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# Pharmaceutical companies' financial outcomes related to innovation and diversity

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***Abstract***

***Purpose:*** 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.

***Design/methodology/approach:*** To this end, a sample of 92 public companies located in 24 countries was analyzed. Their data were obtained from 2015 to 2022. The hypotheses arising from the objectives of the study are verified by means of a panel data regression with fixed effects and year dummies, both for the main and robustness tests. The innovation proxy is operationalized by the ratio of research and development expenses to operating revenue. In turn, the diversity proxy is obtained by Bloomberg's board of directors' diversity score, which includes age and gender features.

***Findings:*** 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.

***Practical implications:*** The 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.

***Social implications:*** Regulators and governments are encouraged to evolve by defining policies focused on research in cutting-edge technologies and diversity in corporate leadership.

***Originality/value:*** This study differs from the others since it analyzes the mentioned effects in the pharmaceutical industry on a global scale. In addition, it innovates by considering a diversity proxy that combines gender and age aspects.

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

***Jel Codes:*** G32

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## 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 International, 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. 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 (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 (Boston Consulting Group [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. On the frontier of the fifth industrial revolution, the pharmaceutical industry is a user and inducer of technological innovation (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 approved the ESG Annex (Brazilian Stock Exchange [B3], 2023). It presents 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; Muhammad et al., 2024).

That said, the relevance of examining how innovation and board diversity affect value creation and financial performance becomes even more pronounced in the context of publicly traded pharmaceutical companies. These firms operate in capital-intensive research and development (R&D) environments. Therefore, long development cycles, high regulatory scrutiny, and substantial technological uncertainty make investors particularly sensitive to signals – regarding innovation efficiency and governance quality (Malerba & Orsenigo, 2015; Liu et al., 2022). Because financial markets continuously price expectations about future drug pipelines, patent renewals, and the strategic oversight of these processes, understanding how R&D spending and board demographic composition interact is crucial for explaining variations in market valuation and operating results (Boiko, 2022; He et al., 2023).

Moreover, publicly listed pharmaceutical firms face stronger disclosure obligations, environmental, social, and governance (ESG) pressures, and governance requirements – amplifying the potential influence of board diversity on monitoring innovation investments and mitigating agency conflicts in long-horizon projects (Brazilian Stock Exchange [B3], 2023; Sanad et al., 2023). Thus, analyzing these relationships within the mentioned companies provides a theoretically and practically relevant setting for assessing how innovation and diversity jointly shape both market and accounting outcomes.

In addition to these aspects, examining R&D and board diversity together is theoretically coherent because the scale and timing of innovation investments interact with the cognitive and demographic attributes of those who allocate and monitor these resources. R&D intensity signals a long-term search for technological breakthroughs under uncertainty. In turn, gender and age-based diversity endow boards with heterogeneous information processing and oversight capabilities that shape selection, evaluation and disclosure of innovation paths (Wu et al., 2022; Sierra-Moran et al., 2024). In this sense, integrating these perspectives settles the governance conditions under which pharmaceuticals R&D are more effectively converted into value creation and financial performance (Malerba & Orsenigo, 2015; Boiko, 2022).

Although value creation and financial performance are often considered as related metrics, they capture distinct yet complementary dimensions of outcomes. Market-based value reflects investors' forward-looking expectations about future benefits shaped by strategic positioning, innovation intensity, and governance attributes (He et al., 2023). On the other hand, accounting-based performance reflects realized operating efficiency and the short-term financial consequences of managerial choices (Boiko, 2022). Therefore, examining both in parallel is essential.

Schumpeterian theory indicates that innovation moves long-term value before short-term earnings respond (Schumpeter, 1934). In turn, the resource-based view (RBV) suggests that heterogeneous resources – such as diverse boards – affect expectations and realized results through different mechanisms (Barney, 1991). Moreover, upper echelons theory links demographic attributes to strategy development and implementation (Hambrick and Mason, 1984). Finally, the integration of these theories with agency one explains why board diversity moderates the effects of innovation on value creation and financial performance. Together, they support this study's hypotheses (Sierra-Moran 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. Previous research identified 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 (Jhunjhunwala et al., 2021). In addition, the primary role of board directors is 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, Farooq and Ahmad (2023) point to a negative relationship with financial performance, while Foster et al. (2023) show no statistical significance to companies´ value creation. 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. It should be noted that these results were obtained by companies that do not necessarily operate in the pharmaceutical industry.

Such results indicate a lack of consensus about this topic (Mack et al., 2025). Therefore, this study aims to add to this discussion by analyzing 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 (2024) and World Bank, during the period from 2015 to 2022. The hypotheses are tested through a panel data regression with fixed effects and year dummies, being 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.

## 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.

### 2.1. Theoretical Background

This study draws on four complementary theories – Schumpeterian economic development, RBV, upper echelons and agency – to explain how innovation and board diversity jointly shape value creation and financial performance (Schumpeter, 1934; Jensen & Meckling, 1976; Hambrick & Mason, 1984; Barney, 1991). Schumpeterian theory identifies innovation as the main driver of economic growth, while acknowledging that its path-dependent and uncertain nature results in divergent returns over time (Schumpeter, 1934; Coad & Rao, 2010; Boiko, 2022). On the other hand, from a RBV standpoint, board diversity – an intangible, hard-to-imitate human capital resource – enhances firm's ability to sense, select, and reconfigure innovation paths. These features are priced by markets and reflected in operational performance (Barney, 1991; Wu et al., 2022; Sierra-Moran et al., 2024).

In turn, upper echelons adds that directors' demographic attributes shape strategic choices, risk postures, and information processing – affecting both market value and implementation quality (Hambrick & Mason, 1984; He et al., 2023). Finally, agency theory highlights boards' role in mitigating intertemporal conflicts – especially the tension between short-term earnings and long-term R&D investments. Thus, board composition – including its diversity – influences monitoring, incentive alignment, and disclosure around innovation (Jensen & Meckling, 1976; Sanad et al., 2023). Taken together, these theories imply that innovation and diversity impact value creation and the financial performance of companies. Furthermore, diversity also has a moderating effect on innovation (Wu et al., 2022; He et al., 2023; Sierra-Moran et al., 2024).

### 2.2. Hypotheses Formulation

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. On the contrary, it stems from its strategic positioning, being influenced by the intuition of decision-makers. Moreover, the future outcome of innovation is not guaranteed (Coad & Rao, 2010).

According to 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. 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.

Prior research shows that the effect of R&D on outcomes is theoretically indeterminate, precluding a strictly positive or negative hypothesis. On one hand, innovation investments can enhance market value and, in some contexts, operational results, consistent with investors' expectations of future growth (Wu et al., 2022; Chen et al., 2023). On the other hand, R&D entails high costs, long maturation, and substantial uncertainty – particularly in pharmaceuticals – yielding negative or null short-term financial outcomes in some studies (Moura et al., 2022; Safiullah et al., 2022). Hence, the direction is inherently ambiguous across firms, industry settings, and horizons. Consequently, the following hypotheses are formulated:

*H1a – Innovation affects the value creation of pharmaceutical companies*

*H1b – Innovation affects the financial performance of pharmaceutical companies*

Furthermore, the RBV theory 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 is done and the company's relationship with the other stakeholders (Farooq & Ahmad, 2023).

It also dialogues with the theory of upper echelons, which suggests that the firm reflects 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; Ermawati & Dianawati, 2024). 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). 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).

It is worth mentioning that gender and age are not the only features of demographic diversity. Religion, educational background, sexual orientation, state of origin, number of children, marital status, for example, are also diversity characteristics. Nevertheless, previous studies have considered these two proxies more frequently given the restrictions on obtaining this other information. According to Sierra-Moran et al. (2024), the prevalence of diversity associated with gender and age is explained by the data availability. This restriction also applies to this study.

Similarly, theory and evidence do not converge on a single directional effect of board diversity. Some studies report positive associations – via improved monitoring, deliberation, and stakeholder alignment – enhancing market valuation or financial performance (Wu et al., 2022; He et al., 2023; Chen et al., 2023). Others find null or negative associations, suggesting that demographic heterogeneity may slow down decisions, increase conflict, or reflect symbolic rather than substantive change (Farooq & Ahmad, 2023; Foster et al., 2023). Given these divergent findings and the contingency on institutional, cultural, and industry conditions, the effect cannot be assumed unambiguously positive or negative. Therefore, the arguments above support the following hypotheses:

*H2a – Diversity affects the value creation of pharmaceutical companies*

*H2b – Diversity affects the financial performance of pharmaceutical companies*

In turn, 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 will benefit another generation of executives instead. 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 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 (Sanad et al., 2023). The conflict established between the parties arises from the following aspects: i. the expenses destined for 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; Jhunjhunwala et al., 2021; Wu et al., 2022).

Actually, Sanad et al. (2023) found that board gender diversity positively affected R&D investment projects of pharmaceutical industry. Sierra-Moran et al. (2024) obtained same result for different types of industries. However, they didn´t investigated the moderating effect of diversity and innovation upon companies' financial outcomes. Nevertheless, this interaction is supported by RBV, upper echelons and agency theories. Cognitive biases influence how investment decisions are made, and those decisions of top management members lead to corporate value creation and financial performance outcomes.

The joint examination of R&D expenditure and board diversity is particularly meaningful in pharmaceuticals. To them, the innovation-driven value creation depends on both the scale and timing of technological investment, as well as on the cognitive and demographic composition of those who oversee it. R&D intensity reflects commitment to novel drugs and technologies amid uncertainty, long cycles, and regulatory complexity, while gender and age-based diversity shapes judgment, risk tolerance, and monitoring of resource allocation.

Integrating innovation and diversity is consistent with Schumpeterian economic development (innovation fuels expectations), RBV (diversity as a non-replicable resource that enhances decision quality), upper echelons (diverse directors shape selection, evaluation and communication of innovation), and agency theories (heterogeneity can strengthen or weaken oversight of long-horizon R&D). This integration provides the conceptual basis for H3's moderating mechanism in linking innovation to value creation and financial performance in the pharmaceutical context.

However, the direction of board diversity's moderating effect on the R&D – outcomes link remains theoretically uncertain, supporting different possibilities. Diversity may strengthen R&D effectiveness by improving evaluation of complex information, broadening perspectives on scientific and market uncertainty, and fostering balanced risk-taking mechanisms – aligned with RBV and upper echelons (Wu et al., 2022; He et al., 2023; Sierra-Moran et al., 2024).

It may also reduce agency frictions, sustaining commitment to long-term projects despite short-term performance pressures (Jensen & Meckling, 1976; Sanad et al., 2023). Conversely, greater heterogeneity can slow decisions, heighten conflict, or raise risk aversion under high technological uncertainty, dampening the translation of R&D into results (Farooq & Ahmad, 2023; Foster et al., 2023). Given these competing mechanisms and mixed evidence, we investigate diversity as a moderator without imposing a predefined directional expectation.

*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*

In summary, while Schumpeterian economic development supports H1 and RBV and upper echelons support H2, their integration with agency theory explains why board diversity moderates the effects of innovation on value creation and financial performance, as formulated in H3.

### 2.3. Empirical Review

Table 1 present a summary of empirical studies' results that are comparable to this one. The dependent variables of value creation proxies are Tobins' Q (TOBQ) and market to book value ratio (MBV). Moreover, the dependent variables of 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 variables' description is presented in Table 2.

Regarding the first four studies – with value creation dependent proxies – two of them show a positive and statistically significant relationship with innovation. Such results instigate the formulation of *H1a – Innovation affects the value creation of pharmaceutical companies*. However, regarding the relationship with board diversity, none of them 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 no 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.*

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.

About 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 of He et al. (2023) test 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).

Still in Table 1, the four last studies have financial performance as the dependent proxy. Two of them present contradictory results regarding the relationship with innovation (RDS) and board diversity (DSCR). 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* and *H2b – Diversity affects the financial performance of pharmaceutical companies*. Finally, once again, there is no research 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*.

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 is 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.

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 other 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.

| Variables | Tobin's Q | | | | Market to Book Value | | | | ROA | | | | ROE | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Dai et al. (2022) | | Foster et al. (2023) | | He et al. (2023) | | Ermawati & Soewarno (2024) | | Chen et al. (2023) | | Khan et al. (2023) | | Safiullah et al. (2022) | | Farooq & Ahmad (2023) | |
| | SI | SS | SI | SS | SI | SS | SI | SS | SI | SS | SI | SS | SI | SS | SI | SS |
| RDS | + | 1% | n/a | n/a | + | 5% | n/a | n/a | + | 1% | n/a | n/a | – | 10% | n/a | n/a |
| DSCR (a) | n/a | n/a | – | n/s | + | n/s | + | n/s | + | 1% | + | n/s | + | n/s | – | 1% |
| DSCR* RDS | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| SIZE | – | 1% | + | 1% | – | 1% | + | 5% | + | 10% | + | 1% | + | n/s | + | s/s |
| LEV | – | 1% | n/a | n/a | – | 1% | + | n/s | n/a | n/a | + | 1% | – | 10% | – | 1% |
| AGE | + | 1% | n/a | n/a | – | 1% | + | 5% | + | 1% | + | 5% | 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 | 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 | n/a | n/a | n/a | n/a |

*Notes:* SI – Sign; 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 2; (b) The proxy for innovation in this study is the Neperian logarithm of research and development expenses

*Table 1. Synthesis of similar empirical studies*

## 3. Methodology

The final sample of this study is composed of 92 publicly traded companies that belong to the pharmaceutical industry, located in 24 countries. Of these, China (21), the United States (20) and Japan (15) account for 56 companies. Data is 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. The econometric software used is Stata. The data is analyzed by descriptive statistics – see Table 3. It's worth noting that the data panel is highly balanced, except for the research and development over sales (RDS) variable. Therefore, there was no need to treat missing values.

The hypotheses are verified through a regression with panel data, including fixed effects and a dummy of time to overcome possible endogeneity problems. The main regressions have Tobin's Q and the return on asset as dependent variables, as proxies for value creation and financial performance, respectively. Robustness tests employ alternative proxies of market to book value for value creation and return on equity for financial performance.

Regarding the possible existence of multicollinearity between the explanatory variables, the variance inflation factor (VIF) test was run, and all values are less than 6. This confirms the absence of multicollinearity (VIF < 10). Furthermore, any heteroscedasticity problems in the residuals were corrected using fixed effects with robust errors (Cameron & Trivedi, 2022). Equation 1 presents the study's econometric model, while Table 2 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)
$\beta_0$ = the coefficient for the intercept term
$\beta_1$ to $\beta_4$ = the coefficient of explanatory variables
$i$ = firm
$t$ = year
$u$ = error term

| Acron | Name | ES | Formula | Components | Source | References |
|---|---|---|---|---|---|---|
| **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<br>TD = Total debt<br>TA = Total assets | CIQ | Foster et al. (2023); Khan et al. (2023) |
| 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<br>TE = Total equity | CIQ | He et al. (2023); Ermawati and Soewarno (2024) |
| **Dependent variables – Financial performance** | | | | | | |
| ROA | Return on assets | n/a | ROA = EBIT/TA | EBIT = Earnings before interest and taxes<br>TA = Total assets | CIQ | Chen et al. (2023); Khan et al. (2023) |
| ROE | Return on equity | n/a | ROE = NI / TE | NI = Net income<br>TE = Total equity | CIQ | Khuong et al. (2022); Farooq and Ahmad (2023) |
| **Independent variable – Innovation** | | | | | | |
| RDS | Research and development over sales | +/– | RDS = R&D/REV | R&D = Research and development expenses<br>REV = Operating revenue | CIQ | He et al. (2023); Khan et al. (2023) |
| **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 | Foster et al. (2023) |
| **Firm control variables** | | | | | | |
| SIZE | Size | + | SIZE = ln (TA) | ln = Natural logaritm<br>TA = Total assets | CIQ | Foster et al. (2023); He et al. (2023) |
| LEV | Leverage | – | LEV = TD / TA | TD = Total debt<br>TA= Total assets | CIQ | Wu et al. (2022); Khan et al. (2023) |
| AGE | Age of incorporation | + | AGE = ln(CY – YF) | ln = Neperian logaritm<br>CY = Current year<br>YF = Year founded | CIQ | He et al. (2023); Khan et al. (2023) |
| **Country control variables** | | | | | | |
| GDPG | Gross domestic product growth | + | GDPG = $(GDP_t / GDP_{t-1}) - 1$ | $GDP_t$ = Gross domestic product of the current year<br>$GDP_{t-1}$ = Gross domestic product of the previous year | WB | Gerged et al. (2023) |
| 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 | Kaufmann et al. (2011); Gerged et al. (2023) |

*Notes:* Acron – Acronym; ES – Expected signal; CIQ – Capital IQ; BLO – Bloomberg; WB – World Bank. (*) The board of directors' diversity score is provided by Bloomberg under the code SR006.

*Table 2. Variable description*

The dependent variables capture distinct temporal dimensions. Accounting-based measures (ROA and ROE) reflect registered operating performance within a period (Boiko, 2022). On the other hand, market-based indicators (Tobin's Q and MBV) embed forward-looking expectations about profitability, innovation potential, and governance quality (He et al., 2023). In pharmaceuticals, high costs, uncertainty, and long cycles imply that R&D may depress short-term accounting returns, while supporting market valuation via expectations of future breakthroughs (Wu et al., 2022; Safiullah et al., 2022). Likewise, board diversity may also affect these metrics differently. It can strength market-based value through oversight quality and governance signaling, even when accounting performance adjusts more slowly (Chen et al., 2023; Foster et al., 2023).

## 4. Result Analysis

### 4.1. Descriptive Statistics

Table 3 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.

| 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 |
| gdpg | 736 | 0.0291 | 0.0370 | –0.1117 | 0.2448 |
| wgi | 736 | 0.7620 | 0.7538 | –1.0420 | 1.7721 |

*Table 3. Descriptive statistics*

Moreover, Table 4 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.

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

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

*Table 4. Correlation matrix*

### 4.2. Main Regression Tests

Table 5 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 confirm H1a, H2a and H3a.

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. 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. 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 (Sierra-Moran et al., 2024). 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 (Sierra-Moran et al., 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 (Sanad et al., 2023).

As for Models 4, 5 and 6, it is observed that only H1b 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).

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. 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 and H3b, 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. According to Khan et al. (2023), 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, 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.

| | TOBQ | | | | | | ROA | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Model 1 | | Model 2 | | Model 3 | | Model 4 | | Model 5 | | Model 6 | |
| Var. | Coef | Sig | Coef | Sig | Coef | Sig | 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.

*Table 5. Panel data results*

### 4.3. Robustness Regression Tests

Table 6 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 5, 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 H2a. 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 5, with a statistical significance not verified by He et al. (2023) and Ermawati and Soewarno (2024). 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 and H3a 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, as shown in Table 5. 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. Regarding hypotheses H2b and H3b, they are tested in Models 5 and 6, respectively. As in Table 5, 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 5 and corroborates the results obtained by He et al. (2023). 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.

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). 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.

| | MBV | | | | | | ROE | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Model 1 | | Model 2 | | Model 3 | | Model 4 | | Model 5 | | Model 6 | |
| Var. | Coef | Sig | Coef | Sig | Coef | Sig | 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.

*Table 6. Robustness tests*

Additionally, a two-stage generalized method of moments (GMM) Granger causality test was conducted for all dependent variables, including both the main and robustness regression analyses. The first test checks if X explains Y (H0: X does not cause Y), while the second one verifies if Y explains X (H0: Y does not cause X). In 11 of 12 tests, a bidirectional relationship was not verified, but rather a unidirectional (X causes Y) or independence relationship. Furthermore, the study by Mangalagiri et al. (2026) confirms that the financial performance of pharmaceutical companies does not show reverse causality with their sustainability practices, including the social and governance dimensions. The study by Wan et al. (2025) also confirms that investment in research and development improves the financial performance of companies in the pharmaceutical industry, with corporate governance playing a relevant mediating role in this process.

Finally, to avoid potential concerns regarding representativeness and the ability to adequately control for country-level heterogeneity, the same tests (main and robustness) were also run on a subsample composed of 56 companies only from China, United States, and Japan. The results were consistent with those obtained for the main sample composed of 92 companies from 24 countries.

## 5. Conclusion

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 moderate 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 5) and for the robustness tests (Table 6): *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 5 proves the theory of economic development that is obtained through the presence of continuous technological innovation promoted by companies. Regarding H3a, Table 5 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 6, 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.

This study challenge prior researches. Unlike them, it found a negative relationship between innovation and financial performance and a positive one between diversity and value creation. Indeed, investments in innovation constrain pharmaceutical companies' operating results in the short term. However, board of directors' diversity has proven crucial for long-term value creation, as suggested by the RBV and upper echelons theories.

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. An example of such policy is the Brazilian law no. 15,177/25 (Brazilian Law, 2025), which requires that 30% of full member positions on state boards of directors be filled by women.

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. varying institutional contexts – e.g.: emerging markets with limited female representation in leadership; ii. analysis of the impact of generative artificial intelligence tools on the results of companies; iii. comparison between publicly and privately held companies; iv. consideration of other proxies of innovation in the pharmaceutical industry – e.g., annual number of new product launches and v. analysis of alternative proxies of diversity and that contemplate other levels of governance in companies – e.g.: educational background, professional experience, ethnicity, nationality, cross-national board participation, compensation committee, internal audit, fiscal council.

## Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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## Authors' contributions

Carlos Henrique Firmino de Oliveira: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Writing - Original Draft, Visualization, Project administration.

Michele Nascimento Jucá: Conceptualization, Methodology, Validation, Formal analysis, Writing - Original Draft, Writing - Review & Editing, Supervision, Project administration, Funding acquisition.

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## Data availability

Data available upon request

## Use of Artificial Intelligence

This study did not use artificial intelligence (AI) resources or tools.

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