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ARTICLE

Understanding financial resilience through innovation and top management

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Abstract

Purpose – We aim to verify if and how the acquired academic characteristics of top management help firms withstand crises by examining the effect of CEOs' and board members' education and scholarly expertise on financial resilience through innovation.

Theoretical framework – We draw upon upper echelons, agency, and information asymmetry theories.

Design/methodology/approach – We collected data on the Brazilian stock market during the COVID-19 pandemic to observe the market during a crisis. Using a unique dataset of academic curricula, we estimate OLS and Cox regressions to examine the stability and flexibility of firms during the pandemic. We perform robustness checks through quantile regression to provide additional evidence for our findings.

Findings – We find that the acquired academic characteristics of top management have an impact on financial resilience. This relationship is sometimes moderated by innovation. Overall, innovation and top managements' acquired academic characteristics seem advantageous during a crisis, as their interaction strengthens these relationships.

Practical & social implications of research – This study provides evidence of the importance of top management to yet another organizational outcome: resilience. Our contributions are both theoretical and empirical, as we advance the discussions about financial resilience, corporate governance, and innovation, and deliver insights to practitioners and policymakers.

Originality/value – We are the first to uncover some of the determinants of financial resilience in Brazil, whose stock market tends to be more sensitive to shocks than those of more developed countries. Our study provides guidance to both investors and managers.

Keywords: financial resilience, innovation, acquired academic characteristics, board members, CEOs.

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1 Introduction

The characteristics of top management, such as board directors and chief executive officers, have a positive or negative impact on organizational outcomes. According to the upper echelons theory, executives' experiences, values, and personalities influence their managerial perceptions and, consequently, their strategic choices (Hambrick, 2007; Hambrick & Mason, 1984). Thus, information about their functional and educational backgrounds can be used to predict their decisions (Hambrick, 2007). Acquired characteristics, i.e., traits obtained from experience and education (Chen et al., 2023), have been shown to be relevant to firm performance (see, for instance, Peterson & Philpot, 2009; Fraga & Silva, 2012; Perlin et al., 2021; Habtoor, 2022).

During macroeconomic shocks, having highly educated and suitably experienced top management may be even more crucial. The impact of top-level management on the financial resilience of firms during crises has increased substantially in the context of the 2008 financial crash and the crisis caused by the COVID-19 pandemic. On the one hand, higher educational levels allow for a better understanding of complex situations, sounder judgment, identification of problems, and recognition of growth opportunities (Chen et al., 2023; Sidki et al., 2024). On the other hand, academic experience brings specialized knowledge (Peterson & Philpot, 2009; Perlin et al., 2021) that can improve the accuracy and reliability of corporate decision-making (Zhang et al., 2024).

Besides these apparent reasons why academics and well-educated executives might contribute to financial resilience, there are also key, less obvious reasons behind this relationship. The board of directors is at the heart of good corporate governance. It is responsible for preventing conflicts of interest, monitoring and advising management, and ensuring compliance in firm operations (Li et al., 2022; Shahid & Abbas, 2019). During crises, when agency conflicts and information asymmetry are more pronounced, the acquired characteristics of its members are especially important. The same goes for CEOs, who play a vital role in a firm's strategic decision-making (Naseem et al., 2020).

A firm demonstrates resilience when it can maintain above-average returns even after facing external shocks. However, to do so in the long run, firms need to foster competitive innovations (Teixeira & Werther, 2013). Thus, an important factor that can influence financial resilience is strategic emphasis on innovation before a shock occurs, something that executives can foster by activating innovation resources when a shock does occur (Engelen et al., 2024). For instance, existing evidence shows that the academic experience of CEOs drives corporate innovation, reducing the risk of corporate debt default (Zhang et al., 2024). Our research calls into question the value of top management's scholarly experience and education in building resilience through innovation and mitigating agency and information asymmetry problems by signaling to the market that the firm is capable of surviving potential disturbances. Such an analysis is particularly important in the context studied in this article. Brazil is a civil law country characterized by weak shareholder protection (La Porta et al., 2000; Martins & Novaes, 2012). Therefore, we are dealing with two aggravating factors of agency and information issues: financial disturbances and market insecurity. The aim of this article is to verify if and how top management's acquired academic characteristics help firms withstand crises by examining the effect of CEOs' and board members' education and scholarly expertise on financial resilience through innovation.

Our contributions to the literature are threefold. First, we examine the roles of both the board and CEOs in financial resilience. Our results support the upper echelons theory that top management's personal and academic characteristics matter, especially during times of asymmetrical information and agency problems. During crises, these characteristics provide the stability and flexibility that firms need to recover. Second, we included innovation in our analysis and found that it plays an important role in financial resilience by moderating the relationship between it and top managers' acquired academic characteristics. It is important to determine whether innovation is a good strategy during turbulent times or merely an unnecessary expense, at least from the principals' point of view. Third, the context analyzed is different from that of previous papers. Brazil, as a developing Latin American country, has a market that is more sensitive to macroeconomic shocks and struggles to recover as quickly as more developed countries. As a civil law country, Brazil is also more susceptible to agency problems and information asymmetry. Therefore, it is important to understand what can make companies more resilient in such circumstances. Additionally, we innovate by examining board members' and CEOs' acquired academic characteristics and by introducing innovation to the discussion.

Practitioners might also benefit from this paper. For managers, we show the importance of high-quality, educated executives and the interaction between universities and firms for organizational outcomes such as resilience. These findings are important for developing and implementing resilience-oriented strategies. Our results on innovation as a moderator are also important for developing effective strategies and building firms' resilience, so that they are ready to face financial shocks without being caught off guard. For investors, this paper is significant because it shows what to look for when deciding which companies are capable of maintaining decent returns in the event of a crisis. Evaluating companies goes beyond examining financial statements; investigating decision-makers is also valuable.

Moreover, it is important to point out the policy implications of this paper. The results show the importance of education and experience. For instance, scholars contribute to firm resilience when they are present in boardrooms. Thus, the paper suggests that (a) firms should invest in the education of their employees, as it will benefit companies even during crises; (b) top management should consist of high-quality, educated executives; and, hence, (c) policymakers should consider the findings of this paper to establish coherent policies on who is (not) capable of assuming top management positions in companies.

2 Literature review and hypotheses

The agency relationship consists of two parties: principals and agents. The former contract the latter to make decisions on their behalf (Jensen & Meckling, 1976). Since both parties are utility maximizers, their interests may not always align, resulting in agents acting against the best interests of the principal (Jensen & Meckling, 1976). Within the framework of agency theory, the chief executive officer (CEO) is the primary agent. What challenges the principal-agent relationship is the information asymmetry between the two parties, with shareholders (principals) being unaware of managerial actions and investment opportunities (Jensen & Murphy, 1990). For example, in the process of allocating capital to investment projects, managers are likely to have more information about their prospects, but they may also have incentives to withhold information (Stein, 2003).

However, from the perspective of upper echelons theory, executives' characteristics shape their interpretations of situations and their subsequent choices (Hambrick, 2007; Hambrick & Mason, 1984). This does not necessarily imply that executives will opt to maximize their own utility instead of that of the principals. The experiences, values, and personalities of top managers are responsible for different organizational outcomes, whether positive or negative. Thus, examining the characteristics of different executives in relation to firm outcomes is relevant, especially in a context of information asymmetry that does not permit the design of shareholder protection-oriented contracts (Jensen & Murphy, 1990). Understanding the traits and behaviors of top executives can serve as a crucial means to mitigate agency problems and safeguard shareholder interests.

This becomes particularly important when companies are under pressure. During macroeconomic shocks, for example, agency and information issues worsen. Therefore, during crises, the impact that top executives' characteristics have on mitigating such problems and enhancing firm resilience becomes even more relevant. CEOs play a crucial role in building firm resilience because they are key decision-makers in this process (Abatecola & Cristofaro, 2020; Sajko et al., 2021; Torres & Augusto, 2021; Wang et al., 2023). This is why existing literature has examined the impact of different CEO traits on resilience. Previous research has examined CEO narcissism (Buyl et al., 2019), greed (Sajko et al., 2021), duality (Torres & Augusto, 2021), and self-oriented perfectionism (Wang et al., 2023) in relation to resilience. Buyl et al. (2019) found that companies led by narcissistic CEOs experienced a slower recovery to pre-shock performance levels, while Sajko et al. (2021) found that, in addition to narcissism, greed is an important CEO trait that can affect resilience beyond risk-taking. This is because greedy CEOs build firms with weak stakeholder support and individualistic cultures due to their excessive focus on current earnings. Conversely, Torres and Augusto (2021) found that CEO duality seemed to have a positive effect on resilience. Self-oriented perfectionism in CEOs also facilitates firm resilience (Wang et al., 2023).

Another characteristic that may impact resilience is scholarly expertise. Although scholar CEOs and their academic experience act as an implicit governance mechanism, highlighting morality and integrity (Zhang et al., 2024), there is no evidence indicating how and whether CEOs' acquired academic characteristics influence resilience. We adopt Chen et al. 's (2023) definition of acquired characteristics as those obtained from education and experience, adding the academic factor in consideration of our focus on scholars.

Based on these assumptions and evidence, we hypothesize the following:

H1a: CEOs' acquired academic characteristics positively affect financial resilience.

Furthermore, in order to be resilient, a firm needs to be innovative. Resilient organizations emerge from the ability to continuously create competitive advantages based on innovations (Teixeira & Werther, 2013). In this sense, the acquired characteristics of CEOs may or may not boost the relationship between innovation and resilience. Current literature suggests examining whether these characteristics determine a firm's ability to mobilize innovative resources in response to a shock (Engelen et al., 2024). According to Zhang et al. (2024), one relevant acquired characteristic is the academic experience of CEOs, which can foster corporate innovation. Resilience would be a consequence of investing in innovation.

Moreover, the impact of CEOs' acquired academic characteristics on innovation, and consequently, resilience, could prevent the mitigation of the previously presented agency and information problems. Built-in information asymmetry in innovation investments intensifies agency costs (Chindasombatcharoen et al., 2023). However, due to their education and scholarly experience, CEOs might value innovation more, favorably evaluating innovative projects and investments and mitigating these agency costs. Thus, we hypothesize that:

H1b. CEOs' acquired academic characteristics positively affect financial resilience through innovation.

Based on agency theory, corporate governance mechanisms were designed to mitigate such conflicts and promote the welfare of principals. The board of directors is a corporate governance mechanism that enables the separation of the management and control of organizational decision-making (Fama & Jensen, 1983), ensuring principals' interests. As the board is at the apex of corporate governance mechanisms in modern organizations (Adams & Jiang, 2020) and is the key to firms' management monitoring (Fraga & Silva, 2012), the characteristics of board members that best fit the board's functions are important yet unresolved questions (Dong et al., 2019). The primary function of the board is to ensure effective governance and transparency in corporate decisions, and the quality of its performance hinges on the expertise of its members, among other factors (Perlin et al., 2021; Sidki et al., 2024). Therefore, expertise can affect board effectiveness, which consequently influences firm performance and, eventually, resilience. Additionally, guaranteeing that the board is prepared to deal with crises is an essential aspect of good governance (Armeanu et al., 2017). This is why the characteristics and expertise of different board members have been the focus of research to understand their impact on resilience.

Despite efforts to understand the role of different corporate governance mechanisms in resilience, including board composition and characteristics, there is still no evidence showing whether or how board members' acquired academic characteristics help organizations endure financial shocks and bolster resilience. Therefore, we formulate the following hypothesis:

H2a. Board members' acquired academic characteristics have a positive impact on financial resilience.

Moreover, in an increasingly competitive world, resilience could be the sole source of sustainable competitive advantages, but companies must continuously create competitive innovations to achieve it (Teixeira & Werther, 2013). Thus, resilience and innovation are closely related. The role of the board in promoting innovation has also been investigated. For instance, Chen et al. (2023) investigated the effect of board diversity on corporate innovation and found that inherent board diversity is positively associated with innovation output, whereas acquired and aggregated board diversity are positively associated with innovation factors. Considering the effect that board characteristics have on both innovation and resilience, it would be interesting to verify more robust relationships:

H2b. Board members' acquired academic characteristics have a positive impact on financial resilience through innovation.

3 Data and method

3.1 Data

We collected data on all Brazilian non-financial companies listed in 2019. Although the crisis discussed in this article started in 2020, we aim to determine if the acquired academic characteristics of pre-existing CEOs and board members contributed during the crisis.

To achieve this goal, four datasets were required to carry out the research, namely:

(1) the composition of boards and CEO information;

(2) financial statements of companies;

(3) the academic curricula of board members and CEOs;

(4) stock prices adjusted for dividends and all other corporate events.

For the first three datasets, we followed Perlin et al. (2021) and collected data for (1) and (2) from the B3's DFP (*Demonstrativos Financeiros Padronizados*) and FRE (*Formulário de Referência*) systems, using GetDFPData (Perlin et al., 2019) to download information on board members and CEOs and the financial data needed to compute the previously proposed variables. For the academic curricula (academic degrees and scholarly expertise), we extracted data from the Lattes platform, the main academic curriculum platform in Brazil. For the fourth dataset, we used EODHD data for stock prices, which enabled the computation of resilience. Datasets (1) to (3) were computed for the year before the crisis (2019), while dataset (4) considered data during the crisis (2020 and 2021) to measure resilience.

Our sample consisted of 348 non-financial, publicly traded companies (Supplementary Data 1 – Database). The cross-sectional dataset captures resilience during a specific crisis – namely, the COVID-19 pandemic. We aimed to determine whether pre-existing top management characteristics were relevant to firms when the crisis struck and, if so, whether innovation also contributed to resilience as previously outlined. Following DesJardine et al. (2019) and Xia et al. (2022), we excluded firms with missing stock data that enabled the measurement of resilience, as well as firms with missing severity of loss values. This variable is one of our proxies for resilience and will be discussed in the following section, along with the other variables used in this paper. Thus, our final sample comprises 160 firm observations.

3.2 Variable construction

Our dependent variable is resilience, which is assessed according to DesJardine et al. (2019). We use severity of loss (Model 1) and time to recovery (Model 2) to capture the stability and flexibility dimensions of resilience, respectively (DesJardine et al., 2019). Since resilience is more easily observed after a shock, we use the period of the COVID-19 breakout as the time during which the resilience of companies was under pressure. Studies on resilience typically begin their analysis on the day before shocks occur (DesJardine et al., 2019; Gittell et al., 2006; Xia et al., 2022). Examples include September 10, 2001, for the Twin Towers attack; September 16, 2008, for the global financial crisis (GFC); and March 10, 2020, for the start of the COVID-19 pandemic.

For the chosen variables, we follow the example of DesJardine et al. (2019), who studied the GFC. The authors defined severity of loss as "the percentage drop in a firm's stock price from the closing price preceding the global financial crisis (on September 16, 2008, considering the starting date of the GFC as September 17, 2008) to the lowest point of the stock price" and time to recovery as "the total time it takes for a firm's stock price to return to its level immediately preceding the start of the disturbance event" (DesJardine et al., 2019, p. 1457). We substitute the dates they used to address the COVID-19 shock as a more current period of turbulence. Specifically, on March 11, 2020, the World Health Organization declared COVID-19 a pandemic.

The independent variables are related to the acquired academic characteristics of CEOs and board members. Following Peterson and Philpot (2009), we define academic board members/CEOs as those who were professionally prepared for a career in and currently work for an educational or independent research institution. Following Sidki et al. (2024), we assess their education based on three criteria: degree level, Ph.D. status, and field of study. We address scholarly expertise in two different ways: experience as a scholar (Zhang et al., 2024) and contributions to research (Perlin et al., 2021).

The moderating variable is innovation, which is assessed as research and development (R&D) intensity (Silva et al., 2018). We control for size, leverage, industry, and corporate governance listing segment. Descriptions of the variables can be found in Table 1 below.

3.3 Model

To achieve the goals proposed in this study, we follow the literature on resilience and estimate two econometric models: ordinary least squares (OLS) (DesJardine et al., 2019; Xia et al., 2022; Yang et al., 2023; Engelen et al., 2024) and survival analysis through the Cox regression model (DesJardine et al., 2019; Sajko et al., 2021; Yang et al., 2023; Engelen et al., 2024).

Table 1
Research Variables

Variable		Measure	Inspired in
Dependent Variable			
Resilience	Severity of Loss	[(Minimum stock price between March 10, 2020, and March 10, 2021 – closing stock price on March 10, 2020) / closing stock price on March 10, 2020] – 1	DesJardine et al. (2019); Sajko et al. (2021); Wu et al. (2024); Xia et al. (2022)
	Time to Recovery	Number of days it takes for a firm's stock price to return to its pre-crisis level	DesJardine et al (2019); Sajko et al. (2021); Xia et al (2022)
Moderating Variable			
Innovation	R & D intensity	R & D investment / Sales	Silva et al. (2018)
Independent Variables			
Education	Board/CEO Univ. Degree	Percentage of board members with a university degree.	Sidki et al. (2024)
		Does the CEO have a university degree?	
		1- Yes, 0- No.	
	Board/CEO Ph.D.	Percentage of board members with a Ph.D.	
		Does the CEO have a Ph.D.?	
		1- Yes, 0- No.	
	Board/CEO Area	Percentage of board members with a degree in business, economics, or accounting.	
		Does the CEO have a degree in business, economics, or accounting?	
		1- Yes, 0- No.	
Scholarly Expertise	Board/CEO Scholar	Percentage of board members with experience in universities, research institutions, or associations.	Zhang et al. (2024)
		Does the CEO have experience in universities, research institutions, or associations?	
		1- Yes, 0- No.	
	Board/CEO Research	Percentage of board members who have published a scientific article.	Perlin et al. (2021)
		Has the CEO published a scientific article?	
		1- Yes, 0- No.	
Control Variables			
Size		Log of total assets	Freitas et al. (2020); Perlin et al. (2021); Pinheiro et al. (2017)
Leverage		Ratio of total financial debt to total assets	Vilhena & Camargos (2015); Ding et al. (2021); Perlin et al. (2021)
Industry		Matrix of dummies indicative of the sector in which company operates	Perlin et al. (2021)
Age		Log of the difference between year t and the year company i was founded	Perlin et al. (2021)
CG listing segments		Matrix of dummies that indicate whether or not company i is listed at different levels of corporate governance in year t	Perlin et al. (2021)

In the former, a positive coefficient suggests a milder drop in a stock price, implying higher stability. In the latter, a positive coefficient indicates a greater chance of recovery and, therefore, greater flexibility (Engelen et al., 2024; Yang et al., 2023). The estimated models adhere to existing literature on resilience (DesJardine et al., 2019; Yang et al., 2023; Engelen et al., 2024) and are given as

$$Resilience_i = \alpha + \beta_1 Innovation \times Education_i + \beta_2 Innovation \times ScholarlyExpertise_i + \Phi \sum Controls_i + \varepsilon_i \quad (1)$$

$$h(t) = \left(\frac{P(t, t+\Delta t)}{\Delta t} \right) \quad (2)$$

where h(t) is the hazard rate (probability of recovery) at time t, as suggested by DesJardine et al. (2019). We analyzed the results in RStudio (Supplementary Data 2 – R script).

4 Analysis of results

4.1 Sample description and descriptive analysis

Our final sample consists of 160 non-financial listed companies dispersed across different listing segments and sectors. A significant proportion of the companies (36.88%) are listed in the "*Novo Mercado*," which demonstrates a commitment to improving corporate governance practices and access to financing (Tristão & Sonza, 2023). The most common sector is "others" (45%), followed by the electricity and construction sectors with 16 and 13 companies, respectively. The sectors with the fewest companies are drinks and smoking, communication, oil and gas, and medical services, with only one company each.

Table 2 shows the descriptive statistics of the research variables. The results show that, on average, non-financial listed companies in Brazil experienced a 40% negative impact when the pandemic struck.

Table 2
Descriptive statistics

Variable	% missing values	Mean	Standard Deviation	Min.	Median	Max.
Severity	0.00	-1.40	0.18	-1.80	-1.36	-1.00
Time to Recovery	15.63	137.02	117.84	1.00	91.00	443.00
R&D Intensity	45.00	208.93	644.77	0.00	14.53	4751.22
Ph.D. Board	18.75	0.02	0.06	0.00	0.00	0.38
Univ. Degree Board	18.75	0.13	0.16	0.00	0.07	0.75
Area Board	18.75	0.03	0.07	0.00	0.00	0.38
Scholar Board	18.75	0.03	0.07	0.00	0.00	0.38
Research Board	18.75	0.01	0.04	0.00	0.00	0.25
Age	25.63	41.41	29.49	1.20	41.03	129.28
Size	33.75	0.11	0.13	0.00	0.06	0.45
Leverage	33.75	15.58	1.86	10.52	15.33	21.35
		Frequency				
		0	**1**			
Ph.D. CEO	35.00	102	2			
Univ. Degree CEO	35.00	93	11			
Area CEO	35.00	104	0			
Scholar CEO	35.00	102	2			
Research CEO	35.00	104	0			

Note: Ph.D. Board indicates the proportion of board members who are Ph.D. holders; Univ. Degree Board indicates the proportion of board members who have a college degree; Area Board is the proportion of board members whose degrees are in business, economics, or accounting; Scholar Board is the proportion of board members who have experience in universities, research institutions, or associations; Research Board is the proportion of board members who have published a scientific article; Ph.D. CEO indicates whether the CEO holds a Ph.D.; Univ. Degree CEO indicates whether the CEO has a college degree; Area CEO indicates whether the CEO's degree is in business, economics, or accounting; Scholar CEO equals 1 if the CEO has experience in universities, research institutions, or associations; Research CEO equals 1 if the CEO has published a scientific article; R&D Intensity is a proxy for innovation; Age is the log of the difference between year t and the year companies were founded; Size is the log of companies' total assets; Leverage is the ratio of total financial debt to total assets.

It took them about 137 days to recover from this loss. However, the high standard deviation in time to recovery indicates that while some companies struggled to bounce back, others recovered quickly, demonstrating resilience (Gittell et al., 2006; DesJardine et al., 2019). The same holds true for severity of loss. Observing the median shows that 50% of the companies experienced losses of more than 36%. The minimum and maximum values strengthen the argument that some companies were more affected than others. The maximum value of -1 indicates that some companies did not experience any setbacks when the COVID-19 pandemic struck.

As for innovation, many companies (about 45%) had no specified information on R&D investment, which is to be expected, since there is limited availability of information on innovation even in developed markets (Silva et al., 2018). Nevertheless, a low mean (208.93) in R&D intensity can be observed, which in turn indicates that the average Brazilian company invests minimally in innovation.

The independent variables referring to board members' acquired academic characteristics have a median of 0, except for the variable referring to board members' university degree. This implies that 50% of the companies do not have a board member with a Ph.D., which confirms the findings of Perlin et al. (2021) that only 20.1% of boards and board of director members were academics with a doctorate. Moreover, most boards lack members with degrees in business, economics, or accounting, as well as scholars and/or researchers. The same goes for CEOs. Most CEOs do not have a university degree (and when they do, it is not in business, economics, or accounting), nor a Ph.D. No CEO was found to have published an article, and only two are scholars. Due to this, we excluded these variables from the main analysis. More specifically, we did not consider: Ph.D. CEOs, the area of the university degree of CEOs, and scholar and researcher CEOs.

Additionally, we estimated the correlation coefficients between the variables and found that time to recovery has a positive, statistically significant relationship with innovation. However, it has a negative interaction with the proportion of board members with a university degree, a university degree in business, economics, or accounting, and who are researchers. CEOs with a university degree have a negative relationship with time to recovery, which is a good sign, since we expect firms with such CEOs to recover more quickly. Severity of loss appeared to have a negative relationship with innovation, suggesting that innovation might jeopardize resilience. Moreover, boards with scholars positively contribute to firm stability. As expected, other significant relationships appeared between the independent variables referring to CEOs' and board members' acquired academic characteristics.

4.2 Regression results

When performing an ordinary least squares regression, it is important to test certain basic assumptions, such as normality, multicollinearity, heteroscedasticity, and autocorrelation. Following Fávero and Belfiore (2017), we performed the Shapiro-Francia test for normality, the Breusch-Pagan test for heteroscedasticity, and the Durbin-Watson test for autocorrelation. Regarding multicollinearity, we obtained data from the correlation matrix and observed some alarmingly high correlations between the independent variables. Table 3 summarizes the aforementioned tests. Although there are no problems with heteroscedasticity, there is autocorrelation, and the residuals are not normally distributed. However, it is important to mention that since our data is not time-variant, the heteroscedasticity and autocorrelation tests might be redundant.

Table 3
OLS assumptions

OLS assumption	Test	Hypothesis	Result
Normality	Shapiro-Francia	H0: The residuals are normally distributed. H1: The residuals are not normally distributed.	p-value = 0.00
Heteroscedasticity	Breusch-Pagan	H0: The variance of the error terms is constant (homoscedastic). H1: The variance of the error terms is constant (heteroscedastic).	p-value = 0.068
Autocorrelation	Durbin-Watson	H0: The residuals are aleatory and independent. H1: The residuals are not aleatory and independent.	DW = 1.79 p-value = 0.00

The OLS regression model used severity of loss as its dependent variable. On the other hand, the dependent variable in the Cox regression is time to recovery. Firms are considered flexible when their recovery time is less than55 days, the second quartile. The results are displayed in Table 4. It is important to mention that the estimation included different sector matrices as control variables; however, to save space, we did not exhibit the results here. For the Cox regression, we excluded the area of expertise of board members and the presence of researchers – variables that affected our estimations. Model 2 is the full model, the baseline model considers only the control variables, and Model 1 does not consider innovation. As expected, Model 2 performs better than the baseline model and Model 1 in the OLS regression, with a higher adjusted R^2 and R^2. In the case of the Cox regression, Model 1 performs better than the others, with a lower AIC and higher R^2 (although it does not consider R&D intensity while maintaining the university degree of CEOs). However, caution is advised when interpreting our results regarding the flexibility of firms, and generalization of the findings is not recommended given the small number of events (13), which is unavoidable even after excluding the control variables related to the different economic sectors in an attempt to avoid estimation convergence.

Table 4
Stability and Flexibility of Firms

	Stability			Flexibility		
	Baseline Model	**Model 1**	**Model 2**	**Baseline Model**	**Model 1**	**Model 2**
(Intercept)	-1.058***	-0.965***	-2.078***			
Age	-0.003***	-0.003**	0.005**	0.019*	0.033**	0.033*
Size	-0.011	-0.02	0.014	0.095	0.033	0.25
Leverage	0.303*	0.430*	0.699***	3.552.	4.981*	4.504*
Ph.D. Board		-0.482	-0.578.		8.813	4.361
Univ. Degree Board		-0.05	-0.999**		-5.646	-1.691
Area Board		-0.697	-1.494**			
Scholar Board		0.15	3.311***		-1.608	6.927
Research Board		0.922	3.951*			
Univ. Degree CEO		-0.032	-1.362***		0.775	
R&D Intensity			0.000**			-0.002
R&D Intensity X Ph.D. Board			-0.391***			0.277
R&D Intensity X Univ. Degree Board			0.006**			0.019
R&D Intensity X Area Board			-0.375***			
R&D Intensity X Scholar Board			0.368***			-0.607
R&D Intensity X Research Board			-0.337**.			
R&D Intensity X Univ. Degree CEO			0.015*			
R^2	0.472	0.6	0.892	0.147	0.246	0.225
Adj. R^2 / AIC	0.337	0.411	0.782	153.873	105.189	130.54
Num. obs. / events	104	85	68	18	13	15

***p < 0.001; **p < 0.01; *p < 0.05; .p < 0.1.

Note: Ph.D. Board indicates the proportion of board members who are Ph.D. holders; Univ. Degree Board indicates the proportion of board members who have a college degree; Area Board is the proportion of board members with degrees in business, economics, or accounting; Scholar Board is the proportion of board members who have experience in universities, research institutions, or associations; Research Board is the proportion of board members who have published a scientific article; Univ. Degree CEO indicates whether the CEO has a college degree; R&D Intensity is a proxy for innovation; Age is the log of the difference between year t and the year companies were founded; Size is the log of companies' total assets; Leverage is the ratio of total financial debt to total assets.

Most importantly, it can be observed that both severity of loss and time to recovery are affected by the interaction between innovation and the board's and CEOs' acquired academic characteristics. Regarding CEO traits, there is a statistically significant positive relationship at the 0.1% level between having CEOs with a university degree and innovation, which, in turn, enhances resilience. Firms led by CEOs with a university degree are more innovative and stable in the face of crises. This finding is particularly relevant considering that CEOs with a university degree were initially associated with greater stock price losses – an effect that was reversed once innovation was accounted for – and longer time to recovery.

The interaction between innovation and board members' characteristics is evident in several cases. For instance, having a higher proportion of Ph.D. holders on the board can jeopardize the stability and flexibility of a firm, even when innovation is considered. Board members with a university degree also negatively impact firm stability, a statistically significant result at the 1% level. On the other hand, scholars in the boardroom can enhance resilience by easing the severity of loss through greater R&D intensity. The area of expertise of board members also plays a significant role in resilience. Firms that have board members with degrees in business, economics, or accounting may endanger resilience, even when combined with innovative efforts.

Additionally, the control variable referring to company age has a positive statistical relationship with resilience in terms of stability (severity of loss) and flexibility (time to recovery). Older companies are less flexible in the face of a crisis. However, older firms may be more stable due to their reputation. Company size and leverage are also fundamental. The bigger the firm is, the less flexible but more stable it will be. The positive relationship between size and time to recovery, as well as severity, is proof of this, considering that greater time to recovery indicates less flexibility and greater stability. However, the results are not statistically significant. Leverage has the same effect on time to recovery. Firms with higher leverage respond more slowly to crises. However, higher leverage enhances the stability of firms.

4.3 Robustness check

Due to the issues with normality, we verified our results by performing quantile regression to assess the stability of the firms. The results are reported in Table 5. The first quartile represents firms with the highest stability, while the last one represents those with the lowest stability. Although the results are not statistically significant, some important trends can be observed in addition to the previously presented findings.

Table 5 confirms the direction of the effects of the independent variables. A greater proportion of undergraduate and/or Ph.D board members, as well as their area of expertise, negatively affects firm stability. However, scholars and researchers boost it. CEOs with a university degree also seem to negatively impact firm resilience. Regarding the interaction with innovation, the results are consistent except for the area of expertise, researchers on the board, and undergraduate CEOs. These findings corroborate those found in our initial analysis.

Moreover, quantile analysis provides some additional insights into the relationships studied. For instance, Ph.D. holders and researchers in boardrooms seem to be less relevant for higher levels of severity of loss, whereas having a university degree, the area of expertise, and being a scholar seem to be more relevant for higher levels of severity of loss. This may indicate that less stable firms depend more on the "basic" education of their board members and their experience as academics. For CEOs with a university degree, the findings show that less stable firms exhibit this specific characteristic more, but the effect is milder for the most severe cases (quantiles 80 and 90).

5 Discussion of results

Overall, the results show that the combination of top management's acquired academic characteristics and innovation can boost resilience. However, it seems that the interaction of these assets can sometimes jeopardize their positive effects, as in the case of board members who are researchers. This may be due to the innovation variable (R&D intensity) chosen for the study, considering that other studies have found innovation to be significant for resilience. For example, Engelen et al. (2024) show that pre-shock product introductions and top management's focus on innovation foster resilience. However, the effect of R&D intensity and other variables related to innovation depends on the firm's profitability prior to the shock. Moreover, innovation might represent an additional cost for shareholders during crises, which top managers may favor depending on their academic backgrounds.

Table 5
Quantile Regression

Quantile/Variable	10th	20th	30th	40th	50th	60th	70th	80th	90th
(Intercept)	-1.70	-1.70	-1.70	-2.08	-2.08	-2.14	-2.14	-1.45	-1.45
R&D Intensity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ph.D. Board	-0.97	-0.97	-0.97	-0.83	-0.83	-0.57	-0.57	-0.05	-0.05
Univ. Degree Board	-0.51	-0.51	-0.51	-0.82	-0.82	-0.97	-0.97	-0.98	-0.98
Area Board	-0.90	-0.90	-0.90	-1.44	-1.44	-2.04	-2.04	-2.52	-2.52
Scholar Board	2.01	2.01	2.01	3.16	3.16	3.66	3.66	3.04	3.04
Research Board	8.61	8.61	8.61	5.96	5.96	5.85	5.85	1.08	1.08
Univ. Degree CEO	-0.94	-0.94	-0.94	-1.30	-1.30	-1.47	-1.47	-1.35	-1.35
Age	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00
Size	-0.01	-0.01	-0.01	0.01	0.01	0.02	0.02	0.01	0.01
Leverage	1.17	1.17	1.17	0.80	0.80	0.83	0.83	0.87	0.87
R&D Intensity X Ph.D. Board	-0.35	-0.35	-0.35	-0.39	-0.39	-0.41	-0.41	-0.38	-0.38
R&D Intensity X Univ. Degree Board	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
R&D Intensity X Area Board	-0.34	-0.34	-0.34	-0.38	-0.38	-0.39	-0.39	-0.36	-0.36
R&D Intensity X Scholar Board	0.33	0.33	0.33	0.37	0.37	0.38	0.38	0.35	0.35
R&D Intensity X Research Board	-0.59	-0.59	-0.59	-0.48	-0.48	-0.43	-0.43	-0.10	-0.10
R&D Intensity X Univ. Degree CEO	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Note: Ph.D. Board indicates the proportion of board members who are Ph.D. holders; Univ. Degree Board indicates the proportion of board members who have a college degree; Area Board is the proportion of board members with degrees in business, economics, or accounting; Scholar Board is the proportion of board members who have experience in universities, research institutions, or associations; Research Board is the proportion of board members who have published a scientific article; Univ. Degree CEO indicates whether the CEO has a college degree; R&D Intensity is a proxy for innovation; Age is the log of the difference between year t and the year companies were founded; Size is the log of companies' total assets; Leverage is the ratio of total financial debt to total assets.

As for the acquired academic characteristics of CEOs, overall, the results show that their university degrees matter. CEOs with a university degree seem to make companies less flexible and stable in the face of shocks. However, the negative effect is mitigated by R&D intensity. Undergraduate CEOs might foster resilience through innovation.

On the other hand, the results regarding board members' acquired academic characteristics provide more insight into how board structure can affect resilience through innovation (or not). Zhang et al. (2024) found that CEOs with academic backgrounds enhance innovation and mitigate debt default risks. Although resilience and debt default risks are distinct concepts, both represent a failure in organizational practices. Our results partially corroborate Zhang et al.'s (2024) findings. We found that boards with a greater proportion of undergraduates and/or scholars affect resilience, considering the moderating effects of innovation. Being a scholar fosters innovation and positively affects resilience in terms of both flexibility and stability. This result is similar to that of Zhang et al. (2024); however, instead of examining CEOs, we examined boards. On the other hand, having Ph.D. holders on the board negatively affects firm stability, even in the presence of greater R&D intensity. This negative result on resilience also applies to the firm's flexibility, though it is not statistically significant.

A greater proportion of Ph.D. holders on the board makes firms less stable during crises. The interaction between the proportion of Ph.D. holders on the board and innovation is incapable of mitigating these effects, making firms less resilient. This result might reflect the costs of innovation during turbulent times. While top managements' academic background enhances innovation (Zhang et al., 2024), the perceived cost of investing in innovation might seem redundant when a crisis arises.

Table 6
Summary of Results by Hypothesis and Resilience Facet

Hypothesis	Variable	Results	
		Severity of Loss (+)	Time to Recovery (-)
H1a. CEOs' acquired academic characteristics positively affect financial resilience.	University Degree	Negative	N/S
H1b. CEOs' acquired academic characteristics positively affect financial resilience through innovation.	R&D Intensity X University Degree	Positive	Not evaluated
H2a. Board members' acquired academic characteristics have a positive impact on financial resilience.	University Degree	Negative	N/S
	Ph.D. Holder	Negative	N/S
	Area of Expertise	Negative	Not evaluated
	Scholar	Positive	N/S
	Researcher	Positive	Not evaluated
H2b. Board members' acquired academic characteristics have a positive impact on financial resilience through innovation.	R&D Intensity X University Degree	Positive	N/S
	R&D Intensity X Ph.D. holder	Negative	N/S
	R&D Intensity X Area of expertise	Negative	Not evaluated
	R&D Intensity X Scholar	Positive	N/S
	R&D Intensity X Researcher	Negative	Not evaluated

While shareholders aim to ensure the survival of companies, top management identifies innovation as a way out of the crisis, resulting in a temporary conflict of interests. The outcome is an agency cost on top of the existing crisis, which negatively affects resilience.

Although the same result holds true when examining the university degrees and areas of expertise of board members, the opposite is true for researchers in the boardroom. Scholars and researchers on the board enhance resilience through innovation. While this relationship is not verified in this article, it is important to mention that, despite limited firm-university interaction in Brazil (Perlin et al., 2021), as confirmed by our descriptive analysis, this engagement fosters resilience, making firms more stable and flexible enough to overcome crises and bounce back to their pre-crisis performance.

Table 6 summarizes the results based on Models and considers the hypothesis previously proposed in this paper. We review the hypotheses, the variables used to test them, and the results for each resilience proxy. As expected, the relationships were positive for severity of loss and negative for time to recovery.

6 Conclusion

Recognizing that organizations operate in an ambiguous environment and drawing on upper echelons theory, we aimed to uncover whether and how top management's acquired academic characteristics help firms withstand crises by examining the effect of CEOs' and board members' education and scholarly expertise on financial resilience through innovation. To achieve our goal, we estimated different models using ordinary least squares and Cox regression.

Overall, we find that top managements' acquired academic characteristics are important for fostering financial resilience. This relationship is sometimes strengthened by innovation. Our first hypothesis suggested that CEOs' acquired academic characteristics would foster resilience. However, we reject this hypothesis (H1a) and instead accept our second hypothesis (H1b), which states that CEOs' acquired academic characteristics positively affect financial resilience through innovation. This result suggests that CEOs with an academic background may favor innovative investments, which will result in greater

stability and flexibility. Our hypotheses regarding board members are partially rejected. Hypothesis 2a suggested that board members' acquired academic characteristics have a positive impact on financial resilience. However, this is true only in the case of scholars and researchers. The greater the proportion of board members with extensive academic experience, the higher the resilience of firms. This finding supports hypothesis 2b. Scholars boost the stability and flexibility of firms through innovation. Other important factors appear to be the previous financial health of companies. For example, being highly leveraged gives firms more stability (though less flexibility) to respond to shocks, and older firms tend to be more stable and less flexible. Conversely, firm size is not valued in times of crises.

We contribute in both theoretical and practical ways. Our results show that financial resilience in developing countries depends on top management's education and expertise. Having highly educated top managers who interact with academia can be advantageous. Thus, policymakers should consider these results when designing new guidelines for professionals assuming top management positions. Investors can also benefit from our findings, as we provide evidence of the importance of the education and experience of the agents acting on their behalf. Therefore, when looking for good deals in the stock market, investors should consider factors that go beyond financial statements, such as who the decision makers are.

The interaction between the educational backgrounds and experience of board members and CEOs and innovation is not always beneficial. This result may reflect the additional cost that innovation represents to shareholders during crises. However, innovation should eventually pay off in the long run, which is why top management with high-quality education and/or academic experience encourages innovation firsthand. We believe that one way to evaluate whether this relationship persists would be to adopt long-term financial resilience proxies. For instance, future research could include a relapse proxy to measure financial resilience, as suggested by Mellado-Garcia et al. (2024).

Future research could also examine the proposals presented in this paper in other contexts. This would strengthen the discussion and provide additional evidence to support our findings. This is particularly important given one of the study's key limitations: the small sample size of just 160 observations. Although small samples are not uncommon in research focused on Brazil (Sampaio et al., 2024; Brandão et al., 2024; Pinheiro et al., 2024; Brandão & Crisóstomo, 2024), it nonetheless limits the generalization of our results, suggesting they should be interpreted with caution. Moreover, it would be advantageous to evaluate other board members' and CEOs' characteristics, such as some personality traits. It is also important to examine innovation to determine whether it represents an additional and unnecessary cost.

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Supplementary Material

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Supplementary Data 2 – R script
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2nd author: definition of research problem; development of hypotheses or research questions (empirical studies); development of theoretical propositions (theoretical work); definition of methodological procedures; data collection; statistical analysis; analysis and interpretation of data; critical revision of the manuscript; manuscript writing.