks greater transparency on the part of the companies, resulting in a lower number of observations. Diversity proxy (DSCR) is measured by a score that combines information about the age and gender of board members. It can be seen that the maximum value (6.52) is lower than the upper limit "10" of the scale. On the other hand, the minimum value (1.09) exceeds the lower limit "0" of the score. This means that the diversity policy of the board of directors is a potential strategic goal in the pharmaceutical companies in the final sample.

As for the control variables, it is noteworthy that the size of the companies was regular, with an average of 8.25 and a standard deviation of only 1.95. In addition, pharmaceutical companies have an average debt of 21.8% and have a wide range of ages. The average GDP growth rate (GDPG) is 2.9% and the level of governance is high (0.76) – for the countries in which pharmaceutical companies are located.

Table 10 - Descriptive statistics

Variables	Obs.	Mean	Std. Dev.	Minimum	Maximum
tobq	731	2.7017	2.4213	0.3631	18.9621
mbv	705	4.4717	4.4448	0.2348	29.245
roa	729	0.0496	0.1830	-0.9150	0.5078
roe	686	0.0949	0.2262	-0.9804	0.9867
rds	487	0.1297	0.1020	0.0055	0.8724
dscr	732	2.8168	1.2185	1.0900	6.5200
size	736	8.2504	1.9518	2.6562	12.192
lev	661	0.2182	0.1817	0.0001	0.9489
age	736	3.8037	1.0557	0.6931	6.1070
gdp	736	0.0291	0.0370	-0.1117	0.2448
wgi	736	0.7620	0.7538	-1.0420	1.7721

Table 11 shows Pearson's coefficient and the level of significance of the correlation matrix. The existence of high positive correlations – above 70% – may signal an eventual multicollinearity (Hair *et al.*, 2018). The highest positive correlations are identified between diversity (DSCR) and size (SIZE) – 69%, as well as between DSCR and age (AGE) – 51%. This indicates that larger and older companies tend to form boards of directors with greater diversity.

In addition, the correlation between size and age (55%) is also highlighted. The size of the company tends to grow over time. Finally, there is a negative correlation between GDP growth and countries' level of governance. This may reflect the macroeconomic reality in the observed period. The developed countries in the sample have high governance scores and nevertheless show low economic growth or even contraction. On the other hand, emerging countries - especially China - showed higher economic growth, despite their institutional evaluation score being, as a rule, lower.

Table 11 - Correlation matrix

	tobq	mbv	roa	roe	rds	dscr	size	lev	age	gdpg	wgi
tobq	1										
mbv	0.77 0.00	1									
roa	-0.00 0.98	0.07 0.06	1								
roe	0.09 0.02	0.26 0.00	0.83 0.00	1							
rds	0.19 0.00	0.06 0.16	-0.20 0.00	0.01 0.80	1						
dscr	-0.17 0.00	0.03 0.40	0.25 0.00	0.29 0.00	0.21 0.00	1					
size	-0.31 0.00	-0.10 0.01	0.44 0.00	0.39 0.00	0.12 0.01	0.69 0.00	1				
lev	-0.16 0.00	0.09 0.01	-0.10 0.00	0.02 0.57	-0.10 0.02	0.08 0.03	0.21 0.00	1			
age	-0.20 0.00	-0.08 0.03	0.37 0.00	0.31 0.00	0.11 0.02	0.51 0.00	0.55 0.00	-0.09 0.01	1		
gdpg	0.10 0.00	0.05 0.19	0.07 0.05	0.03 0.42	-0.23 0.00	-0.23 0.00	-0.14 0.00	0.05 0.21	-0.16 0.00	1	
wgi	-0.15 0,00	0.01 0.86	-0.17 0.00	-0.07 0.06	0.33 0.00	0.37 0.00	0.30 0.00	0.16 0.00	0.21 0.00	-0.38 0.00	1

Note: The upper values refer to the Pearson coefficient, while the lower ones refer to the significance level of the correlation.

3.4.2 Main regression tests

Table 12 presents the results of the main regressions, whose proxy for the value-creation dependent variable is the Tobins' Q (TOBQ) – Models 1 to 3. In Models 4 to 6, the dependent variable is the financial performance of the companies, represented by the return on assets (ROA). In Models 1-4, 2-5 and 3-6, the independent variables are innovation proxies (RDS), board diversity (DSCR) and moderation of board diversity in pharmaceutical innovation (DSCR*RDS), respectively.

Models 1, 2 and 3 confirm the positive and statistically significant relationship – at the level of 1% – of innovation (RDS) and board diversity (DSCR) on value creation in companies. In Model 1, for every 1% increase in the RDS ratio, there is a 6.06% increase in the TOBQ. Model 2, on the other hand, indicates that an increase of 1 DSCR score is associated with a 40% appreciation of the company. As for Model 3, the positive coefficients of the RDS and DSCR variables are even higher, with a negative effect on the DSCR*RDS interaction variable. These results allow the confirmation that *H1a - Innovation affects the value creation of pharmaceutical companies*, *H2a - Diversity affects the value creation of pharmaceutical companies* and *H3a - Diversity moderates the effects of innovation on the value creation of pharmaceutical companies*.

Regarding H1a, there is confirmation of the Schumpeterian theory. It states that economic development is achieved by continuous technological innovation promoted by companies. However, there are limits to the survival of companies, even with constant investments in research and development. On the one hand, its continuity is positively affected if it operates in more concentrated industries – such as pharmaceuticals. On the other hand, it is abbreviated due to the decrease in the scale effect of innovations (Ugur *et al.*, 2016; Ugur & Vivarelli, 2021). The study by Dai *et al.* (2022) also finds this same positive relationship – see Table 7. According to the authors, R&D-intensive companies develop the ability to learn quickly, which is a characteristic valued by the market.

As for H2a, the theories of RBV and upper echellons suggest that the human resources of companies are fundamental determinants in their value creation, especially in the case of those in leadership positions. In addition, as human beings, leaders are subject to cognitive biases stemming from their personal characteristics – such as gender and age. Regarding the gender

issue, the presence of women on boards of directors contributes to more careful and thoughtful decision-making (Ermawati & Soewarno, 2024). A greater age range of board members integrates the experience of the more senior members with the update on the demands of the other younger stakeholders (Khan *et al.*, 2023; Sierra-Moran *et al.*, 2024). The study by Jhunjhunwala *et al.* (2021) also confirms a positive relationship between the diversity of board members and value creation in companies – see Table 7. Therefore, both RBV and upper echelons theories were corroborated by the confirmation of H2a.

With regard to H3a, the interaction variable DSCR*RDS presents a negative and statistically significant relationship – at the level of 1% – with the value creation of pharmaceutical companies. The integrated effect of an additional 1 score on board diversity on R&D expenses reduces the value of companies by 2.33%. In this case, the corporate governance tool of the diversity of the board of directors had a negative effect on innovation investment decisions, in relation to the value of the company. A priori, the market is favorable to innovation and diversity in pharmaceutical boards of directors (Malerba & Orsenigo, 2015; Boiko, 2022; Sierra-Moran, 2024).

Nevertheless, it does not positively evaluate the interference of boards with diversity in decisions on R&D spending. Therefore, the presence of diversity in boards did not favor the performance of the boards in their role of mitigating conflicts of interest between managers and shareholders. While the former prioritize short-term returns, the latter favor investments in innovation – which offer returns only in the long term (Coad & Rao, 2010; Wu *et al.*, 2022; Sanad *et al.*, 2023).

As for Models 4, 5 and 6, it is observed that only *H1b - Innovation affects the financial performance of pharmaceutical companies* is confirmed. In Models 4 and 6, a negative relationship is identified – at the level of 1% – between R&D expenses and the companies' ROA. In other words, a 1% increase in RDS reduces the ROA of pharmaceutical companies by 0.63% (Model 4) and 0.76% (Model 6). This is because investments in innovation decrease the EBIT of these companies in the short term, contrary to the results obtained by Chen *et al.* (2023) – see Table 8.

This divergence of empirical results may be related to the specific characteristics of pharmaceutical companies that require high investments and with greater return maturity,

compared to other industries. An example is the approval process for new drugs. The period between the discovery of a molecule and the commercialization of that drug can last several years (Malerba & Orsenigo, 2015). Moreover, this evidence is in line with the agency theory, according to Shleifer and Vishny (1997). They argue that corporate governance is a means of preventing managers from prioritizing high positive returns based on short-term objectives, sacrificing value creation possibilities through innovation. Therefore, the negative effect of innovation in the short-term result ratifies the agency theory, ensuring the continuity of investments and the value creation in the long term.

Regarding the hypotheses *H2b - Diversity affects the financial performance of pharmaceutical companies* and *H3b - Diversity moderates the effects of innovation on the financial performance of pharmaceutical companies*, it was not possible to confirm them, due to the statistical insignificance of the coefficients of the independent variables in Models 5 and 6. It can be seen that the diversity of the boards of directors, as well as their moderating effect on innovation, did not have a significant impact on the financial performance of pharmaceutical companies in the short term. This result aligns with those of Khan *et al.* (2023) that test both age and gender diversity in isolation – see Table 8. According to the authors, this type of diversity can create complexities that reduce the efficiency of the board and, consequently, of the firm.

Finally, with regard to the control variables, the negative (positive) association between size and value creation (financial performance) of the companies is highlighted. A priori, the size of pharmaceutical companies reduces their value, given the possibility of larger companies acquiring smaller ones, promoting their greater indebtedness. On the other hand, a larger size contributes to obtaining more operating profit (Ebit) (Boiko, 2022). There is also a negative relationship between the level of governance of the countries and the ROA of the companies.

This result is contrary to what was expected. An adequate general governance environment in a country should favor the performance of companies headquartered in that country. However, Eldomiaty *et al.* (2023) consider that among the six dimensions that make up the WGI are regulatory quality and the rule of law. The regulatory quality dimension is composed of different elements, such as the effect of taxation, bureaucratic inefficiency, and the burden of government regulations. It turns out that high tax rates, for example, discourage foreign direct investment, impacting companies' ROA.

In turn, the rule of law includes distinct elements such as the quality of contract enforcement, property rights, the effectiveness of the police and the courts, as well as the likelihood of crime and violence. Therefore, an appropriate rule of law helps to create a business environment that leads to improved performance of companies (Eldomiaty *et al.*, 2023). On the contrary, their absence or inefficiency has inverse impacts on corporate financial performance in the form of increased operating costs. In addition, Borges Junior *et al.* (2023) clarify that local culture also impacts company performance. Therefore, notwithstanding the fact that some countries have a high level of the overall WGI score, it is possible that some specific dimension has a greater weight in the financial performance of companies, due to the moderating aspect of their local culture.

Table 12 - Panel data results

Var.	TOBQ						ROA					
	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Coef	Sig	Coef	Coef	Sig	Coef	Coef	Sig	Coef	Sig	Coef	Sig
rds	6.06	0.00	n/a	n/a	11.5	0.00	-0.63	0.00	n/a	n/a	-0.76	0.00
dscr	n/a	n/a	0.40	0.00	0.54	0.00	n/a	n/a	0.00	0.48	-0.00	0.36
dscr*rds	n/a	n/a	n/a	n/a	-2.33	0.00	n/a	n/a	n/a	n/a	0.05	0.09
size	-0.66	0.00	-0.18	0.31	-0.63	0.00	0.02	0.00	0.04	0.00	0.02	0.00
lev	0.29	0.68	0.36	0.36	-0.07	0.91	-0.03	0.20	-0.15	0.00	-0.03	0.24
age	-1.27	0.09	1.00	0.12	-0.96	0.21	0.02	0.31	-0.01	0.65	0.03	0.25
gdpg	4.74	0.08	4.13	0.18	5.35	0.04	0.07	0.42	0.06	0.70	0.06	0.52
wgi	-0.46	0.60	-1.09	0.13	-0.56	0.52	-0.08	0.00	-0.11	0.00	-0.08	0.01
cons	13.0	0.00	0.63	0.82	10.3	0.01	-0.08	0.54	-0.13	0.37	-0.08	0.56
i.year	Yes		Yes		Yes		Yes		Yes		Yes	
FE	Yes		Yes		Yes		Yes		Yes		Yes	
No. obs	450		655		449		450		660		449	
Prob>F	0.0000		0.0000		0.0000		0.0000		0.0000		0.0000	
Within R2	0.1295		0.0889		0.1593		0.3150		0.1298		0.3203	

Notes: Var. – Variables, Coef – Coefficient, Sig – Statistical significance, i.year – Dummy of year, FE – Fixed effects, No. obs – Number of observations

3.4.2 Robustness regression tests

Table 13 presents the results of the robustness tests, whose proxy for the dependent variable of value creation is the market to book value (MBV) ratio – Models 1 to 3. In Models 4 to 6, the dependent variable is the financial performance of the companies, represented by the return on equity (ROE). As in Table 12, in Models 1-4, 2-5 and 3-6, the independent variables are the proxies of innovation (RDS), diversity of the board of directors (DSCR) and moderation of the diversity of the board of directors in pharmaceutical innovation (DSCR*RDS), respectively.

Model 2 confirms the hypothesis *H2a - Diversity affects the value creation of pharmaceutical companies*. It shows that for every 1point increase in the board's diversity score, there is a 0.47% increase in the value of the company. This result confirms the results obtained in Table 12, with a statistical significance not verified by He *et al.* (2023) and Ermawati and Soewarno (2024) – see Table 7. Thus, we have the corroboration of the RBV and upper echelons theories. The market perceives the age and gender diversity of the board as characteristics of human resources – in leadership positions – that favor the valuation of pharmaceutical companies' shares.

Moreover, the hypotheses *H1a - Innovation affects the value creation of pharmaceutical companies* and *H3a - Diversity moderates the effects of innovation on the value creation of pharmaceutical companies* are tested in Models 1 and 3, respectively. They did not show statistically significant results at the 5% level. Among the possible reasons for this, it should be noted that the MBV considers market and accounting values related only to the company's equity. Nevertheless, the TOBQ value creation proxy includes equity and third-party capital. Therefore, it is possible that the impact of innovation, as well as the moderating effect of diversity on innovation, is better measured by value creation proxies that consider all sources of funding.

In turn, Models 4 and 6 ratify *H1b - Innovation affects the financial performance of pharmaceutical companies*, as shown in Table 12. Thus, for every 1% increase in RDS, there is a reduction of 0.97% (Model 4) and 1.33% (Model 6) in the ROE of companies. This result reinforces the agency theory. It suggests that managers - concerned with profitability - tend to invest less company resources in R&D, while the board of directors guarantees that the company keeps investing in innovation (Shleifer & Vishny, 1997).

Regarding hypotheses *H2b - Diversity affects the financial performance of pharmaceutical companies* and *H3b - Diversity moderates the effects of innovation on the financial performance of pharmaceutical companies*, they are tested in Models 5 and 6, respectively. As in Table 12, they were also not confirmed.

As for the control variables, the inverse relationship between size and value creation is highlighted (Models 1, 2 and 3). This result confirms the results presented in Table 12 and corroborates the results obtained by He *et al.* (2023) – see Table 7. According to Carosi (2016), investors in smaller companies are better informed than those who invest in large companies.

Therefore, the larger the size of the company, the greater the informational asymmetry and the market's response time on the stock price. On the other hand, the relationship between leverage and value creation is positive. Debts have a lower cost, due to the effect of their tax benefit, among other aspects. Therefore, the financing of investments through an optimal capital structure is valued by the market (Ahmed *et al.*, 2023).

Regarding the control variables of Models 4, 5 and 6, the negative relationship between age and ROE is highlighted. This result is also obtained by Jhunjhunwala *et al.* (2021) – see Table 8. According to Akben-Selcuk (2016), the effects of age on performance can be negative when the company starts to suffer from inertia, losing dynamism in its relationships. However, the author considers that older companies can overcome this point of inertial inefficiency and return to a positive effect after a certain time – a "U" shaped curve.

Table 13 - Robustness tests

Var.	MBV						ROE					
	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Coef	Sig	Coef	Coef	Sig	Coef	Coef	Sig	Coef	Sig	Coef	Sig
rds	-8.52	0.06	n/a	n/a	-11.2	0.15	-0.97	0.00	n/a	n/a	-1.33	0.00
dscr	n/a	n/a	0.47	0.05	0.41	0.24	n/a	n/a	-0.01	0.62	-0.02	0.13
dscr*rds	n/a	n/a	n/a	n/a	0.58	0.78	n/a	n/a	n/a	n/a	0.12	0.20
size	-1.74	0.00	-1.69	0.00	-1.86	0.00	0.04	0.14	0.05	0.03	0.04	0.09
lev	4.08	0.05	8.59	0.00	3.98	0.06	0.12	0.21	-0.09	0.23	0.10	0.30
age	1.62	0.35	2.20	0.09	2.46	0.17	-0.30	0.00	-0.22	0.00	-0.30	0.00
gdpg	5.78	0.31	5.83	0.31	5.26	0.36	-0.22	0.39	-0.18	0.54	-0.26	0.33
wgi	0.01	0.99	-1.71	0.21	0.38	0.84	-0.14	0.11	-0.17	0.01	-0.14	0.12
cons	13.6	0.15	9.02	0.12	10.1	0.29	1.24	0.01	0.74	0.03	1.24	0.00
i.year	Yes		Yes		Yes		Yes		Yes		Yes	
FE	Yes		Yes		Yes		Yes		Yes		Yes	
No. obs	438		638		437		435		620		434	
Prob>F	0.0266		0.0000		0.0224		0.0000		0.0044		0.0000	
Within R2	0.0658		0.1233		0.0748		0.1571		0.0561		0.1628	

Notes: Var. – Variables, Coef – Coefficient, Sig – Statistical significance, i.year – Dummy of year, FE – Fixed effects, No. obs – Number of observations

To sum up, it is assumed that the hypotheses *H1b - Innovation affects the financial performance of pharmaceutical companies* e *H2a - Diversity affects the value creation of pharmaceutical companies* were confirmed in both the main and robustness tests. On the other hand, the hypotheses *H1a - Innovation affects the value creation of pharmaceutical companies* and *H3a – Diversity moderates the effects of innovation on the value creation of pharmaceutical companies* were confirmed only in the main test. Lastly, the hypotheses *H2b - Diversity affects the financial performance of pharmaceutical companies* and *H3b - Diversity moderates the*

effects of innovation on the financial performance of pharmaceutical companies have not been confirmed. Table 14 presents a compilation of hypotheses confirmation.

Table 14 - Compilation of hypotheses confirmation

Hypotheses	Table 12 Main test	Tabel 13 Robustness test
H1a - Innovation affects the value creation of pharmaceutical companies	Yes	No
H1b - Innovation affects the financial performance of pharmaceutical companies	Yes	Yes
H2a - Diversity affects the value creation of pharmaceutical companies	Yes	Yes
H2b - Diversity affects the financial performance of pharmaceutical companies	No	No
H3a – Diversity moderates the effects of innovation on the value creation of pharmaceutical companies	Yes	No
H3b - Diversity moderates the effects of innovation on the financial performance of pharmaceutical companies	No	No

3.5 Conclusion

The pharmaceutical industry is a high-tech sector. Therefore, innovation is part of its business model. The importance of this industry to society can be seen in the creation of vaccines during the Covid-19 pandemic, for example. In addition, pharmaceutical companies represent an important portion of publicly traded companies. Thus, they are subject to governance norms and social pressures to include diversity in their leadership. Nevertheless, the impact of innovation and diversity of the board of directors on the value creation and financial performance of pharmaceutical companies is not yet consensual. The same is true for the moderating effect of diversity on innovation.

According to Schumpeterian theory, investments in innovation are fundamental for the long-term continuity of companies. However, empirical studies highlight that the return on R&D spending depends on the particularities of the companies, including the type of industry. On the other hand, the RBV and upper echellons theories understand that companies are a reflection of the characteristics of their human resources – especially those of the members of senior governance. Thus, the diversity of gender and age of directors can impact the results of companies.

In view of the above, this study aims to verify the effect of innovation and board diversity on the value and financial performance of pharmaceutical companies. To this end, a sample of 92 publicly traded companies located in 24 countries was considered. The data were obtained from the databases of Capital IQ, Bloomberg and World Bank, during the period from 2015 to 2022. The hypotheses were proven by means of a regression with panel data, both for the main tests and for the robustness tests.

The results point to the confirmation of the following hypotheses – both for the main tests (Table 6) and for the robustness tests (Table 7): *H1b - Innovation affects the financial performance of pharmaceutical companies* and *H2a - Diversity affects the value creation of pharmaceutical companies*. As for H1b, there was a negative relationship between innovation (RDS) and ROA/ROE. This means that investments in innovation reduce the operating results of these companies in the short term. On H2a, greater diversity in board age and gender (DSCR) improves its oversight capacity, adding more value to companies in the long run (TOBQ and MBV). This positive relationship ratifies the theories of RBV and upper echelons.

On the other hand, the hypotheses *H1a - Innovation affects the value creation of pharmaceutical companies* and *H3a - Diversity moderates: the effects of innovation on the value creation of pharmaceutical companies* were confirmed only in the main test. In the case of H1a, Table 6 proves the theory of economic development that is obtained through the presence of continuous technological innovation promoted by companies. Regarding H3a, Table 6 points to a negative relationship between DSCR*RDS and TOBQ. The moderating effect of an additional 1 score on board diversity on R&D expenses reduces the value of companies by 2.33%. In the case of Table 7, there was no significance for these relationships. Therefore, it is possible that the impact of innovation, as well as the moderating effect of diversity on innovation, is best measured by value creation proxies that consider all sources of financing – not just equity.

As for the hypotheses *H2b - Diversity affects the financial performance of pharmaceutical companies* and *H3b - Diversity moderates the effects of innovation on the financial performance of pharmaceutical companies*, they have not been confirmed. Thus, the diversity of boards of directors - as well as its moderating effect on innovation - did not have a significant impact on the financial performance of pharmaceutical companies in the short term. One possible explanation for this is that the benefits of diversity in board decisions take time to be realized, and are reflected in companies' long-term results.

The present study adds to the existing academic literature by analyzing the decoupled and combined effects of innovation and board diversity on the value creation and financial performance of the global pharmaceutical industry. The article also innovates by adopting a recent variable to measure the diversity of boards, jointly considering the age and gender of its members. For shareholders and pharmaceutical companies, the results obtained can contribute to a better targeting of their investments in innovation, as well as to the composition of boards that are more appropriate to the industry's profile. For regulators and governments, this research points out that innovation and diversity on boards are perceived as elements that add value to markets. This can encourage the intensification of policies in favor of research into cutting-edge technologies and diversity in the leadership of companies.

Regarding the limitations of this study, the small number of publicly traded pharmaceutical companies that did not have negative equity stands out, which would make it impossible to calculate the variables related to the capital structure. Another aspect to be highlighted is the low availability of data from the board of directors' diversity score (DSCR) metric, calculated by Bloomberg. Finally, it is suggested for the purposes of the evolution of this research: i. analysis of the impact of generative artificial intelligence tools on the results of companies; ii. comparison between publicly and privately held companies; iii. consideration of other proxies of innovation in the pharmaceutical industry – e.g., annual number of new product launches and iv. analysis of alternative proxies of diversity and that contemplate other levels of governance in companies – e.g., academic background, experience, professional qualification, ethnicity, nationality, compensation committee, internal audit, fiscal council.

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3.7 Appendix C – Number of pharmaceutical companies for each country in the sample

Country	# Companies	Country	# Companies	Country	# Companies
China	21	France	2	Finland	1
United States	20	Germany	2	Indonesia	1
Japan	15	Pakistan	2	Israel	1
Cayman Islands	5	Switzerland	2	Italy	1
Hong Kong	3	Belgium	1	Singapore	1
Ireland	3	Brazil	1	South Africa	1
United Kingdom	3	Canada	1	Spain	1
Bermuda	2	Denmark	1	Taiwan	1
Total					92

3.8 Appendix D – Board of directors’ diversity score

Board of directors’ diversity score (DSCR) follows Bloomberg’s ESG general methodology, which considers three main pillars: environment (E), social (S) and governance (G). With respect to the governance pillar, it is divided into themes. The theme related to DSCR is board composition, which is divided into four issues: diversity, refreshment, independence and director roles. Finally, the issue diversity is composed by two sub-issues: age and gender (Bloomberg, 2023, 2024).

Concerning the age sub-issue, it considers two fields: i. board average age and ii. board age range. About the first one, the maximum score of 10 is given to the board average age of 50 years old, while 70 corresponds to 2, and 90 to 0. Regarding the second one, it calculates the age difference between the oldest (capped at 75 years) and the youngest director. Thus, having a director older than 75 won’t bring any additional score. Besides, the age range won’t be wider than 35 years, since this is the maximum span. Therefore, a range of 35(15) years corresponds to a maximum score of 10(5), respectively. The total age diversity score is obtained by the average of both individual scores.

About the gender diversity sub-issue, it also considers two fields: i. percentage of board members that are women and ii. chairman or equivalent a woman. The first one is a nonlinear tabulated score. Thus, 0% of women on board corresponds to 0 score, while 20% to 3 and 50% to the maximum score of 10. If there is more than 50% of women on the board, the score hits the upper limit of 10. Regarding the second one, it refers to the chairperson gender. If a woman occupies this position, the company scores one extra point for this sub-issue, limited to a maximum of 10.

After obtaining both age and gender sub-issue scores, the diversity issue score is determined by a weighted average - with a weight of 33.3% for age and 66.7% for gender. Since each sub-issue score ranges between 0 and 10, the diversity issue score also has the same scale. Having said that, lowering the age average from 70 to 50, it represents 1 point more in the issue score. Also, rising the age range from 15 to 35, it leads to an increment of 2.7 points in the issue score. On the other hand, increasing the percentage of board members that are women from 0% to 10% (20% to 50%), it represents 2 (4.67) points in the diversity issue score. Finally, nominating a woman as the chairman, it increases 0.67 points in the diversity issue score.

In summary, a company will have a better board diversity issue score if it replaces an old male for a young female director. By doing this, the company may: i. reduce the board average age, ii. increase the board age range and iii. expand the gender diversity sub-issue score. Therefore, one single change may raise the board diversity issue score by three different channels. Ultimately, if a woman chairs the board, there is an additional 0.67 score.

4. CONCLUSION

The pharmaceutical industry is a high-tech sector at the leading edge of the ongoing 5.0 industrial revolution. Furthermore, companies of all sort of sectors are being pressured to include diversity in its leadership positions. Therefore, understanding the potential impacts of both innovation and diversity on companies' outcomes, as well as how those two phenomena interact with each other is of societies' great interest. Thus, this thesis presents a literature review (Chapter 2), as well as an empirical analysis (Chapter 3) about these topics.

Chapter 2 performs a bibliometric analysis and a systematic review about innovation and diversity on the value creation and financial performance of companies. Sample identification is done by specifying keywords related to both topics at Web of Science and Scopus databases. After applying database filters' and excluding papers - whose topics were different from those of research interest - the final sample consists of 34 articles, obtained from January 1, 2017, to May 22, 2023. The bibliometric analysis was carried out using Biblioshiny and Rank Words softwares, with the verification of the main bibliometric laws – Bradford (journals), Lotka (authors) and Zipf (Keywords).

As for bibliometric analysis, the main results obtained were: i. the study's theme has increasing attention over time, ii. no author stands out in terms of publication because each of them presents only one article in the final sample, iii. the most cited articles are those associated with French institutions, iv. the journal Business Strategy has received the most citations and v. researchers affiliated with the University of Teramo publish the most.

Regarding the results of the systematic review, the main knowledge gaps identified were: i. examine the moderating impact of diversity in innovation on business outcomes; ii. investigate social identity theory premises to support study hypotheses; iii. confirm the hypotheses using regression models with the binary dependent variable and structural equations; iv. select substitute measures for diversity in the board, financial performance, innovation, and value creation and v. examine data from Latin American companies with extended time series.

Based on the main insights identified in the systematic review of Chapter 2, the Chapter 3 of this research was developed. Therefore, it aimed to test the impacts of innovation and diversity on value creation and financial performance of pharmaceutical companies, as well as investigating the interaction between innovation and diversity in this industry. The concept of diversity is related to board diversity, in terms of gender and age. In order to do this, the hypotheses of the study were tested by a panel data regression and confirmed via robustness tests. The final sample consists of 92 publicly traded pharmaceutical businesses spread over 24 countries. The information was taken from the World Bank, Bloomberg, and Capital IQ databases between 2015 and 2022.

Most of the hypotheses were confirmed, being: *H1a - Innovation affects the value creation of pharmaceutical companies*, *H1b - Innovation affects the financial performance of pharmaceutical companies* and *H2a - Diversity affects the value creation of pharmaceutical companies* and *H3a - Diversity moderates: the effects of innovation on the value creation of pharmaceutical companies*. In summary, the study confirms that: i. innovation affects positively (negatively) the value creation (financial performance), ii. diversity impacts positively the value creation and iii. diversity negatively moderates the impact of innovation.

As for the hypotheses *H2b - Diversity affects the financial performance of pharmaceutical companies* and *H3b - Diversity moderates the effects of innovation on the financial performance of pharmaceutical companies*, they have not been confirmed. The diversity of boards of directors - as well as its moderating effect on innovation - did not have a significant impact on the financial performance of pharmaceutical companies in the short term. A plausible rationale for this could be that the advantages of having a diverse board of directors take time to materialize and are seen in the long-term performance of the companies.

This study provides evidence to policymakers supporting the diversity and inclusion policy enforcement. Moreover, it informs investors about the effects of diversity in the leadership. At the limit of our knowledge, this is the first empirical study that analyzes a global sample of pharmaceutical companies and that uses the Bloomberg board diversity issue score as proxy for

diversity. Additionally, it innovates by analysing the moderating effects of diversity on innovation.