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CEO's FINANCIAL SOPHISTICATION AND R&D INVESTMENTS: EVIDENCE FROM COMPANIES LISTED ON B3

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ABSTRACT

This study analyzed the relationship between CEO's Financial Sophistication (FS) and the investments made in Research and Development (R&D), disclosed in the profit and loss statement and intangible assets. To this end, data were collected from companies listed on B3 from 2011 to 2019 on R&D and the personal characteristics of the CEO (experiences and training) from various sources. Factor analysis methods, probit regression models, and panel data with fixed effects were used for the analyses. It was found that, of the total sample, less than 20% of companies spend on R&D. Among the economic sectors, what most invest resources in R&D is information technology. As for the CEO's FS, the evidence found does not confirm the hypothesis of the relationship with R&D. However, the tests conducted with the academic and professional dimensions of FS pointed out that the CEO with higher levels of the professional dimension is likely to disclose R&D in the profit and loss statement. In contrast, the academic dimension of the FS has a weak negative relationship with levels of resources applied in R&D and recorded in the intangible assets.

Keywords: Professional experience. Intangible training. Profit and loss statement. R&D projects.

1 INTRODUCTION

Research and Development (R&D) is among the main business investment decisions, as success in developing new products, technologies, or internal processes leads the company to a

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competitive advantage, which adds value (Barker & Mueller, 2002). However, the decision to invest in R&D is complex. Given the inherent uncertainty in the process, it has high risks, mainly due to R&D expenses impersonating the evaluation of a temporal trade-off. In other words, expenditures incur in the short term with expected long-term returns (Góis et al., 2015). This temporal difference may reflect in conflicts of interest since there is the main objective – to seek long-term returns to ensure the perpetuity and financial health of the company; and the agent's parallel – to tend to seek short-term returns to maintain and/or improve their reputation in the position, achieving the performance required for the annual goal and, consequently, obtaining equivalent remuneration (regarding the existence of variable remuneration). Although there is this temporal mismatch, CEOs (*Chief Executive Officers*) understand that R&D investments are essential for the company's success in the future (Chen, 2013; Gonçalves & Lemes, 2018; Izidoro et al., 2020), which may affect their permanence in the long-term mandate. However, spending on R&D does not guarantee future profitability. It is an expectation of future economic benefits calculated based on forecasts (Gonçalves & Lemes, 2018).

Often, the financial statements do not communicate the real expectation of future profitability (Gonçalves & Lemes, 2018) to shareholders, which can occur due to regulatory rigidity and what is intended to be communicated by the company's responsible party, the CEO. The activation of R&D in the intangible account demonstrates that the company has a research project in the development phase and, therefore, there are expectations of future profitability (*CPC 04 R1*, 2010). This information should be interpreted positively by the market. On the other hand, the R&D expense shows that the company is in the research phase, or even in the development phase and that it is not possible to record it in the asset for many reasons that lead the company to believe there is a lot of uncertainty regarding the recovery of the amounts spent. Thus, this information can be interpreted positively initially because there is a project in the research phase. Still, if not activated, it starts to be interpreted negatively by the market over time. When R&D spending is recorded in the profit and loss statement, the recording strategy purely to reduce the income tax and social contribution tax base is not always the best choice. The expense activation and, subsequently, the write-off by amortization (which occurs in a specific account) when the asset does not present an indefinite useful life can be an interesting alternative for the company. If the project has an indefinite useful life, there is some certainty about the expectations of future economic benefits, so it is more interesting to keep it in the asset and let this information show.

CEOs are responsible for the profits and losses presented in the financial statements, so they act according to their reading of the business situation and what they want to show to the market (Hambrick & Mason, 1984). From the perspective of Upper Echelon Theory, R&D spending varies according to the observable characteristics of CEOs, as the strategies adopted to produce business results tend to reflect the cognitive basis of executives (Hambrick & Mason, 1984). Also, it is known that the CEO has the greatest power over business decisions. Although their decisions involve allocating resources, they must do it quickly, in other words, resorting to the cognitive basis. According to Agnihotri and Bhattacharya (2021), in emerging countries, the decision to do R&D can be even more complex, as there are more significant resource limitations, so an expert CEO can effectively decide. In this sense, the research by Custódio and Metzger (2014), Harymawan et al. (2020), and Bortoli and Soares (2021) highlight that CEOs with more excellent professional knowledge in finance tend to contribute more to decisions related to financial policy. Thus, the observable characteristics of the CEO related to professional experience and academic training in finance, called financial sophistication, can produce skills that help CEOs make complex decisions, such as in the decision to spend on R&D.

Therefore, if the CEO is financially sophisticated, they tend to pay attention to the importance of company continuity through expectations of future profitability on developing R&D projects. Thus, they have a cognitive basis for presenting this strategy via accounting

information. Thus, despite the complexity of activating R&D spending, it can be argued that the financially sophisticated CEO understands in more depth the financial statements and the meaning that such information conveys to users, especially to shareholders. For this reason, they tend to make a greater effort to promote research and to activate spending when the project is in development. In this context, this study aims to analyze the impact of the CEO's financial sophistication on R&D expenses, recorded in the profit and loss account and the intangible assets account of Brazilian companies listed on B3.

Researchers have shown interest in advancing the topic, more specifically in identifying the determinants of R&D. According to Barker and Mueller (2002), the business and property characteristics were explored internationally. However, the research ignored that the CEO characteristics could impact this vital business decision, this being an existing gap in the literature. Thus, in the last two decades, it has been admitted that the CEO is one of the main determinants in R&D spending, as they are responsible for decision-making and resource allocation (Agnihotri & Bhattacharya, 2021; Barker & Mueller, 2002; Chen, 2013; Custódio et al., 2017; Harymawan et al., 2020; Jiang & Liu, 2020). At the national level, existing research on the determinants of R&D spending also follows this path, seeking explanations in business and property characteristics (Góis et al., 2015; Jensen et al., 2004), so there is no research investigating the impact of CEO characteristics. Therefore, it is observed that there is still room for research that seeks to understand the determinants of R&D, and there is a gap in the need to investigate the characteristics of the CEO as a determinant. In particular, the characteristics of the CEO's financial sophistication contribute to investigating the form of record adopted, a theme not yet discussed.

This study is justified by the importance of understanding elements influencing companies to invest in R&D since this practice drives business performance. R&D projects can produce innovation by improving existing products, creating new products and technologies, or improving internal processes, benefiting society directly or indirectly and, consequently, reflecting on the country's economic development. In particular, the power granted to the CEO at the national level is admitted, and the importance of their financial sophistication for making complex decisions quickly and efficiently is understood. Therefore, it is crucial to understand the possible impacts of this strategic decision. Moreover, the CEO's importance cannot be summarized in the relationships that explain the scope of short-term business performance. Still, it should consider their influence on business perpetuity decisions, especially in a country with constant contractual renewal for the individual who occupies this position. Success in business perpetuity tends to reflect, in the second instance, on society and economic development. Hiring an individual with certain characteristics is a possible positive side effect. Also, studies such as this one can contribute to selecting and hiring a professional who has the potential to produce the expected reflexes in a company.

2 THEORETICAL FRAMEWORK AND PRESENTATION OF HYPOTHESES

Until 2008, R&D expenses were accounted for in deferred assets. However, after this period, there was a distinction in the disclosure between the R&D phases. Hence, a part was accounted for in intangible assets, a specific account for R&D investments, and another in R&D expenses (Gonçalves & Lemes, 2018). An intangible asset does not obtain physical substance but needs to result from a controlled event that generates an expectation of future profitability. Also, to be effectively recognized, intangible assets must likely expect future economic benefits over the useful life and be measured reliably. If the expense does not meet the above definition, it must be recognized as an expense when it is incurred. R&D expenditure can be fit as an internally generated intangible asset. To this end, the company must be able to classify it as: (a) research phase and (b) development phase. If it is impossible to make the classification, the

expense must be considered a research phase (in which the project is still being developed internally) and, therefore, recognized as an expense. This is due to the company's inability to demonstrate probable future economic benefits at this project stage. In contrast, in the development phase, the company must recognize the asset only if there is: interest of the company and technical feasibility to complete it to the point of leaving it in conditions for use or sale; ability to use or sell; expectation of future profitability and, therefore, must demonstrate the existence of the market for the product generated or if it will be used internally; availability of technical, financial, and other resources that are necessary; and ability to measure the expenses corresponding to the development of the asset with reliability (*CPC 04 (R1)*, 2010).

It is observed that *CPC 04 (R1)* (2010) is clear as to the criteria for activating R&D spending. Regarding R&D expenditure, there are also some crucial aspects to be noted for the in-depth understanding of the analysis of this study. Expenses obtained with intangible assets previously recognized as expenses cannot be recognized as assets later. Another critical issue is that the intangible asset with a defined useful life must be amortized (systematically until the use of the project ceases so that the asset's residual value is written off or disposed of). Still, the same does not occur if the asset's useful life is indefinite (and should not be amortized). The uncertainty of the useful life of an asset justifies the use of caution in estimating its life. However, one should avoid estimating such a short period that it eludes reality. Amortization should start only when the project is available for use. Write-off with amortization must be recorded in a specific amortization expense account. There are several methods of systematic asset amortization to appropriate the expense over the useful life. However, the company must choose the measurement method for asset amortization recorded as a "project under development", consistent with the consumption pattern of the future economic benefits generated. And when it is not possible to make such an estimate with reliability, the linear method must be used (*CPC 04 (R1)*, 2010).

In Brazil, Oliveira et al. (2019) found a negative relationship between R&D expenses and current abnormal return, concluding that this could be related to timeliness. That means investors prefer returns today to returns tomorrow. In this case, the expense demonstrates a reduction in the return expected momentarily. Nevertheless, this may also reflect the understanding that the recording of R&D in expenses occurs due to the high level of uncertainty of a project under development or when there are problems regarding compliance with the recognition criteria in the intangible asset (which means high uncertainty). Thus, it is understood that the form of recognition and disclosure can provoke different interpretations. For this reason, it is understood there is an important research gap open in Brazil, as it was not investigated what causes the distinct accounting of R&D. Most published studies use only the expenses recorded in a specific account of the Profit and Loss Statement (P&L) as an investment proxy with R&D since the (Izidoro et al., 2020; Oliveira et al., 2019)amount recorded in intangible assets can be obtained only in the analytical account available in an explanatory note(Góis et al., 2015; Oliveira et al., 2019), so few studies investigated the R&D of the two accounts (Hungarato & Teixeira, 2012; Gonçalves & Lemes, 2018). And no research using R&D as a dependent variable used the two forms of record as an object of investigation in the same study to contribute to the literature with a more in-depth analysis.

This study, therefore, focuses on analyzing whether R&D investments, accounted for in intangible assets and R&D expenses, can be impacted by the observable characteristics of the CEO's financial sophistication. According to Bortoli and Soares (2021), CEO's financial sophistication is defined by the set of financial knowledge acquired in the course of their academic and professional trajectory, composed of characteristics that tend to contribute to strategic decision making, such as R&D. Therefore, it is understood that: (1) the CEO training in the business area makes them averse to risk (Barker & Mueller, 2002; Harymawan, et al., 2020), in order to accept research projects with a greater propensity for development; in addition, both

(2) international training and (3) international experience allows viewing new opportunities for investment in R&D arising from global technologies and makes it easier to search for devices for the implementation of investment in R&D (Custódio et al., 2017; Jiang & Liu, 2020); (4) it is likely that CEOs with specific knowledge of the sector will see more R&D opportunities (Agnihotri & Bhattacharya, 2021); (5) experience in the financial sector can contribute to raising the necessary funds for implementing R&D projects since this is a limiting condition in developing countries, and Brazil has credit institutions with specific lines to foster innovation; (6) career experience in productivity, accounting, and finance functions, makes CEOs worry more about efficiency than the amount of spending in R&D (Barker & Mueller, 2002); and (7) the CEO experience in the mandate tends to offer qualified support for making investments in R&D, and the longer the CEO's term of office, the greater the absorbed organizational culture (Chen, 2013) and the feeling of responsibility with the perpetuity of the company, consequently the interest in ending their career with prestigious status (especially in countries where the CEO's mandate is continuously renewed). The CEO characteristics are important for companies to achieve short-term and long-term success (Harymawan, et al., 2020) since they can evaluate the temporal trade-off related to R&D.

From the context presented, it is believed that financially sophisticated CEOs (with technical knowledge about finance obtained through academic training and professional experience) are better able to make decisions about: (H1) conducting R&D and (H2) spending more resources on R&D, compared to their non- (or less) financially sophisticated peers. It is also worth remembering that R&D expenditure: (a) in intangible assets – refers to the project development phase. That means there is an expectation of returns in evident future cash flows, although it still has implicit uncertainty, it is lower than in the previous phase; (b) in expense – refers to the project research phase, that is, more significant implicit uncertainty in accounting while having the advantage of deducting the amount of this expense from the taxable calculation basis. Thus, the following hypotheses are presented:

H1(a): A positive and significant relationship exists between the CEO's financial sophistication and intangible R&D disclosure.

H1(b): A positive and significant relationship exists between the CEO's financial sophistication and R&D expense disclosure.

H2(a): A positive and significant relationship exists between the CEO's financial sophistication and the disclosed value of R&D in intangible assets.

H2(b): A positive and significant relationship exists between the CEO's financial sophistication and the disclosed amount of R&D expenses.

3 METHODOLOGICAL PROCEDURES

3.1 Sampling and data collection

To achieve the proposed objective and analyze the impact of the CEO's financial sophistication on companies' R&D investments, companies that were listed on the B3 (Brasil, Bolsa, Balcão) at some point in the period between 2011 and 2019 were selected. This period is justified by adopting the disclosure of the standardized information in the reference form by the companies promoted by the new S/A Law (Law No. 11.638/07 and 11.941/09), which was mandatory from 2010. However, there were many cases of missing information in the first year (2010) of disclosure, so it was decided to eliminate this period. With the total sample of companies collected, the exclusions were conducted according to the criteria described in Table 1.

Table 1
Research Sample

Selection criteria	Quantitative
Companies listed at some point in the period 2011 to 2019	452
(-) companies in the financial sector	81
(-) companies with insufficient financial data	2
(-) companies with insufficient CEO data	9
(-) holding companies in other companies	21
(-) duplicates	11
Final sample	328

Note. This Table describes the criteria for reaching the final sample used in the study analysis from 2011 to 2019. Duplicate companies are those that have changed their name or merged with another. For this reason, duplicates appear in the database. Financial sector companies and holding companies in other companies were excluded due to their characteristics biasing some of the variables in the study (for example, indebtedness and revenue).
Source: Research data (2022).

The data on R&D investments, activated by the companies, were collected directly from the explanatory notes, as there is the presentation of the "intangible asset" synthetic account in the financial statements (available on the website of the Brazilian Securities and Exchange Commission – CVM), but not its segregation. As for the data related to R&D expenses and control variables were extracted from the Refitiv Eikon® database. Information regarding the CEO's financial sophistication was collected on the companies' reference form, companies' website, LinkedIn, Bloomberg, Lattes curriculum, news portals, and internet interviews (G1, O Globo, Veja, Valor, Exame, and Estadão), and from the Refitiv Eikon® database.

3.2 Construction and measurement of the dependent variable

According to each of the two sets of hypotheses, changes in the form of measurement of the dependent variable were necessary, as they caused different interpretations. It was defined that the hypotheses with complementation "a" – are related to investment with R&D; and "b" are related to expenditure with R&D. Regarding the amounts collected directly in the intangible asset, they were sometimes segregated in R&D and project with R&D. Thus, they were added, constituting the variable corresponding to the investment with R&D. When testing one of these forms of record as a dependent variable, the other was considered as a control variable because once a possible relationship is expected, there would be a possible variable omitted. This tends to avoid possible endogeneity problems. For the first set of hypotheses, it was measured in a dichotomous way, in which "1" was assigned to the presence of the investment or expense and "0" otherwise(Santos et al., 2020). For the second set of hypotheses, the following method was considered: R&D expenses in the profit and loss statement were divided by the total asset (Kouaib & Jarboui, 2016); the values related to R&D found in the intangible asset were accounted for by discounting the value of the previous year (t_{-1}). This allowed the actual amount invested in the year in question to be captured. The result was divided by the total assets.

3.3 Construction and measurement of the independent variable

The CEO's Financial Sophistication (FS), used as a variable of interest in this study, is based on the study by Bortoli and Soares (2021). The calculation logic is to detect the level of distinct importance between the construct elements by weighting the factorial loads. Since this variable is composed of multiple items that represent the characteristics of managers, Confirmatory Factor Analysis (CFA) is the most appropriate method to test whether the measured variables represent a smaller number of factors (Hair et al., 2009). The R *software* (version 4.13) was used as an analysis tool. As the data referring to the characteristics of the CEOs are composed of numerical variables and dummies, which did not present normality, the estimator was used by the diagonal weighted least squares method (DWLS). The results obtained

for the fit tests of the elements to the factors were: *Model Test User Model* (χ^2 (9) = 36.138, p-value = 0.000); *Comparative Fit Index* (CFI) (0.972); *Tucker-Lewis Index* (TLI) (0.934); *Root Mean Square Error of Approximation* (RMSEA) (0.04); *Standardized Root Mean Square Residual* (SRMR) (0.026). Except for the Chi-Square test of the model (the null hypothesis that the correlation matrix of the data is equal to the correlation matrix of the factors was rejected), the other fit elements presented acceptable results according to the recommendations (Hair et al., 2009). The CFI (checks for discrepancies in the data and the proposed model) and TLI (assesses the relative reduction in the mismatch per degree of freedom of the model) tests above 0.9, as well as the RMSEA (represents the square root of the mean approximation error of the covariance matrix of the variables) and SRMR (represents the mean square root between the covariance matrix of the sample and model residues) tests below 0.8 indicate a favorable fit of the data to the factors.

Thus, the factorial loads corresponding to each of the items of financial sophistication were obtained, so it was decided to parameterize the loads by assigning a score for each item, whose total of the weights of the summed items results in 100% to form the index of financial sophistication. The results of the score assigned to each element can be seen in Table 2.

Table 2

Percentage of corresponding importance of the item for financial sophistication

Dimension	Weight	Characteristic	Weight
Professional	57.08%	Experience as CEO	10.64%
		Experience as Chief Financial Officer	18.09%
		Experience in the financial sector	18.41%
		Experience in the field	9.95%
Academic	42.92%	International experience	15.28%
		International training	13.13%
		Financial training	14.51%

Source: Research data (2022).

3.4 Control variables

Size (TAM). Managers of larger companies may be more likely to invest more in R&D due to their own interests (Izidoro et al., 2020). Besides, larger companies have a better structure, better credit access conditions, and information (Góis et al., 2015; Harymawan et al., 2020). Thus, larger companies are expected to make more investments and obtain more expenses with R&D. The company size is calculated by the natural logarithm of the total asset (Izidoro et al., 2020).

Cash and cash equivalents (CCE). CEOs of companies with more resources available in cash tend to invest more than those that find themselves in a restricted situation of such resources. Thus, companies with more cash and cash equivalents resources are expected to make greater investments and obtain more R&D expenses (Harymawan, et al., 2020). This variable was used to measure cash and cash equivalents on total assets (Kim et al., 2022).

Indebtedness (IND). Companies with large amounts of third-party capital enable investments in larger amounts in R&D (Góis et al., 2015; Harymawan et al., 2020; Kim et al., 2022), and managers seek to invest these resources in projects that generate future benefits. Therefore, a positive relationship is expected so that more indebted companies make greater expenses with R&D. To calculate the indebtedness, the total liability value was divided by the company's total assets (Glova & Mrázková, 2018).

Company age (AGE). Younger companies tend to obtain greater investment needs in R&D projects than older companies already established in the market (Harymawan, et al., 2020; Kim et al., 2022). A negative relationship is expected between the company's age and R&D. The

company's age will be represented by the natural logarithm of the number of years since the company is listed on the stock exchange.

Revenue variance (ΔRT). Revenue variance was used to determine the company's investment level in R&D (Kim et al., 2022). The reason for this is that this variable controls the growth of R&D spending due to the product life cycle. In other words, the investments made in new product research. Therefore, greater variances in revenue are expected to cause the company to invest less in R&D. The variance is calculated by dividing the revenue for year t by year t-1.

Performance / Return on Assets (ROA). The company's current performance can impact the decision to spend on R&D since it will determine the ability to continue with the R&D project until it is in conditions of use or sale. Thus, if the company does not see a good current performance, it tends not to make R&D expenses, and the opposite is also valid, so a positive relationship is expected. Also, a positive ROA represents that the company had taxable profits. Hence, the variable also controls whether the existence of taxable profits leads the CEO to prefer to record with R&D in the profit and loss statement to take advantage of the tax incentive or not (compared to the result of the regression that has R&D of the intangible asset as a dependent variable). Performance is measured through ROA, which is calculated by the ratio of net income to total assets(Góis et al., 2015; Harymawan et al., 2020).

Regulated sector (RS). The Brazilian National Electric Energy Agency (ANEEL), through the Manual of the Research and Technological Development Program of the Electric Energy Sector, and in compliance with Law No. 9.991 of 2000, established guidelines for companies in the electricity sector to apply a minimum value in investment in R&D annually. Therefore, controlling the electricity sector through a dummy variable is necessary, assigning 1 to the electricity sector and 0 to the other sectors (Góis et al., 2015).

Economic Policy Uncertainty (EPU). It was considered necessary to control an economic variable due to the impacts that the economic environment causes on corporate investments. Companies facing economic uncertainty delay their crucial investment projects, especially in R&D, where spending is irreversible (Jiang & Liu, 2020). In addition, periods of uncertainty impact the country's interest rate and inflation, leading companies to postpone investments. Therefore, it is understood that the EPU has a negative relationship with the amount invested in R&D. This variable was extracted from the website "www.policyuncertainty.com", referring to the data calculated for Brazil monthly. To use the EPU in the models of this research, it was necessary to transform the index, considering a weighted average of the index of months for the analysis period (Schwarz & Dalmácio, 2020), so that it was transformed to year for use in this study, as in equation 1. Weighting occurs because more recent uncertainty levels may have a stronger effect (Schwarz & Dalmácio, 2020).

$$EPU = \frac{\sum EPUBR_m \times weight_m}{\sum weight_m} \quad (1)$$

Where EPUBR is the index of EPU referring to Brazil in month *m*.

3.5 Econometric model

The models below were constructed to test the hypotheses proposed in this research. The variable of interest used here – CEO's financial sophistication (FS), is the result of confirmatory factor analysis. The main objective of this study is to verify the relationship between CEO's FS and R&D investments translated as the expenses disclosed by companies. That means it is intended to analyze whether the previous experience or the manager's academic background impacts the level of investment in R&D projects. Thus, the first set of hypotheses (H1a and H1b) aims to test the relationship between the CEO's FS and the disclosure of R&D in the intangible assets (H1a) or profit and loss statement (H1b). As the dependent variable, in this case, is

dichotomous, it was necessary to use an appropriate method to test the probability of the CEO making investments in R&D. Also, the observations regarding R&D are restricted to a small number of companies so that the most appropriate method for estimating is a *probit* model for panel data (Cameron & Trivedi, 2009). Thus, the dichotomous dependent variable can vary between individuals and over time.

$$Pr(R\&D_{i,t} = 1) = F(\beta_0 + \beta_1 FS_{i,t} + \beta_2 CONT_{i,t} + \beta_3 SIZ_{i,t} + \beta_4 CCE_{it} + \beta_5 IND_{i,t} + \beta_6 AGE_{it} + \beta_7 \Delta RT_{it} + \beta_8 EPU_t + REG + n_{i,t}) \quad (2)$$

Where *R&D* is "1" when company *i* in period *t* discloses investments (H1a) or expenses (H1b) (tested two models in which the dependent variable assumes investments/expenses according to the hypothesis) in R&D and "0" otherwise. FS represents the financial sophistication of the CEO of the company *i* in period *t*, the coefficient β_1 measures the relationship between the variable of interest of the study and the probability of the company investing in R&D, CONT represents the control made for investment when the dependent variable is expense, and expense when the dependent variable is an investment, *n* is the specific error term at the company level. The control variables are described in topic 3.4.

The second set of hypotheses (H2a and H2b) aims to test the relationship between the CEO's FS and the disclosed value of R&D in the intangible asset (H1a) or profit and loss statement (H1b) and the panel data method was used since the data vary between individuals and over time.

$$\frac{R\&D_{i,t}}{TA_{i,t}} = \beta_0 + \beta_1 FS_{i,t} + \beta_2 CONT_{i,t} + \beta_3 SIZ_{i,t} + \beta_4 CCE_{it} + \beta_5 IND_{i,t} + \beta_6 AGE_{it} + \beta_7 \Delta RT_{it} + \beta_8 EPU_t + n_{i,t} \quad (3)$$

The dependent variable in equation 3 is the total R&D disclosed by company *i* in period *t*, either as investments in intangible assets (H2a) or expenses (H2b) in the profit and loss statement. TA is the total asset.

With the aid of Stata 16 software, the panel model for fixed effects was used for the analyses. The decision for fixed effects was based on the following tests, with their respective results: Chow (F (309, 1875) = 32.14 p-value = 0.0000) in favor of fixed effects; Breusch-Pagan test (p-value = 0.0000) in favor of random effects; Hausman's specification (p-value = 0.0156) in favor of fixed effects. As the sample was also composed of companies not listed throughout the analysis period (to avoid problems with survival bias), it was necessary to use an unbalanced panel. Except for the variables related to the financial sophistication index, the sector, and the EPU, all others were winsorized at 1% to avoid outlier impacts.

4 Analysis and discussion of results

4.1 Descriptive statistics

Table 3 shows the number of companies in the sample that disclosed R&D in their financial statements per year.

Table 3

Companies that reported R&D expenditures by accounts and year

Accounts	2011	2012	2013	2014	2015	2016	2017	2018	2019
R&D in EN	12	17	20	23	24	28	24	28	36
R&D at P&L	13	15	16	17	15	18	21	22	23
Sample per year	278	286	295	308	319	324	325	325	327

Note. Sample per year refers to the total number of companies (observations) with data available in the year (column). For example, in 2011, of the 278 companies in the sample, 12 disclosed R&D in the explanatory notes, and 13 disclosed R&D in the P&L.

Source: Research data (2022).

It is possible to observe that most companies that reported spending on R&D did so in the intangible assets. When considering the total number of companies that disclosed R&D in the Explanatory Notes – EN (intangible assets) and P&L, it is noted that the number of companies that disclose R&D is close to that observed in the study by Oliveira et al. (2019) (44 companies). However, the number of companies that disclose R&D is far below what is found in international studies. This highlights the importance of best practices for disclosing these investments (Oliveira et al., 2019). It is also noted that the number of companies that disclosed R&D increased in the last years of the period in all accounts analyzed. This may indicate that companies that did not invest started to invest in R&D. Nonetheless, this fact may also mean that companies that did not disclose R&D in previous periods started to do so. Table 4 shows the descriptive statistics by sector and variables used in the research.

Table 4

Descriptive statistics for the period 2011 to 2019

PANEL A – total R&D by sector					
Sector	**Observations**	**Mean**	**Standard D.**	**Minimum**	**Maximum**
Public utility (Electricity)	89	0.003	0.003	0.002	0.018
Cyclical consumption	68	0.015	0.023	0	0.098
Non-cyclical consumption	17	0.002	0.002	0	0.08
Industrial goods	98	0.006	0.009	-0.001	0.035
Health	35	0.024	0.035	0	0.11
Basic materials	34	0.002	0.003	-0.001	0.012
Oil, gas, and biofuels	31	0.023	0.032	0	0.148
Information Technology	39	0.084	0.093	-0.001	0.245
Total	411	0.017	0.040	-0.001	0.245
PANEL B – statistics by total sample variable					
Variable	**Observations**	**Mean**	**Standard D.**	**Minimum**	**Maximum**
FS	2317	0.244	0.173	0	0.945
Professional FS	2317	0.148	0.111	0	0.531
Academic FS	2317	0.096	0.126	0	0.429
R&D of the total sample	2310	0.002	0.011	-0.001	0.084
Size	2310	21.467	1.856	16.579	25.655
Cash and equivalents	2310	0.070	0.078	0.000	0.415
Indebtedness	2310	0.829	0.990	0.094	8.236
Revenue variance	2241	0.121	0.518	-0.984	3.791
ROA	2310	-0.001	0.163	-0.957	0.263
Age	2310	2.321	0.843	0.000	3.912

Note. FS – Financial Sophistication.
Source: Research data (2022).

In panel A, the economic sectors are classified according to the criteria of B3. The statistics referring to the sectors only consider observations of companies that spent on R&D during the analysis period. It is noted that, on average, companies invested 1.7% of their total assets in R&D. However, when considering the total sample, this value is close to 0.2% (panel B), similar to that found by Oliveira et al. (2019). The public utility sector, in which only electric power companies were present, presented a result similar to that found by Izidoro et al. (2020). Besides, an interesting fact about the electricity sector (regulation given by Law No. 9.991) is that of the 49 companies that are part of the sector, only 33 disclosed R&D spending, indicating a lack of disclosure or non-compliance with said law. The information technology sector stands out the most, with 8.4%. In panel B, it is observed that CEOs, on average, are 24% financially

sophisticated, considering a maximum of 100%, and the professional dimension (14.8%) exceeds the academic dimension (9.6%). This may mean companies are inclined to prioritize hiring CEOs with more experience than academic backgrounds.

The next step of the analyses was to test the hypothesis that financially sophisticated CEOs are more likely to spend on R&D. To this end, a *probit* regression with random effects was run since it was impossible to use fixed effects for this method. Models are estimated using robust standard errors per company to mitigate problems with heteroscedasticity and serial autocorrelation. The results can be seen in Table 5.

Table 5

Results of probit regression

	Dependent variable – R&D disclosure = 1					
	P&L		**Intangible assets**		**Total**	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
FS	-0.062		-1.091		-0.034	
	(0.825)		(1.716)		(0.640)	
Professional FS		2.477***		-1.424		0.919
		(0.961)		(2.570)		(0.989)
Academic FS		-1.453		-0.906		-0.617
		(1.249)		(2.027)		(0.965)
Active R&D/P&L	0.182	0.112	-0.431	-0.408		
	(0.621)	(0.721)	(1.770)	(1.749)		
Size	0.096	0.118	0.457	0.452	0.280***	0.292***
	(0.177)	(0.096)	(2.869)	(2.838)	(0.100)	(0.100)
Cash and equivalents	1.380	1.412	-4.004	-3.943	-0.547	-0.550
	(3.204)	(1.801)	(6.359)	(6.229)	(1.783)	(1.780)
Indebtedness	-0.449	-0.227	-0.630	-0.666	-0.505	-0.488
	(7.337)	(0.000)	(1.643)	(1.635)	(1.318)	(1.292)
Revenue variance	-0.268	-0.243	0.023	0.023	-0.143	-0.139
	(0.224)	(0.215)	(1.137)	(1.124)	(0.152)	(0.153)
ROA	0.394	0.625	1.272	1.297	0.672	0.699
	(6.778)	(1.186)	(4.111)	(4.105)	(1.997)	(1.990)
Age	0.250	0.162	1.149	1.173	0.671***	0.645***
	(0.234)	(0.211)	(2.980)	(3.037)	(0.252)	(0.250)
EPU	0.009	-0.038	0.038	0.040	-0.009	-0.020
	(0.326)	(0.311)	(1.837)	(1.832)	(0.248)	(0.248)
SR	1.677	1.758***	-2.183	-2.224	0.379	0.400
	(1.815)	(0.457)	(14.292)	(14.990)	(0.684)	(0.678)
Constant	-7.619***	-9.231***	-22.835	-22.755	-12.286***	-12.526***
	(0.196)	(2.840)	(122.885)	(122.225)	(2.713)	(2.697)
Observations	2,317	2,193	2,193	2,193	2,193	2,193
Wald test (p-value)	0.0026***	0.0008***	0.9605	0.9775	0.0530*	0.0593*

Note. FS – Financial Sophistication. RS - Regulated sector. Roa – Return on assets. EPU – Economic policy uncertainty. Robust standard errors are in parentheses. Significance: *** p<0.01; ** p<0.05; * p<0.1.
Source: Research data (2022).

Models 1, 3, and 5 were tested using the FS index. Models 2, 4, and 6 were independently tested using the professional and academic dimensions. Through the *probit* regression, it was not possible to confirm hypothesis H1, in which there would be a positive relationship between the CEO's FS and the disclosure of R&D. It is noted that there is no relationship between the FS variables and total spending on R&D (models 5 and 6), as well as in the spending of accounts in separate – assets (models 1 and 2) and P&L (models 3 and 4). However, when the FS constituted by the professional and academic dimensions was tested, a positive and significant relationship at the level of 1% was observed in model 2, indicating a tendency of CEOs with higher professional FS to disclose R&D in P&L. This demonstrates that the more experienced CEO is prone to show the market the projects that are in the research phase (CPC 04 classification). In

contrast, this has the advantage of deducting the amount of this expense from the taxable calculation basis. In addition, in line with the study by Agnihotri and Bhattacharya (2021), the CEO characteristics that make up the professional FS (experience in the financial sector as CEO and as Chief Financial Officer) contribute to increasing the manager's commitment to spending on R&D.

In Table 6, the H2 hypothesis set was tested where there is a relationship between the CEO's FS and the disclosed value of R&D.

Table 6

Regression results with fixed effects

	Dependent variable – R&D					
	P&L		**Intangible assets**		**Total**	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
FS	-0.003		-0.000		-0.010	
	(0.003)		(0.000)		(0.007)	
Professional FS		-0.001		-0.000		-0.010
		(0.004)		(0.000)		(0.010)
Academic FS		-0.004		-0.001*		-0.010
		(0.005)		(0.000)		(0.010)
Active R&D/P&L	0.050	0.044	0.001	0.001		
	(0.348)	(0.347)	(0.005)	(0.005)		
Size	0.004	0.004	-0.000	-0.000	0.009	0.009
	(0.003)	(0.003)	(0.000)	(0.000)	(0.006)	(0.006)
Cash and equivalents	0.017	0.017	-0.002*	-0.002*	0.022	0.022
	(0.021)	(0.021)	(0.000)	(0.000)	(0.038)	(0.038)
Indebtedness	-0.011*	-0.011*	0.000	0.000	-0.006	-0.006
	(0.006)	(0.006)	(0.000)	(0.000)	(0.011)	(0.011)
Revenue variance	-0.000	-0.000	0.000	0.000	-0.001	-0.001
	(0.001)	(0.001)	(0.000)	(0.000)	(0.002)	(0.002)
ROA	-0.011	-0.011	0.001	0.001	-0.015	-0.015
	(0.008)	(0.008)	(0.000)	(0.000)	(0.015)	(0.015)
Age	-0.007*	-0.007*	-0.000	-0.000	-0.017**	-0.017**
	0.004	0.004	(0.000)	(0.000)	(0.007)	(0.007)
EPU	-0.001	-0.001	0.000	0.000	-0.002	-0.002
	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)
Constant	-0.055	-0.056	0.004	0.004	-0.139	-0.139
	(0.055)	(0.055)	(0.004)	(0.004)	(0.109)	(0.109)
Observations	363	363	363	363	399	399
R^2	0.161	0.161	0.050	0.050	0.168	0.168

Note. FS – Financial Sophistication. ROA – Return on assets. EPU – Economic policy uncertainty. Robust standard errors are in parentheses. Significance: *** p<0.01; ** p<0.05; * p<0.1.
Source: Research data (2022).

Table 6 shows no relationship between the CEO's FS and the level of R&D spending. The variance in companies' R&D spending is not explained, to a significant extent, by the variance in the FS of their CEOs. However, it was possible to observe a weak negative relationship between the academic dimension and R&D expenditures disclosed in the intangible assets (model 4) at a significance level of 10%. This is in line with the findings of Harymawan et al., 2020, who finds that education in accounting negatively affects the level of investment in R&D. In a way, this may mean that training in finance makes managers more averse to investing in projects with risk or uncertainties, as in the case of R&D.

In the general context, the results do not indicate a significant relationship between the CEO's FS and the level of R&D, contrary to other studies that found a relationship (Agnihotri & Bhattacharya, 2021; Harymawan et al., 2020; Jiang & Liu, 2020; Kuo et al., 2018) for items that make up the FS.

However, it is necessary to emphasize that this finding does not rule out the possibility that managers' knowledge about finance, obtained through academic training and professional experience, can support them in making decisions about investments in R&D since the analysis through the *probit* model indicated a positive probability relationship between professional FS and R&D expenses, and a negative relationship between academic FS and the amount invested in R&D, in the models considering fixed effects. Hence, it is possible to infer that financially sophisticated CEOs are more inclined to record R&D expenses in the profit and loss statement, benefit from tax advantages, and not disclose in intangible assets, thus not transmitting the information of probable future returns to investors.

Unlike what was imagined, because the CEO has accounting and financial knowledge, CEOs with academic FS do not prefer activating spending and prefer to record it as an expense. It is understood that the gains from disclosing expectations of future profitability to shareholders could exceed the tax benefits. Nevertheless, precisely because these CEOs have accounting and financial knowledge, they prefer to comply with the legislation strictly, keep the record as an expense, and later consider activation. Concerning control variables, it is noted that the company's age variable (models 5 and 6) maintains a significant negative relationship (p-value<0.05) with the level of R&D, a result similar to that found by Jiang and Liu (2020). This suggests that younger companies invest larger amounts in R&D. The variables size and indebtedness presented weak significance (p-value<0.1), both negatively.

5 CONCLUSIONS

This study sought to analyze the impact of the CEO's Financial Sophistication (FS) on R&D expenses, recorded in the profit and loss account and in the intangible assets account, in a sample of Brazilian companies listed on B3, from 2011 to 2019. To this end, factor analysis multivariate techniques, *probit* regressions, and panel data with fixed effects were used. It was found that the proportion of companies that reported spending on R&D does not exceed 20% of the total number of companies on the stock exchange. This may mean that companies are not investing in R&D, or they invest but do not disclose these expenses in a specific account (intangible assets or P&L), according to the classifications of the R&D phase. The sector that invested the most relative to total assets was information technology, whose characteristics of the branch contribute to such practices. The electricity sector, regulated for investment in R&D, was composed of companies that did not disclose R&D in the analyzed period. As for CEO's FS, it was observed that Brazilian companies have CEOs with greater professional load – experiences in the field as CEO, in the financial sector, and as Chief Financial Officer – than academic – training in finance, international, and international experience – suggesting that companies prefer to hire a manager with such attributes.

The regression analyses made it possible to partially confirm the hypothesis (H1b) of the relationship between the CEO's FS and the disclosure of R&D in the P&L, where only the professional dimension was significant at the level of 10%. Regarding the level of spending on R&D, it was not possible to confirm the relationship (hypotheses H2). Therefore, it cannot be said that the financially sophisticated CEO produces a more significant effort to promote research nor to activate spending when the project is under development (according to the guidelines of CPC 04). However, this relationship is not ruled out, given the limitations of the sample and the characteristics of the Brazilian market, as there is an understanding that the CEO with more in-depth knowledge of the financial statements and experience in the financial sector contributes to applying resources in R&D projects, according to studies from developed countries (Harymawan et al., 2020; Jiang & Liu, 2020; Kuo et al., 2018). The evidence of this study allows us to advance the discussion on the determinants of R&D in Brazilian companies, and the results suggest that FS is not related to the levels of resources invested. The evidence

found aligns with the study by Jensen et al. (2004), which suggests that R&D investments behave randomly. For the market in general, the realization of investments in R&D does not seem to affect the investor's decision, except in the information technology sector.

Finally, this study is not without limitations. The Brazilian scenario presents a few listed companies that disclose R&D expenditures. Also, the legislation changed the way of accounting for these expenditures from 2010 (from deferred assets to intangible assets and P&L) so that many of the disclosed expenditures may not reflect the actual investment made in R&D but rather from past projects that made up the asset and started to be recorded in P&L, impacting the research result. It is suggested that future research analyze the same hypotheses raised in this study in a period more distant from the change in the accounting mentioned above legislation so that the impact of the change can be minimized and then verify the hypotheses raised with greater reliability. As the activation proportions increase, both in terms of values and the number of companies (especially in the first case), which may indicate greater usualness with the standard, the control of the impairment variable in the statistical model should be considered. It is noteworthy that the results found may be affected due to the high stockholding concentration existing in the Brazilian market, so the behavior of the financially sophisticated CEO in the academic and professional scope can be equally predictable, as it may demonstrate the real preference to use the tax advantage instead of transmitting the information of expectations of future profitability to minority stockholders. Thus, future studies should pay attention to the control of this variable or even test a possible moderation with CEO's FS. Finally, it is understood that the recording of R&D expenses is complex for activation so that they may be recorded as an expense in a specific account (or not); or that the records may be occurring properly, precisely because the CEO holds financial accounting knowledge. In this case, it may be interesting to conduct qualitative studies on the subject, with immersion in companies that record R&D and have CEOs with and without FS, to investigate the record of R&D spending further.

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