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Business strategy, environmental, social, and governance performance, and cost asymmetry in Brazilian firms

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ABSTRACT

The objective of this study was to examine business strategy as a contingency factor in the relationship between environmental, social, and governance (ESG) performance and cost asymmetry in Brazilian firms. A gap was identified concerning the scarcity of empirical evidence in emerging economies on the interaction among ESG performance, business strategy, and asymmetric cost behavior from the perspective of contingency theory. This study contributes to a deeper understanding of the relationships among ESG practices, strategic orientations, and cost-related decisions for the financial sustainability of organizations operating in volatile markets. The findings alert managers to the risks associated with cost rigidity in scenarios of declining revenues, indicating that high levels of ESG performance or different strategic profiles do not necessarily ensure greater operational flexibility. Accordingly, without alignment between internal processes and strategy, ESG investments may generate undesirable cost rigidity, undermining competitiveness during periods of revenue decline. A descriptive, archival, and quantitative research design was adopted, based on 1,693 observations from 222 firms listed on B3 S.A. – Brasil, Bolsa, Balcão, using data from LSEG[®] covering the period from 2015 to 2024. Multiple linear regression estimated by ordinary least squares was employed using Stata[®] software. The results reveal that cost asymmetry is a persistent characteristic of Brazilian firms. However, they challenge the international literature by demonstrating that ESG performance and business strategies do not act as determinants of cost rigidity in the Brazilian context. The findings further indicate that the COVID-19 pandemic can be considered a critical contingency condition, during which firms with higher ESG performance adjusted their costs more intensively in response to declining revenues. This suggests that, in Brazil, ESG practices have not yet matured to the point of being fully integrated into operational cost decisions during periods of economic stability. Additional tests confirmed the robustness of the findings.

Keywords: cost asymmetry, ESG, business strategy, contingency theory, sticky costs.

1. INTRODUCTION

Distinct business strategies can be characterized by decisions aimed at leveraging firms' strengths and maximizing performance (Miles et al., 1978). In turn, environmental, social, and governance (ESG) information is relevant to market transparency, capital allocation, and competitiveness (European Commission, 2022).

ESG performance is associated with financing costs, firm value, and organizational risk. By investing in sustainable practices, firms tend to attract investors and strengthen their institutional reputation (Li et al., 2024). In this regard, firms that adhere to sound corporate governance principles and adopt good environmental practices are more likely to achieve competitive success (DasGupta & Roy, 2023), establishing ESG as a central element in strategic decision-making and the management of organizational resources (Habib & Hasan, 2019).

Considering that ESG performance may affect the cost structure, it is relevant to understand how costs behave in response to changes in economic activity. Under the traditional approach, costs change proportionally with variations in production volume or revenues (Richartz & Borgert, 2020). Nevertheless, evidence indicates that costs tend to

adjust asymmetrically, increasing more substantially when activity expands than they decrease when revenues decline (Anderson et al., 2003).

This behavior is referred to as sticky costs and is characterized by greater rigidity in reducing costs during periods of economic downturn, which may compromise firms' operational flexibility (Anderson et al., 2003; Medeiros et al., 2005; Richartz & Borgert, 2020). Firms with high ESG performance tend to maintain ongoing investments in environmental projects, social programs, and governance structures, even during adverse periods, in an effort to preserve their reputation and meet the expectations of investors and stakeholders, which may intensify such rigidity (Golden et al., 2020; Habib & Hasan, 2019; Usman et al., 2020).

This relationship, however, may be conditioned by internal and external factors that influence organizational dynamics. Among these factors, business strategy stands out as a contingency factor that guides the configuration of organizational resources and firms' adaptation to the competitive environment (Freitag et al., 2021). Chenhall (2003) and Donaldson (2006) argue that organizational performance results from the alignment among different factors, such as the environment, strategy, structure, control systems, and managerial decisions. Under this premise, ESG practices may generate organizational demands that are absorbed differently depending on the prevailing business strategy.

The typologies proposed by Miles et al. (1978) suggest that different strategic orientations, such as prospector and defender strategies, may shape organizational behavior, investment levels, risk-taking propensity, and cost structure decisions. Prospector firms tend to maintain higher levels of investment and greater cost rigidity, whereas defender firms prioritize efficiency and control, potentially exhibiting lower cost asymmetry (Ballas et al., 2020; Karampinis et al., 2024; Widyasari, 2018).

Although the evidence on the relationship between ESG and cost asymmetry has been systematically documented in the international literature (Golden et al., 2020; Habib & Hasan, 2019; Huang & Wang, 2024), and Brazilian studies have established evidence of cost asymmetry in the domestic market (Medeiros et al., 2005; Richartz & Borgert, 2020), including investigations into the isolated influence of social responsibility (Deconto et al., 2022), a gap remains regarding how business strategy acts as a contingency factor in this relationship. Therefore, the contribution of this study lies in the integrated analysis of ESG, business strategy, and cost behavior from a contingency perspective, incorporating organizational and environmental variables.

In light of contingency theory (CT), the relationship between ESG performance and cost asymmetry can be analyzed as a phenomenon that depends on the fit between sustainable practices and the strategic context adopted by each firm (Freitag et al., 2021). Therefore, business strategy constitutes a relevant contingency factor (Chenhall, 2003; Donaldson, 2006), as it influences how organizations allocate resources to address ESG demands, thereby affecting decisions to maintain or adjust organizational capacities and, consequently, the degree of cost asymmetry in response to variations in economic activity (Golden et al., 2020; Usman et al., 2020). In this context, the objective of this study is to examine business strategy as a contingency factor in the relationship between ESG performance and cost asymmetry in Brazilian firms.

The development of this study is justified by the relevance of ESG performance in both the national and international contexts, as it has become a central metric for assessing corporate sustainability, attracting investment, and strengthening organizational legitimacy (Li et al., 2024; Possebon et al., 2024). Additionally, as climate change becomes increasingly

evident and concerns about social responsibility grow, ESG factors play an essential role in building more resilient and competitive firms over the long term (Huang & Wang, 2024; Li et al., 2024).

The study of cost asymmetry is relevant because it enables an understanding of how managerial decisions and long-term commitments affect the rigidity or flexibility of cost structures, an aspect that is fundamental to firms' operational efficiency and financial resilience (Habib & Hasan, 2019). Complementarily, the analysis of business strategies is justified by their determining role in shaping organizational resources and investment patterns (Bentley et al., 2013). An integrated approach is therefore necessary to understand whether and how strategic choices affect ESG investments, influence cost adjustment mechanisms, and shape performance.

The findings revealed that ESG performance and business strategies did not have significant effects on asymmetric cost behavior. In addition, further tests demonstrated that the results remained consistent across different operationalizations of ESG, its individual dimensions, and the distinction between sensitive and non-sensitive sectors. Furthermore, the pandemic was identified as a relevant contingency condition, during which ESG performance was associated with more timely cost adjustments in response to declining revenues.

Regarding theoretical contributions, this study demonstrates that ESG performance and business strategy do not constitute contingency factors for explaining cost rigidity in the Brazilian context. This finding provides conceptual insights to guide future research aimed at further investigating these relationships from the perspective of CT, thereby broadening the understanding of the factors underlying cost rigidity. From a practical perspective, the study provides managers and decision-makers with insights into how different strategic configurations and levels of commitment to ESG practices may influence cost flexibility or rigidity in response to variations in economic activity, supporting more efficient decisions aligned with competitiveness.

From a social perspective, this study is expected to contribute to the strengthening of responsible corporate practices aligned with the Sustainable Development Goals (SDGs), more specifically Target 8.4 (SDG 8), Target 9.5 (SDG 9), and Target 12.2 (SDG 12). In addition, it contributes to a broader understanding of the social role played by organizations by encouraging greater transparency in ESG practices and communication with stakeholders.

2. THEORETICAL FRAMEWORK AND RESEARCH HYPOTHESES

2.1 ESG Performance, Cost Asymmetry, and Business Strategy

The three dimensions that comprise ESG reflect management practices widely used to assess the economic and financial impacts associated with sustainability (Golden et al., 2020; Habib & Hasan, 2019; Usman et al., 2020). The environmental (E) dimension encompasses practices aimed at emissions control, waste management, and the efficient use of resources; the social (S) dimension addresses aspects related to working conditions, health and safety, diversity, and relationships with communities; and the governance (G) dimension encompasses internal controls, board independence, transparency, and accountability (Possebon et al., 2024).

Although the ESG dimensions have distinct operational focuses, studies on the subject (see, for example, Clément et al. [2025], Golden et al. [2020], Habib and Hasan [2019], and Usman et al. [2020]) frequently employ aggregate ESG measures. This perspective is

grounded in the premise that organizations' overall commitment to ESG performance acts as a conditioning factor in decision-making processes related to resource retention, with the aim of preserving corporate reputation.

The implementation of ESG practices influences decisions related to the allocation and management of resources, also affecting cost behavior. In this context, cost asymmetry occurs when costs respond differently to increases and decreases in the level of activity. Anderson et al. (2003) introduced the discussion of sticky costs, showing that costs do not change to the same extent as revenues: when revenues increase, costs rise proportionally more than they decline when revenues decrease. This behavior contrasts with the traditional model, which assumes proportional cost adjustments in response to changes in production or sales volume (Medeiros et al., 2005; Richartz & Borgert, 2020).

Two broad perspectives may explain this phenomenon: deliberate managerial decisions (based on expectations regarding future demand) and delays in cost adjustments, resulting from the time required or the inability to rapidly adapt costs to declining revenues. Thus, cost behavior may be influenced by operational factors and by decisions regarding the allocation and retention of resources (Ibrahim et al., 2022).

Concerning business strategies, firms can be classified as defenders and prospectors (Miles et al., 1978). Organizations pursuing a defender strategy prioritize operational efficiency, risk reduction, and process improvements, whereas prospector firms seek new market opportunities through innovation and greater investments in research and development (Bentley et al., 2019; Miles et al., 1978; Zhang, 2020). Therefore, the effectiveness of ESG initiatives may vary depending on the business strategy adopted (Xaviera & Rahman, 2024).

2.2 Research Hypotheses

Engagement in ESG initiatives is associated with reputation management and sustainable value creation, which may lead managers to avoid abrupt spending reductions that could undermine corporate image and investor confidence (Golden et al., 2020; Li et al., 2024). Although firms that prioritize ESG practices generally incur higher initial costs, these investments may be offset by long-term gains in operational efficiency and reputation (Li et al., 2024). Accordingly, expectations of future benefits may encourage managers to retain resources allocated to ESG initiatives, contributing to asymmetric cost behavior (Golden et al., 2020).

Huang and Wang (2024) argue that firms with better ESG performance tend to adjust their costs less reactively during economic downturns, preserving sustainable investments. This behavior contributes to cost asymmetry by reducing the sensitivity of costs to changes in revenues. Accordingly, firms with better ESG performance tend to exhibit greater operational stability and stronger commitment to long-term objectives, which reduces their flexibility to cut costs in response to revenue fluctuations.

This stability, combined with the continued maintenance of ESG programs, results in costs that are less sensitive to changes in activity levels, thereby characterizing cost rigidity. Consequently, costs become more dependent on strategic and institutional decisions, potentially increasing cost asymmetry over time (Deconto et al., 2022; Golden et al., 2020).

Golden et al. (2020) identified a positive relationship between ESG performance and cost asymmetry, indicating that firms with stronger sustainability practices tend to retain resources to maintain ESG initiatives, thereby increasing cost rigidity and reducing their

ability to adjust costs in response to changes in activity levels. Deconto et al. (2022) also found evidence that firms more engaged in corporate social responsibility (CSR) activities exhibit greater cost asymmetry, particularly during periods of declining revenues. The positive relationship between ESG performance and cost asymmetry may be explained by the fact that ESG practices require ongoing, structural, and often difficult-to-reduce investments in the short term (Habib & Hasan, 2019).

This relationship can be supported by CT, which recognizes that organizational effectiveness depends on the alignment between internal and external factors (Chenhall, 2003; Donaldson, 2006). Therefore, organizations should adapt their structures, strategies, and management practices to the environmental and institutional conditions in which they operate. Accordingly, the adoption of ESG practices and the resulting cost rigidity can be interpreted as contingent responses to competitive pressures and stakeholder expectations (Freitag et al., 2021). Given this context, the following hypothesis is proposed:

H₁: there is a positive relationship between ESG performance and cost asymmetry.

Among the four business strategy typologies characterized by Miles et al. (1978), prospector and defender strategies can be considered opposite ends of the same strategic continuum (Bentley et al., 2013). In this regard, the inherent characteristics of a business strategy may influence managerial decisions, making it possible to observe the consequences of strategy on cost asymmetry (Widyasari, 2018).

The study by Xu and Zheng (2018) supports this view by demonstrating that business strategy acts as a moderator in the relationship between economic variables and cost behavior. Cost asymmetry was found to be more pronounced in prospector firms, which require greater resources to sustain investments and innovation, and less significant in defender firms.

The positive relationship between prospector strategy and cost asymmetry can be explained by the innovative and exploratory orientation inherent in this type of strategy. Prospector firms continuously invest in new products and markets, increasing fixed costs and reducing their flexibility to adjust them during periods of declining revenues (Miles et al., 1978). These organizations have more decentralized and complex structures, which increase resource commitments and, consequently, cost rigidity (Bentley et al., 2013).

Ballas et al. (2020) observe that such rigidity results from deliberate managerial choices aimed at maintaining innovation capabilities and competitive advantage, even in the face of economic downturns. Consistent with this view, Karampinis et al. (2024) emphasize that the pursuit of innovation and long-term growth by prospector firms generates structural financial commitments, thereby intensifying cost asymmetry.

Conversely, defender strategy tends to exhibit a negative relationship with cost asymmetry because it prioritizes operational efficiency, control, and stability (Chenhall, 2003). Chenhall (2003) and Zhang (2020) point out that these firms adopt well-structured control and performance measurement systems, enabling proportional adjustments in expenses in response to changes in revenues. Ballas et al. (2020) further emphasize that managers of defender firms tend to reduce costs more substantially during periods of economic downturn, resulting in anti-sticky cost behavior.

Karampinis et al. (2024) argue that a centralized structure and a focus on efficiency enable defender organizations to respond rapidly to market fluctuations by adjusting costs and maintaining financial stability. This reasoning is consistent with CT, according to which

organizational success depends on the fit among strategy, structure, and environment (Donaldson, 2006). Thus, from a CT perspective, this positive relationship can be understood as a response to the need for organizational adaptation to dynamic and uncertain environments (Chenhall, 2003; Donaldson, 2006). Based on the studies discussed above, the following hypothesis is proposed:

H₂: there is a positive relationship between prospector business strategy and cost asymmetry.

This study assumes that the relationship between ESG performance and cost asymmetry in Brazilian firms may be influenced by their business strategy. Firms pursuing prospector strategies (Miles et al., 1978) are characterized by their continuous search for new market opportunities and innovation. These firms tend to invest substantially in research and development, which may result in higher operating costs and greater cost asymmetry (Bentley et al., 2019).

Prospector strategy may amplify the positive relationship between ESG performance and cost asymmetry by requiring greater exposure to risk and investment in sustainable practices that may initially increase costs. Given that such investments generate returns over the long term and require more time to reduce costs, they may result in asymmetric cost behavior relative to revenues (Li et al., 2024).

When examining the relationship between CSR and cost asymmetry, Deconto et al. (2022) discuss the possibility that organizational strategy may influence this relationship, which may be more pronounced in prospector firms due to their tendency to maintain investments in sustainable practices even during periods of declining revenues. The empirical study by Widyasari (2018) suggests that business strategy may moderate the relationship between ESG performance and cost asymmetry, finding that prospector firms exhibit greater cost rigidity, whereas defender firms tend to exhibit lower cost asymmetry. In addition, Xaviera and Rahman (2024) highlight that defender strategy weakens the negative relationship between ESG and firm value, suggesting that defender firms may provide higher-quality ESG information, thereby increasing firm value.

These findings provide evidence that business strategy may play a significant moderating role in the relationship between ESG performance and cost asymmetry. In addition, firms with diversified business segments tend to achieve higher ESG scores but may ultimately develop less balanced cost structures in their operations, thereby increasing cost asymmetry (Barros et al., 2024).

Considering that ESG practices and cost behavior are influenced by contextual and strategic factors, CT provides an appropriate theoretical framework for understanding how firms adjust their sustainability decisions and cost structures according to the environments in which they operate (Freitag et al., 2021). In this regard, CT helps to explain how organizations adapt to the environmental, structural, and strategic conditions in which they are embedded (Donaldson, 2006). Accordingly, the moderating effect of business strategy reflects a contingency response to the environmental and strategic conditions that determine the degree of cost rigidity or flexibility in firms with different levels of ESG performance. Therefore, the following hypothesis is proposed:

H₃: prospector business strategy strengthens the positive relationship between ESG performance and cost asymmetry.

3. METHODOLOGICAL PROCEDURES

This study is descriptive in terms of its objective, as it aims to investigate relationships among variables using statistical techniques (Richardson, 2017). Concerning the research procedures, it is classified as archival, given that it uses organizational data obtained from corporate reports published by the firms (Das et al., 2018). Regarding the research approach, the study is characterized as quantitative, as the data were subjected to statistical tests to support their analysis and interpretation (Martins & Theóphilo, 2016).

The population comprises publicly traded Brazilian firms with data available in the LSEG® database as of October 2025. Data were collected for the period from 2010 to 2024, with the period from 2010 to 2014 used exclusively to calculate the moving averages of the business strategy variables. These observations were subsequently excluded, such that the empirical analysis was conducted using data for the years 2015 to 2024. Table 1 presents the sample of 1,693 firm-year observations, by year and sector, comprising 222 firms.

Table 1
Research sample

Sector	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total
Communication services	4	3	5	9	11	13	9	9	10	9	82
Consumer discretionary	31	32	35	40	45	49	48	50	48	48	426
Consumer staples	9	12	11	14	17	18	17	17	18	17	150
Energy	5	3	4	5	6	4	5	5	6	7	50
Health care	8	9	10	10	13	12	15	12	12	12	113
Industrials	19	22	23	26	36	39	37	36	39	38	315
Information technology	2	2	4	6	9	8	9	9	8	9	66
Materials	17	18	19	21	20	19	21	22	22	20	199
Real estate	7	7	6	7	8	7	7	6	7	6	68
Utilities	19	18	19	17	19	20	21	21	25	22	201
Others	0	0	1	2	2	3	3	4	4	4	23
Total	121	126	137	157	186	192	192	191	199	192	1,693

Source: Prepared by the authors.

In order to define the sample, financial-sector firms were excluded due to their specific regulatory requirements and distinct operational structures, which could compromise the comparability of the results (Richartz & Borgert, 2020), as well as those that did not have activity in at least one of the years in the net sales revenue (NSR), cost of goods sold (COGS), or selling, general, and administrative expenses (SG&A) accounts, and firms that did not appear in the sample for at least 3 years. Firms that did not have a defined sector in the database were classified as “others.”

In terms of handling outliers, changes in NSR exceeding 100% relative to the previous year were used as the cutoff criterion for both increases and decreases in revenue. These extreme variations were considered indicative of extraordinary events, such as mergers or acquisitions, which may affect the cost structure and compromise the analysis for the corresponding period. Table 2 presents the research construct.

Table 2
Research construct

Variable	Description	Metric	Authors
Dependent variables			
LOGTC	Total cost variation	Logarithm of the variation in TC relative to the immediately preceding year (t/t-1)	Richartz and Borgert (2020)
LOGCOGS	Cost of goods sold variation	Logarithm of the variation in COGS relative to the immediately preceding year (t/t-1)	Ibrahim et al. (2022)
LOGSG&A	Selling, general, and administrative expenses variation	Logarithm of the variation in SG&A relative to the immediately preceding year (t/t-1)	Anderson et al. (2003)
Independent variable			
ESG	Environmental, social, and governance performance	Overall firm score based on self-reported information across the environmental, social, and corporate governance pillars. Score ranging from 0 to 100.	Possebon et al. (2024), Usman et al. (2020)
Moderating variables			
EN1	New product development	Ratio of research and development expenditures to sales	Bentley et al. (2019)
EN2	Exploration of new product market opportunities	Ratio of selling, general, and administrative expenses to sales	
EN3	Growth opportunity	Annual sales growth rate	
EN4	Production and distribution efficiency	Ratio of the number of employees to sales	
EN5	Capital intensity	Ratio of property, plant, and equipment to total assets	
EN6	Management stability	Standard deviation of the number of employees	
Control variables			
SIZE	Firm size	Natural logarithm of total assets	Deconto et al. (2022)
ROA	Return on assets	Net income before extraordinary items/total assets	Usman et al. (2020)
LEV	Leverage	Total liabilities/total assets	Bentley et al. (2013)
AUD	Sustainability report audit	Dummy variable, equal to 0 for firms that do not have their ESG reports audited and 1 otherwise	Proposed by the authors
BDSIZE	Board size	Number of members of the board of directors	Usman et al. (2020)
PFBD	Female representation on the board of directors	Proportion of female directors on the board of directors	Hou and Zhang (2024)

BDIND	Board independence	Percentage of independent directors on the board of directors	Hou and Zhang (2024)
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Source: *Prepared by the authors.*

The dependent variable comprises the three cost groups used to measure cost asymmetry: total cost (TC), COGS, and SG&A. Each of these variables was calculated based on the annual change in the respective cost items relative to the previous period, following the model proposed by Anderson et al. (2003).

The independent variable, ESG performance, ESG pillars (Possebon et al., 2024). The choice of the ESG metric is based on its ability to synthesize information related to the ESG dimensions into a single indicator that is comparable across firms. ESG scores constitute one of the main metrics used in the literature to assess corporate ESG performance (Clément et al., 2025). In addition, such indicators are more suitable for representing firms’ aggregate ESG performance than specific constructs, such as sustainability or CSR (Clément et al., 2025), which is why they are employed in this study as the measure of ESG performance.

The variables comprising business strategy, as proposed by Bentley et al. (2019), use financial items to construct a proxy that classifies organizations as either strong prospectors or defenders. This classification is based on the typology proposed by Miles et al. (1978), which comprises six measures. Following this classification, a moving average is calculated for each metric based on the 5 years preceding the beginning of the analysis (for example, in order to calculate the 2015 moving average, data from 2010 to 2014 were used, and so on up to 2024).

The moving-average values of each of the six variables were grouped into quintiles, considering each sector and year. The scale of variable EN5 was reversed so that values in the fifth quintile represented the characteristics of prospector firms, consistent with the other variables (Bentley et al., 2019). The quintile values were then summed to develop a score for each firm, ranging from 8 to 23, which allows firms to be classified according to their strategy, with higher (lower) scores representing prospector (defender) firms.

Following Zhang (2020), the business strategy scores constructed as presented in Table 2 were organized into two mutually exclusive binary variables: (1) a value of 1 was assigned to firms with a prospector strategy (PROSP) when their score was above the 75th percentile, and 0 to firms with other strategies (defenders, analyzers, and reactors); and (2) a value of 1 was assigned to firms with a defender strategy (DEFEN) when their score was below the 25th percentile, and 0 to firms with other strategies (prospectors, analyzers, and reactors).

The baseline model proposed by Anderson et al. (2003) aims to capture changes in costs resulting from a 1% change in NSR, which is used as a proxy for firms’ production volume. In this model, the binary variable (dNSR) takes the value of 1 when firm *i*’s NSR in period *t* is lower than its NSR in period *t*–1, and 0 otherwise. When the increase in costs associated with a 1% increase in NSR is greater than the reduction in costs associated with a 1% decrease in NSR, the behavior is characterized as asymmetric sticky cost behavior. In this case, the coefficient β_1 should be greater than the sum of β_1 and β_2 ($\beta_1 > \beta_1 + \beta_2$). Thus, asymmetric sticky behavior can be identified by a negative β_2 coefficient. Conversely, when the reduction in costs associated with a 1% decrease in NSR is greater than the increase in costs associated with a 1% increase in NSR, the behavior is characterized as asymmetric anti-sticky cost behavior, which can be identified by a positive β_2 coefficient.

$$\begin{aligned}
\log \left\{ \frac{Costs_{i,t}}{Costs_{i,t-1}} \right\} = & \beta_0 + \beta_1 \log \left\{ \frac{NSR_{i,t}}{NSR_{i,t-1}} \right\} + \beta_2 dNSR \left\{ \frac{NSR_{i,t}}{NSR_{i,t-1}} \right\} + \beta_3 dNSR \\
& * \log \left\{ \frac{NSR_{i,t}}{NSR_{i,t-1}} \right\} * ESG_{i,t} + \beta_4 dNSR \left\{ \frac{NSR_{i,t}}{NSR_{i,t-1}} \right\} * PROSP_{i,t} \\
& + \beta_5 dNSR \left\{ \frac{NSR_{i,t}}{NSR_{i,t-1}} \right\} * DEFEN_{i,t} + \beta_6 dNSR \left\{ \frac{NSR_{i,t}}{NSR_{i,t-1}} \right\} * ESG_{i,t} * PROSP_{i,t} \\
& + \beta_7 dNSR \left\{ \frac{NSR_{i,t}}{NSR_{i,t-1}} \right\} * ESG_{i,t} * DEFEN_{i,t} + \varepsilon_{i,t}
\end{aligned} \tag{1}$$

where costs correspond to the different dependent variables used in the study (TC, COGS, SG&A), TC is the sum of COGS and SG&A, and ε is the regression error.

Eq. 1 was used to assess the moderating effect of business strategy on the relationship between ESG performance and cost asymmetry. This analysis was based on the combined signs of β_6 and β_2 for prospector firms and on the combined signs of β_2 and β_7 for defender firms. A negative β_6 coefficient indicates that prospector strategy acts to increase sticky cost behavior, either by attenuating the negative effect of ESG performance on sticky cost behavior (if β_3 is positive) or by strengthening its positive effect (if β_3 is negative). Similarly, a negative β_7 coefficient indicates that defender strategy acts to increase sticky cost behavior, either by attenuating the negative effect of ESG performance on sticky cost behavior (if β_3 is positive) or by strengthening its positive effect (if β_3 is negative).

The data were analyzed using multiple linear regression models estimated by ordinary least squares, controlling for sector and year fixed effects. For all hypotheses, two model specifications were estimated: one without control variables and another including the control variables. Regarding the regression assumptions, the use of robust standard errors mitigated heteroskedasticity concerns, multicollinearity was assessed using the variance inflation factor, residual autocorrelation was tested using the Durbin-Watson test, and the normality assumption was relaxed due to the large number of observations.

4. RESULTS

In order to demonstrate that changes in the cost items were identified as a result of a 1% variation in NSR, the coefficients reported in Table 3 can be examined. The table presents the coefficients of the variables LogNSR (under the “Increase” column) and dNSR*LogNSR (under the “Decrease” column). In these regression models, no control variables were included; only year and sector fixed effects were controlled for, and standard errors were clustered at the firm level.

Table 3*Summary of the impact on cost items of 1% changes in net sales revenue (NSR)*

Cost item	1% change in NSR		p>z	R ²	Asymmetry
	Increase	Decrease			
Total cost	0.85	0.15	0.00	0.77	Sticky costs
Cost of goods sold	0.89	0.04	0.00	0.75	Sticky costs
Selling, general, and administrative expenses	0.62	0.19	0.00	0.31	Sticky costs

Source: *Prepared by the authors.*

It can be observed that when NSR increases by 1%, firms' TC increases, on average, by 0.85%. Conversely, when NSR decreases by 1%, TC decreases by only 0.15%. This behavior evidences asymmetry in the response of costs to changes in revenues, a phenomenon known as sticky costs. These results corroborate the findings of Richartz and Borgert (2020), who also identified asymmetric cost behavior among Brazilian firms over a 20-year period, based on 11 different explanatory factors. The results are also consistent with the study by Medeiros et al. (2005), which investigated Brazilian firms across various sectors over a 16-year period.

It is worth noting that the coefficient of determination, measured by the R² of the model relating NSR to SG&A expenses, indicates that only 31% of the variation in this cost item is explained by changes in NSR. This result suggests a low explanatory power of revenues for expense components, which is consistent with the observations of Richartz and Borgert (2020), who indicate that the influence of NSR is more significant on TC and COGS than on operating expenses (SG&A).

Table 4 presents the results for each of the hypotheses tested. Each of the models reported (Models 1, 2, and 3) corresponds to one of the respective hypotheses.

Table 4
Results of the relationships and moderating effect

[illegible]

No. of Obs.	1,693	1,693	1,693	1,693	1,693	1,693	1,693	1,693	1,693
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
VIF	3.327	3.327	3.327	4.029	4.029	4.029	5.093	5.093	5.093

Note: *The variables are described in Table 2.*

FE = fixed effects; VIF = variance inflation factor.

**** = significant at the 1% level; ** = significant at the 5% level; * = significant at the 10% level.*

Source: *Prepared by the authors.*

First, it is observed that the variables $\log\text{NSR}$ and $\log\text{NSR_dNSR}$ (representing increases and decreases in NSR) have a positive and statistically significant relationship with TCs (LOGTC) at the 1% level for Models 1 and 3 and at the 5% level for Model 2. The negative coefficients of the $\log\text{NSR_dNSR}$ variable indicate that, when revenues increase by 1%, TCs increase by approximately 86%, whereas when revenues decrease by 1%, TCs (LOGTC) decrease by only 16%, 20%, and 20% for Models 1, 2, and 3, respectively, reinforcing the asymmetric sticky cost behavior, consistent with the findings reported by Richartz and Borgert (2020). In Model 1, the interaction between the revenue variables and ESG performance ($\log\text{NSR_dNSR_ESG}$) did not yield statistically significant coefficients for any of the three types of costs (LOGTC, LOGCOGS, or LOGSG&A).

This result indicates that, in general, ESG performance does not exert a statistically significant influence on firms' total costs, suggesting a lack of empirical evidence that ESG practices directly affect cost asymmetry. These findings differ from those reported by Golden et al. (2020) and Habib and Hasan (2019), who found that cost asymmetry is significantly and positively associated with sustainability-related factors and ESG performance.

The behavior observed for ESG may reflect the stage of maturity of sustainable practices among Brazilian firms (Possebon et al., 2024). Unlike the findings reported by DasGupta and Roy (2023) and Li et al. (2024), which identify tangible operational impacts arising from the adoption of more robust ESG policies, the Brazilian context appears to reflect a scenario in which ESG still plays a more institutional than operational role. Accordingly, the absence of a significant association between ESG and cost asymmetry suggests that the ESG performance of Brazilian firms has not yet been fully integrated into decision-making processes involving capacity adjustments, organizational structure, and expenditures (Possebon et al., 2024).

The literature also suggests that firms with stronger governance and more developed social and environmental policies tend to exercise greater discipline in resource management, avoiding unnecessary expenditures and reducing rigid cost behavior (DasGupta & Roy, 2023). Nonetheless, under the assumptions of CT, these effects tend to emerge only when there is alignment among practices, strategy, and the organizational environment (Chenhall, 2003; Donaldson, 2006). This helps to explain the lack of influence of ESG on sticky cost behavior among the firms analyzed.

The divergence from the findings reported by Deconto et al. (2022), Golden et al. (2020), Habib and Hasan (2019), and Huang and Wang (2024) may indicate that the ESG practices of the firms analyzed have not yet been sufficiently integrated into resource management decisions to produce the resource retention and cost rigidity effects identified in the literature. Accordingly, the impact of ESG performance on cost asymmetry may depend on the alignment among strategy, governance, and control systems (Chenhall, 2003; Donaldson, 2006; Li et al., 2024).

ESG practices require firms to make continuous investments, and their benefits may only become apparent in the long term (Li et al., 2024). The findings of this study suggest that, in the Brazilian context examined, managers reduce expenditures on ESG practices during periods of declining revenues in order to preserve short-term performance.

From a contingency perspective, the lack of statistical significance may indicate that the effect of ESG performance on cost rigidity is not uniform across the Brazilian firms in the sample. In some firms, ESG performance may increase cost rigidity due to the maintenance of social and environmental programs. In others, ESG performance may enhance operational efficiency and facilitate cost adjustments. This behavior is consistent

with the assumption that the same management practice may produce different outcomes depending on factors related to the competitive environment, organizational maturity, governance structure, technological intensity, strategy, and sector-specific characteristics.

According to Model 2, the variables `logNSR_dNSR_PROSP` and `logNSR_dNSR_DEFEN`, which represent the interaction between the revenue variables and the prospector and defender strategies, respectively, did not exhibit statistical significance, indicating that, for the sample analyzed, strategic types do not substantially alter the asymmetric behavior of costs. These results are supported by studies such as those of Ballas et al. (2020) and Widyasari (2018), which highlight that the influence of business strategy on costs may be less evident in emerging markets such as Brazil, where managerial practices do not necessarily correspond to the stated strategic classification.

The results presented suggest the rejection of hypothesis 2 and show that both the prospector and defender strategies exhibited positive and statistically non-significant coefficients for `LOGTC` and `LOGSG&A`. These findings contradict those reported by Karampinis et al. (2024), who indicate that prospector firms tend to exhibit greater cost rigidity during periods of declining activity due to the need to sustain continuous investments in innovation and internal capabilities. In addition, defender organizations tend to adjust costs more responsively to revenue fluctuations, given their emphasis on efficiency and operational stability (Karampinis et al., 2024).

The results of Model 2, concerning the strategic variables tested to address hypothesis 2, demonstrate that, although the prospector strategy is theoretically associated with more rigid cost structures, it did not yield statistically significant coefficients confirming the expected positive relationship with cost asymmetry. This finding contrasts with the study by Ballas et al. (2020), which indicates that prospector firms tend to maintain high levels of continuous investment in innovation, technology, and internal capabilities, naturally limiting their ability to reduce costs during periods of revenue decline.

Miles et al. (1978) had already highlighted that prospector firms tend to exhibit more complex and decentralized structures oriented toward the development of new products and markets, making their expenditures less adjustable in the short term. Similarly, Bentley et al. (2019) emphasize that, given the exploratory nature of this strategy, such organizations face greater difficulty in reducing discretionary resources during periods of declining revenues. Nevertheless, the absence of statistical significance in the coefficients indicates that, in the Brazilian context of the firms analyzed, this rigidity did not manifest itself in a statistically robust manner.

Regarding the other end of the business strategy spectrum, defender firms tend to operate with more stable structures, more formalized routines, and a focus on internal efficiency (Zhang, 2020). Karampinis et al. (2024) found that defender firms prioritize cost control, process standardization, and resource optimization, characteristics that facilitate more rapid adjustments during periods of declining demand. However, the results obtained did not provide statistical evidence to confirm this behavior.

From the perspective of CT, firms classified as prospectors may simultaneously maintain cost control mechanisms, whereas firms classified as defenders may be required to make continuous investments to remain competitive. Thus, classifying firms as prospectors or defenders did not generate operational differences sufficient to produce asymmetric cost behavior.

This result suggests that the business strategies adopted by firms, in isolation, may have limited explanatory power for cost asymmetry. From a CT perspective, cost behavior is

influenced by several organizational and environmental factors, such as sector characteristics, the competitive environment, governance structure, and control systems (Chenhall, 2003; Donaldson, 2006). Furthermore, Xu and Zheng (2018) suggest that the alignment of business strategy with internal processes and organizational logic may explain the absence of significant differences.

When analyzing the main variables of the proposed moderating effect, $\log\text{NSR_dNSR_ESG_PROSP}$ and $\log\text{NSR_dNSR_ESG_DEFEN}$, presented in Table 4, no statistical significance was observed in any of the models for the cost components. Prospector and defender firms exhibited similar behavior, providing no evidence that strategy strengthens or attenuates the effect of ESG performance on cost rigidity. The findings indicate that asymmetric cost behavior exists among the firms in the sample; however, this behavior is not affected by ESG performance or by the business strategy adopted.

The results obtained for hypothesis 3 show that business strategies do not act as moderators of the relationship between ESG performance and cost asymmetry. The absence of statistical significance in the interaction terms suggests that, even when firms exhibit higher levels of ESG performance, the way they respond to increases or decreases in revenue does not vary according to their strategic type.

This evidence contrasts with the classical view of Miles et al. (1978), according to which prospector and defender organizations exhibit distinct structures and operational responses. It also differs from the findings of Bentley et al. (2019), who argue that prospector strategies tend to be associated with more rigid costs, and from those of Karampinis et al. (2024), who suggest that defender strategies enable firms to adjust costs more efficiently.

Furthermore, the lack of statistical significance in the moderating effect analysis may indicate that ESG practices have not yet reached a sufficient level of maturity to influence cost behavior in an integrated manner with organizational strategy (Possebon et al., 2024). This argument is consistent with studies indicating that, for ESG performance to generate significant operational impacts, it must be aligned with internal processes, governance, and the firm's strategic logic (DasGupta & Roy, 2023; Li et al., 2024).

The results observed suggest that, among Brazilian firms, ESG operates relatively independently of business strategy, without the necessary synergy to shape more or less rigid cost behavior. This interpretation is also supported by research such as Possebon et al. (2024), which shows that ESG practices remain unevenly developed across Brazilian firms and are often adopted on a piecemeal basis, thereby limiting their ability to influence deeper managerial systems.

In summary, the results suggest that, during the period and within the context of the Brazilian firms analyzed, prospector and defender strategies did not exhibit sufficiently distinct behaviors to influence cost asymmetry. Although the literature associates prospector strategies with the maintenance of continuous investments in innovation, technology, and market development, which tends to hinder cost reductions during periods of contraction (Ballas et al., 2020; Bentley et al., 2019), and defender strategies with structures more strongly oriented toward control, standardization, and operational efficiency (Karampinis et al., 2024; Zhang, 2020), these differences were not reflected in a statistically significant manner in the sample examined. This result suggests that business strategies, in isolation, may not be sufficient to explain asymmetric cost behavior, particularly in environments where organizational factors may attenuate the expected differences between strategic typologies.

Under the assumptions of CT, there is no organizational structure or management practice that produces the same outcomes across all firms. Its effects depend on the fit between organizational characteristics and environmental conditions. The absence of a moderating effect in the Brazilian context investigated may be interpreted as evidence of a lack of alignment among the ESG practices implemented, the business strategies adopted, and the mechanisms used to manage costs by the firms in the sample.

Unreported regression models were estimated as additional tests. The additional tests examined whether ESG performance and business strategies (prospector, defender, analyzer/reactor), considered alone, without the interactions with the revenue variable, influenced cost asymmetry (LOGTC, LOGCOGS, and LOGSG&A). The results indicated that the regressions exhibited multicollinearity issues and that the coefficients were not statistically significant, reinforcing the behavior observed for the variables in the respective interaction terms.

The ESG measure was operationalized using a categorical variable identifying firms with ESG scores above the 90th percentile, in order to investigate whether the relationships examined differed among firms with a high level of engagement in ESG practices. The results remained unchanged relative to the main analyses, suggesting that the findings are not driven by organizations with high levels of ESG performance.

Alternative models were estimated to test the relationships proposed in H_1 and H_3 , considering the ESG dimensions independently. The results remained consistent with those obtained for aggregate ESG performance, indicating that these dimensions do not exhibit distinct effects when analyzed individually.

Subsamples were also constructed for firms belonging to environmentally sensitive and non-environmentally sensitive sectors, following the approach adopted by Cai et al. (2012), Garcia et al. (2017), and Kumari et al. (2022). The results indicated no differences in the behavior of the relationships investigated between these two groups.

Finally, subsample analyses considering the pandemic period (2020 and 2021) and the non-pandemic period revealed that, during the pandemic, firms with higher ESG performance adjusted their costs more substantially in response to declining revenues than other firms. A possible explanation for this behavior stems from the premise that firms with ESG practices are more committed to resource-use efficiency, governance quality (Eccles et al., 2014), and risk management (Hoepner et al., 2024). In a context of uncertainty such as that experienced during the COVID-19 pandemic, this commitment may have enabled more timely adjustments of resources in response to the contraction in business activity while also supporting the achievement of short-term financial objectives.

5. CONCLUSION

The main objective of this study was to assess business strategies as a contingency factor in the relationship between ESG performance and cost asymmetry in Brazilian firms. In this regard, the study provided insights into how aspects related to ESG performance and the adoption of prospector and defender strategies may affect cost behavior.

The results suggest that, in the Brazilian context investigated, ESG performance does not influence cost rigidity. This finding reinforces the perspective of CT, according to which management practices do not produce the same effects across different environments. ESG maturity in Brazil still appears to be limited, and its integration into internal processes remains uneven, which helps to explain the rejection of H_1 .

The results concerning the relationship between business strategies and cost asymmetry also showed no statistical significance in any of the estimated models, leading to the rejection of H₂. Although they represent distinct strategic positions, neither the prospector nor the defender strategy, considered in isolation, proved to be a determinant of the rigid cost pattern observed among Brazilian firms.

Regarding the moderating effects, the findings indicate that, in the Brazilian context, business strategies do not alter the way ESG performance relates to cost asymmetry, leading to the rejection of hypothesis H₃. The absence of statistical significance suggests that ESG and business strategy may still operate as isolated elements without being aligned within the decision-making processes of Brazilian firms. This reinforces the notion that, although sustainable practices are important from an institutional and social perspective, they are not yet sufficiently integrated into operational logic to modify cost behavior in response to fluctuations in revenue.

Furthermore, additional tests showed that the findings remain consistent under different approaches to measuring ESG performance, when its dimensions are analyzed independently, and when the sample is divided between environmentally sensitive and non-sensitive sectors. Additionally, the results point to the pandemic as a relevant context in which ESG contributed to more timely cost adjustments in response to declining revenues.

The study contributes to the literature by confirming the presence of asymmetric costs among Brazilian firms listed on B3 S.A. – Brasil, Bolsa, Balcão. However, its main theoretical contribution lies in indicating that cost rigidity is determined by contingencies that are more relevant than ESG performance or business strategy, which may be associated with aspects of labor legislation, production structure, capital intensity, sector characteristics, or the macroeconomic environment.

From a practical perspective, the results provide evidence of the consistent presence of sticky cost behavior, reinforcing the need for managers to pay close attention to internal structures that hinder expenditure adjustments during periods of declining revenues, as well as to the importance of integrating ESG practices into strategic planning and organizational processes. This integration can help to avoid isolated initiatives and promote greater efficiency, particularly in firms pursuing more aggressive strategies focused on expansion and innovation.

From a social perspective, the study contributes by highlighting the relevance of ESG practices not only to firms' economic efficiency but also to community well-being and environmental preservation. Furthermore, it promotes greater awareness of the adoption of sustainable and responsible business strategies, with the potential to influence investment decisions and strengthen a more balanced economic environment aligned with the principles of sustainable development and CSR.

Taken together, the results reinforce one of the premises of CT, namely, that there are no universally valid relationships between organizational practices and managerial outcomes. The absence of significant effects of both ESG performance and business strategy suggests that cost asymmetry in the firms investigated may be conditioned by other organizational and environmental contingencies not captured by the model employed. The findings suggest that ESG maturity is heterogeneous across the firms analyzed and that the strategic typology may not capture actual operational differences. The results indicate that ESG practices and strategic orientation, whether considered independently or jointly, do not constitute sufficient contingencies to explain asymmetric cost behavior in the context analyzed.

One of the main limitations of the study is that external economic context variables, such as macroeconomic and geopolitical factors and public health crises, were not incorporated into the analysis. These factors may influence strategic decisions, cost adjustments, and sustainable investments.

Although the results differed from expectations, they point to opportunities for further research from the perspective of CT. Future studies could incorporate other contingency variables that may be more relevant for explaining the relationship between ESG performance and cost asymmetry, such as organizational life cycle, ownership structure, and technological intensity. Another avenue would be to investigate intermediate mechanisms, such as operational efficiency, governance quality, and innovation capability, as mediators of the relationship between ESG performance and cost asymmetry.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The entire dataset supporting the results of this study can be made available upon request to the authors.

DECLARAÇÃO DE USO DE INTELIGÊNCIA ARTIFICIAL

The authors declare that no generative artificial intelligence was used in any stage of the production of this manuscript (including research, writing, data analysis, formula generation, or the creation of graphic elements).

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APPENDIX**ESG Dimensions Analyzed Independently (Supplementary Tables 1, 2 and 3)****Supplementary Table 1**

Results of the relationships and moderating effect for the environmental dimension

	Model 1 (hypothesis 1)			Model 2 (hypothesis 3)		
	TC	COGS	SG&A	TC	COGS	SG&A
logNSR	0.862*** (32.81)	0.901*** (32.35)	0.618*** (12.39)	0.861*** (32.57)	0.903*** (32.41)	0.622*** (12.53)
dNSR	-0.151*** (-2.71)	-0.027 (-0.40)	-0.186* (-1.67)	-0.214** (-2.44)	-0.097 (-0.98)	-0.291* (-1.74)
logNSR × dNSR × ENV	0.016 (0.13)	-0.071 (-0.54)	0.075 (0.36)	0.120 (0.66)	0.038 (0.17)	0.305 (0.98)
logNSR × dNSR × PROSP				0.073 (0.73)	-0.042 (-0.36)	0.039 (0.18)
logNSR × dNSR × DEFEN				0.105 (1.30)	0.132 (1.36)	0.202 (1.17)

logNSR × dNSR × ENV × PROSP	-0.164	0.009	-0.110			
	(-0.71)	(0.04)	(-0.27)			
logNSR × dNSR × ENV × DEFEN	0.235	0.122	-1.279			
	(0.52)	(0.23)	(-1.60)			
SIZE	0.005**	0.005*	0.002	0.005**	0.004*	0.001
	(2.34)	(1.96)	(0.37)	(2.17)	(1.77)	(0.32)
ROA	-0.122***	-0.173***	-0.116	-0.121***	-0.175***	-0.121
	(-3.06)	(-2.84)	(-1.36)	(-3.00)	(-2.79)	(-1.42)
LEV	-0.015	-0.022	0.026	-0.012	-0.019	0.026
	(-0.93)	(-1.15)	(0.89)	(-0.77)	(-1.02)	(0.87)
AUD	0.006	0.012*	-0.012	0.005	0.012*	-0.010
	(1.03)	(1.73)	(-0.82)	(0.85)	(1.69)	(-0.69)
BDSIZE	-0.135	-0.146	-0.065	-0.110	-0.115	-0.078
	(-1.57)	(-1.47)	(-0.39)	(-1.26)	(-1.14)	(-0.48)
PFBD	-0.049	-0.045	0.004	-0.050	-0.048	0.003
	(-1.57)	(-1.13)	(0.08)	(-1.64)	(-1.24)	(0.06)
BDIND	0.001	-0.004	-0.002	0.002	-0.004	-0.002
	(0.08)	(-0.23)	(-0.11)	(0.16)	(-0.20)	(-0.08)
Constant	-0.099**	-0.099*	-0.041	-0.090*	-0.089	-0.033
	(-1.97)	(-1.66)	(-0.46)	(-1.82)	(-1.51)	(-0.36)
R ²	0.772	0.754	0.311	0.773	0.755	0.314
Model Sig.	0.000	0.000	0.000	0.000	0.000	0.000
No. of Obs.	1,693	1,693	1,693	1,693	1,693	1,693
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The variables are described in Table 2. Standard errors in parentheses. Robust standard errors clustered by firm.

FE = fixed effects.

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

Source: Prepared by the authors.

Supplementary Table 2

Results of the relationships and moderating effect for the social dimension

	Model 1			Model 2		
	TC	COGS	SG&A	TC	COGS	SG&A
logNSR	0.862***	0.901***	0.619***	0.863***	0.903***	0.621***
	(32.87)	(32.62)	(12.36)	(33.14)	(32.71)	(12.43)
dNSR	-0.141***	-0.005	-0.199*	-0.163**	-0.035	-0.250
	(-3.12)	(-0.09)	(-1.77)	(-2.48)	(-0.51)	(-1.48)
logNSR × dNSR × SOC	-0.038	-0.156	0.121	-0.162	-0.257	0.049
	(-0.19)	(-0.71)	(0.53)	(-0.50)	(-0.68)	(0.14)
logNSR × dNSR × PROSP				-0.052	-0.128	-0.109
				(-0.55)	(-1.21)	(-0.52)
logNSR × dNSR × DEFEN				0.038	0.065	0.108
				(0.55)	(0.79)	(0.62)

logNSR × dNSR × SOC × PROSP	0.293	0.367	0.426			
	(0.87)	(0.94)	(1.04)			
logNSR × dNSR × SOC × DEFEN	0.477	0.417	0.124			
	(1.28)	(0.95)	(0.22)			
SIZE	0.005**	0.005*	0.002	0.004**	0.004	0.001
	(2.29)	(1.83)	(0.43)	(2.05)	(1.60)	(0.32)
ROA	-0.124***	-0.176***	-0.114	-0.125***	-0.180***	-0.118
	(-3.18)	(-2.93)	(-1.33)	(-3.20)	(-2.94)	(-1.39)
LEV	-0.015	-0.022	0.026	-0.013	-0.020	0.027
	(-0.93)	(-1.16)	(0.88)	(-0.81)	(-1.04)	(0.91)
AUD	0.006	0.012*	-0.013	0.004	0.011	-0.013
	(0.99)	(1.71)	(-0.84)	(0.66)	(1.50)	(-0.89)
BDSIZE	-0.140*	-0.155	-0.060	-0.118	-0.129	-0.047
	(-1.72)	(-1.63)	(-0.36)	(-1.50)	(-1.38)	(-0.29)
PFBD	-0.047	-0.042	0.003	-0.042	-0.038	0.010
	(-1.53)	(-1.07)	(0.05)	(-1.37)	(-0.98)	(0.19)
BDIND	0.000	-0.006	-0.001	0.002	-0.005	-0.001
	(0.03)	(-0.33)	(-0.04)	(0.11)	(-0.26)	(-0.03)
Constant	-0.094*	-0.091	-0.046	-0.087*	-0.082	-0.038
	(-1.93)	(-1.55)	(-0.51)	(-1.76)	(-1.38)	(-0.42)
R ²	0.772	0.754	0.311	0.774	0.756	0.313
Model Sig.	0.000	0.000	0.000	0.000	0.000	0.000
No. of Obs.	1,693	1,693	1,693	1,693	1,693	1,693
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The variables are described in Table 2. Standard errors in parentheses. Robust standard errors clustered by firm.

FE = fixed effects.

* = $p < 0.10$; ** = $p < 0.05$; *** = $p < 0.01$.

Source: Prepared by the authors.

Supplementary Table 3

Results of the relationships and moderating effect for the governance dimension

	Model 1			Model 2		
	TC	COGS	SG&A	TC	COGS	SG&A
logNSR	0.863***	0.901***	0.620***	0.864***	0.905***	0.624***
	(32.80)	(32.48)	(12.36)	(33.00)	(32.49)	(12.48)
dNSR	-0.168***	-0.038	-0.233**	-0.200***	-0.080	-0.289*
	(-3.21)	(-0.59)	(-2.01)	(-2.72)	(-0.98)	(-1.71)
logNSR × dNSR × GOV	0.085	0.002	0.254	-0.004	-0.081	0.242
	(0.81)	(0.01)	(1.47)	(-0.01)	(-0.26)	(0.74)
logNSR × dNSR × PROSP				-0.031	-0.142	-0.120
				(-0.28)	(-1.08)	(-0.55)
logNSR × dNSR × DEFEN				0.070	0.100	0.123
				(0.95)	(1.14)	(0.69)

logNSR × dNSR × GOV × PROSP	0.146	0.292	0.270			
	(0.51)	(0.86)	(0.65)			
logNSR × dNSR × GOV × DEFEN	0.215	0.206	0.010			
	(0.77)	(0.62)	(0.03)			
SIZE	0.005**	0.005**	0.002	0.005**	0.004*	0.001
	(2.50)	(2.08)	(0.50)	(2.17)	(1.74)	(0.35)
ROA	-0.120***	-0.171***	-0.110	-0.123***	-0.177***	-0.116
	(-3.01)	(-2.81)	(-1.28)	(-3.07)	(-2.85)	(-1.35)
LEV	-0.014	-0.022	0.027	-0.013	-0.020	0.028
	(-0.91)	(-1.15)	(0.90)	(-0.79)	(-1.05)	(0.92)
AUD	0.006	0.013*	-0.014	0.004	0.011	-0.014
	(0.99)	(1.77)	(-0.91)	(0.68)	(1.52)	(-0.97)
BDSIZE	-0.128	-0.139	-0.045	-0.112	-0.119	-0.032
	(-1.56)	(-1.45)	(-0.27)	(-1.38)	(-1.23)	(-0.19)
PFBD	-0.050	-0.046	0.001	-0.046	-0.043	0.004
	(-1.60)	(-1.16)	(0.02)	(-1.51)	(-1.12)	(0.08)
BDIND	0.003	-0.004	0.003	0.004	-0.002	0.005
	(0.21)	(-0.21)	(0.15)	(0.25)	(-0.12)	(0.21)
Constant	-0.104**	-0.105*	-0.054	-0.091*	-0.088	-0.041
	(-2.13)	(-1.78)	(-0.61)	(-1.87)	(-1.51)	(-0.46)
R ²	0.772	0.754	0.313	0.773	0.756	0.314
Model Sig.	0.000	0.000	0.000	0.000	0.000	0.000
No. of Obs.	1,693	1,693	1,693	1,693	1,693	1,693
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The variables are described in Table 2. Standard errors in parentheses. Robust standard errors clustered by firm.

FE = fixed effects.

* = $p < 0.10$; ** = $p < 0.05$; *** = $p < 0.01$.

Source: Prepared by the authors.

.Environmentally Sensitive and Non-Sensitive Sectors (Supplementary Table 4)

Based on Cai et al. (2012), Garcia et al. (2017), and Kumari et al. (2022), environmentally sensitive sectors were classified as those whose activities are more exposed to environmental impacts, regulatory pressures, and reputational risks. According to the Global Industry Classification Standard sector classification, a value of 1 was assigned to the energy sector (including oil and gas), chemicals, paper and pulp, mining, and steel, and 0 otherwise. Accordingly, the sample consisted of 249 observations from environmentally sensitive sectors and 1,444 observations from non-sensitive sectors.

Supplementary Table 4

Moderating effect results for the subsamples of environmentally sensitive and non-sensitive sectors

	Sensitive sectors			Non-sensitive sectors		
	TC	COGS	SG&A	TC	COGS	SG&A
logNSR	0.763*** (14.49)	0.816*** (13.89)	0.389*** (3.22)	0.897*** (30.99)	0.937*** (30.92)	0.675*** (12.17)
dNSR	0.051 (0.58)	0.147 (1.61)	0.330* (1.93)	-0.266*** (-3.18)	-0.146 (-1.58)	-0.400** (-2.04)
logNSR × dNSR × ESG	-0.174 (-0.55)	-0.530* (-1.80)	0.942 (1.29)	0.082 (0.29)	0.041 (0.12)	0.235 (0.59)
logNSR × dNSR × PROSP	-0.157 (-0.92)	-0.186 (-0.85)	-0.390 (-1.43)	0.037 (0.33)	-0.084 (-0.64)	-0.021 (-0.08)
logNSR × dNSR × DEFEN	-0.136 (-1.19)	-0.218* (-1.76)	-0.827* (-1.85)	0.095 (1.16)	0.132 (1.40)	0.216 (1.10)
logNSR × dNSR × ESG × PROSP	0.074 (0.16)	0.174 (0.38)	-0.187 (-0.27)	0.071 (0.22)	0.225 (0.62)	0.217 (0.45)
logNSR × dNSR × ESG × DEFEN	-0.272 (-0.64)	-0.154 (-0.36)	1.176 (1.05)	0.345 (0.98)	0.230 (0.56)	-0.069 (-0.11)
SIZE	0.005 (1.18)	0.002 (0.43)	0.011 (1.07)	0.006** (2.52)	0.007** (2.36)	-0.001 (-0.12)
ROA	-0.186* (-1.99)	-0.257** (-2.50)	0.088 (0.42)	-0.111** (-2.44)	-0.174** (-2.34)	-0.091 (-0.95)
LEV	-0.025 (-1.07)	-0.038 (-1.36)	0.031 (0.53)	-0.009 (-0.51)	-0.018 (-0.83)	0.043 (1.25)
AUD	0.008 (0.58)	0.009 (0.57)	0.012 (0.32)	0.003 (0.44)	0.010 (1.36)	-0.019 (-1.18)
BDSIZE	0.034 (0.25)	0.067 (0.53)	-0.272 (-0.72)	-0.102 (-1.07)	-0.102 (-0.86)	0.033 (0.18)
PFBD	-0.279*** (-4.45)	-0.339*** (-4.85)	0.194 (0.99)	-0.028 (-0.92)	-0.017 (-0.44)	-0.031 (-0.57)
BDIND	-0.016 (-0.46)	-0.013 (-0.37)	-0.065 (-1.02)	0.004 (0.26)	-0.008 (-0.37)	0.022 (0.96)
Constant	-0.067 (-0.79)	0.013 (0.15)	-0.239 (-1.11)	-0.124** (-2.26)	-0.146** (-2.13)	-0.016 (-0.16)
R ²	0.815	0.814	0.274	0.777	0.758	0.344
Model Sig.	0.000	0.000	0.000	0.000	0.000	0.000
No. of Obs.	249	249	249	1,444	1,444	1,444
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The variables are described in Table 2. Standard errors in parentheses. Robust standard errors clustered by firm.

FE = fixed effects.

* = $p < 0.10$; ** = $p < 0.05$; *** = $p < 0.01$.

Source: Prepared by the authors.

Pandemic Period (2020 and 2021) (Supplementary Table 5)

In order to examine whether the crisis context potentially affected the relationships investigated, the years 2020 and 2021 were classified as the critical period of the COVID-19 pandemic. This delimitation is based on the high intensity of the health, social, and economic impacts observed during these years, when the World Health Organization (WHO, 2022) estimated approximately 14.9 million excess deaths worldwide.

Supplementary Table 5

Moderating effect results for the pandemic (2020 and 2021) and non-pandemic period subsamples

	Pandemic period			Non-pandemic period		
	TC	COGS	SG&A	TC	COGS	SG&A
logNSR	0.906*** (24.61)	0.928*** (24.14)	0.787*** (9.19)	0.850*** (27.43)	0.894*** (27.43)	0.557*** (9.05)
dNSR	-0.135** (-2.24)	0.031 (0.49)	-0.162 (-1.07)	-0.207** (-2.37)	-0.097 (-1.00)	-0.276 (-1.35)
logNSR × dNSR × ESG	0.152** (2.02)	0.129* (1.90)	0.479* (1.78)	-0.076 (-0.24)	-0.181 (-0.49)	0.049 (0.14)
logNSR × dNSR × PROSP	-0.191 (-1.56)	-0.443* (-1.87)	-0.229 (-0.53)	0.037 (0.33)	-0.036 (-0.28)	-0.031 (-0.13)
logNSR × dNSR × DEFEN	0.121 (1.35)	0.111 (0.99)	-0.058 (-0.32)	0.065 (0.76)	0.110 (1.07)	0.180 (0.83)
logNSR × dNSR × ESG × PROSP	-0.318 (-1.49)	0.120 (0.24)	-0.433 (-0.58)	0.184 (0.52)	0.288 (0.72)	0.466 (1.01)
logNSR × dNSR × ESG × DEFEN	1.135 (0.99)	0.921 (0.73)	0.370 (0.16)	0.330 (0.95)	0.286 (0.69)	0.024 (0.04)
SIZE	0.001 (0.28)	0.003 (0.67)	-0.009 (-0.83)	0.005** (2.05)	0.005 (1.57)	0.003 (0.66)
ROA	-0.289** (-2.51)	-0.128 (-1.24)	-0.755*** (-3.61)	-0.055 (-1.24)	-0.166** (-2.23)	0.058 (0.55)
LEV	-0.034 (-0.89)	-0.020 (-0.54)	-0.018 (-0.27)	-0.005 (-0.27)	-0.020 (-1.02)	0.040 (1.19)
AUD	-0.012 (-0.86)	-0.004 (-0.27)	-0.035 (-1.22)	0.013* (1.82)	0.019** (2.24)	-0.002 (-0.11)
BDSIZE	0.122 (0.86)	0.069 (0.42)	0.357 (1.07)	-0.175* (-1.83)	-0.177 (-1.50)	-0.155 (-0.81)
PFBD	-0.055 (-0.95)	0.019 (0.28)	-0.075 (-0.60)	-0.060 (-1.65)	-0.079* (-1.78)	0.021 (0.38)
BDIND	0.005 (0.24)	-0.020 (-0.75)	0.024 (0.53)	0.002 (0.10)	0.002 (0.10)	-0.006 (-0.20)
Constant	0.013 (0.13)	-0.052 (-0.45)	0.237 (1.03)	-0.115** (-2.09)	-0.103 (-1.59)	-0.088 (-0.83)
R ²	0.814	0.803	0.438	0.756	0.735	0.271

Model Sig.	0.000	0.000	0.000	0.000	0.000	0.000
No. of Obs.	384	384	384	1,309	1,309	1,309
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: *The variables are described in Table 2. Standard errors in parentheses. Robust standard errors clustered by firm.*

FE = fixed effects.

** = $p < 0.10$; ** = $p < 0.05$; *** = $p < 0.01$.*

Source: *Prepared by the authors.*

In Supplementary Table 5, a positive coefficient was observed for the variable $\log\text{NSR} \times \text{dNSR} \times \text{ESG}$, significant at the 5% level for total costs and at the 10% level for COGS and SG&A. Although results significant at the 10% level are statistically sensitive, the overall set of findings may provide evidence that, during the pandemic, firms with higher ESG performance adjusted their costs more intensively in response to declining revenues than other firms. One possible explanation for this behavior stems from the premise that firms with ESG practices are more committed to resource-use efficiency, governance quality (Eccles et al., 2014), and risk management (Hoepner et al., 2024). In a context of uncertainty such as the pandemic, this commitment may have enabled more timely adjustments of resources in response to the contraction in business activity.

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