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RELATIONSHIP BETWEEN SYSTEMATIC RISK AND ESG IN BRAZIL

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ABSTRACT

Sustainability has become a central concern for both academia and financial markets, particularly regarding the potential of Environmental, Social, and Governance (ESG) practices to mitigate corporate risk. This study addresses the limited empirical evidence from developing economies by examining whether ESG performance influences systematic risk among publicly traded firms in Brazil, an emerging market characterized by volatility and evolving sustainability practices. Using a quantitative approach, this research employs panel data regression models with fixed effects, based on 456 firm-year observations from 108 companies listed on B3 between 2015 and 2023. ESG indicators were obtained from Refinitiv Eikon™ (LSEG), one of the most widely used databases in the literature. Four regression models were constructed: one for the composite ESG score and three for the individual environmental, social, and governance pillars. The robustness of the analysis was verified through winsorization, variance inflation factor (VIF) tests, heteroskedasticity checks, and the Hausman specification test to ensure estimator reliability. The results indicate that only the environmental pillar exhibits a statistically significant negative relationship with systematic risk ($\beta = -0.00032$; $p = 0.058$), suggesting that better environmental performance is associated with lower exposure to market volatility. The composite ESG score and the social and governance dimensions did not show significant effects. These findings diverge from those in developed economies, where ESG performance is often linked to risk reduction.The study provides novel empirical evidence on the partial risk-mitigating role of ESG in emerging markets, highlighting the relevance of environmental practices as the only dimension currently priced by investors in Brazil. It advances the understanding of how institutional maturity and market structure influence the financial materiality of ESG factors, offering implications for policymakers, investors, and researchers interested in sustainable finance in developing contexts.

Keywords: ESG. CSR. Risk. Brazil. Emerging Markets.

Edited in English.

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1 INTRODUCTION

Sustainability has become an increasingly central issue in recent decades, as the survival of societies depends on a transition toward more sustainable patterns of production and consumption (United Nations, 2020). This relevance is clearly reflected in the corporate world: investments in Environmental, Social, and Governance (ESG) assets are expected to surpass USD 50 trillion by 2025 (Bloomberg, 2021). Academia has followed this trend. A meta-analysis conducted in 2015 identified more than 2,000 studies examining the relationship between Corporate Financial Performance (CFP) and Corporate Social Performance (CSP), and more recent bibliometric analyses show a sixfold increase in publications referencing "ESG," confirming its growing importance in both research and practice (Friede et al., 2015; Gao et al., 2021).

Another phenomenon gaining prominence is the growing divergence in financial stability between developing and developed markets. Both academic and professional sources have expressed concerns regarding the lower resilience of emerging economies. Limited capacity to absorb macroeconomic fluctuations and regulatory shocks may be partially mitigated through the adoption of widespread sustainable practices, both at the regulatory level and within firms. Prior research suggests that strong sustainability performance can reduce corporate risk in developed contexts (Comissão de Valores Mobiliários, 2025; Godfrey et al., 2009; Menshchikova, 2024; World Bank, 2024).

The integration of social and environmental concerns into business practices is not a recent development. The concept of Corporate Social Responsibility (CSR) dates back nearly a century and emphasizes socially beneficial practices that go beyond profit maximization (Bowen, 2013; Carroll, 1999). From the 1990s onward, and particularly after the mid-2000s, the ESG framework gained prominence alongside the development of sustainability indices and socially responsible investment (SRI) strategies, such as negative screening (Valls Martínez et al., 2022; Widyawati, 2020). Although CSR and ESG are sometimes used interchangeably, recent literature increasingly frames ESG as an investment evaluation tool and a mechanism for assessing CSR-related actions (Aust, 2013; Kim & Li, 2021). These actions include both compliance with legal obligations and discretionary practices that exceed regulatory requirements, often guided by ethical considerations aimed at creating broader societal value (Carroll, 1979; Gupta & Aggarwal, 2024). In this paper, ESG is the preferred term, except when specific references to CSR are required.

Growing investor interest in ESG has generated extensive research on its financial implications, particularly regarding the performance of SRI portfolios relative to conventional investments. While evidence remains mixed, recent studies suggest that SRI portfolios may yield slightly lower returns, potentially reflecting a "green premium" driven by investor preferences and the risk-hedging properties of ESG strategies (Bhattacharjee & De, 2022; Eom et al., 2024; Pastor et al., 2021).

In contrast, research examining the relationship between ESG performance and corporate risk remains relatively limited. Literature reviews indicate that this stream of research is less developed than studies focusing on ESG and returns, and findings are still inconclusive (Gao et al., 2021; Gillan et al., 2021). Moreover, most empirical evidence is concentrated in developed markets, such as the United States and Europe (Widyawati, 2020). Studies addressing developing economies are comparatively scarce, despite their distinct characteristics, including higher economic and political instability, which may shape the ESG–risk relationship (Belli et al., 2023; Janah & Sassi, 2021; Gupta & Aggarwal, 2024).

This study seeks to contribute to this gap by focusing on Brazil, one of the largest economies among developing countries and home to the Corporate Sustainability Index (BCSI) since 2005 (Ortas et al., 2012; World Data, 2022). Brazil is currently in the process of adopting regulations proposed by the International Sustainability Standards Board (ISSB), with the objective of modernizing financial markets, aligning them with international standards, and facilitating SRI. These regulatory changes impose stricter reporting requirements, which may

affect firms that are less prepared and influence investor perceptions (CVM, 2025). The main objective of this study is to empirically investigate the relationship between ESG performance and corporate risk in this context. Although this relationship has been explored in prior research using cross-sectional data, this paper adopts a longitudinal approach (Farias & Almeida, 2024).

The underlying rationale is that voluntary ESG engagement can strengthen stakeholder relationships, enhance corporate reputation, reduce the cost of capital, and build trust among employees and customers (Jo & Harjoto, 2011; Valls Martínez et al., 2022). These potential benefits are grounded in Freeman's (1984) Stakeholder Theory, which argues that firms must manage the interests of multiple stakeholders, not solely shareholders, to achieve sustainable outcomes. ESG practices provide a structured framework for addressing these multiple interests by emphasizing engagement with employees, communities, and society at large, while also prioritizing environmental concerns. As a result, ESG performance has increasingly been used as a proxy for stakeholder responsibility (Signore, 2021). By reducing information asymmetries and managerial blind spots, stakeholder-oriented practices may help firms hedge against environmental and social shocks, thereby lowering risk exposure (Hoepner et al., 2024; Ndlela, 2018). ESG engagement may also generate "insurance-like" benefits through the accumulation of moral capital, which can shield firms from regulatory and reputational damage (Godfrey et al., 2009). While such effects are well documented in developed markets, their applicability in emerging economies remains uncertain due to institutional and cultural differences (Gupta & Aggarwal, 2024).

Recent studies examining ESG and risk in developing markets suggest that ESG performance can mitigate risk in specific contexts. Higher ESG scores have been associated with lower stock price volatility in Asian markets, reduced insolvency and liquidity risk in the banking sector across several emerging economies, and lower systematic and total risk among energy firms operating in developing countries (Gangwani & Kashiramka, 2024; Gidage & Bhide, 2024; Kurniawan & Husodo, 2023). However, uncertainty persists, as some studies report that sustainable firms may experience stronger negative effects during adverse events, challenging the "insurance-like" effect proposed by Godfrey et al. (2009) (Sabbaghi, 2023). In the Brazilian context, earlier studies generally find that stronger sustainability performance reduces various risk measures (Bodhanwala & Bodhanwala, 2020; Dandaro, 2019; Ortas et al., 2012; Teixeira et al., 2011), whereas more recent evidence presents mixed results (Farias & Almeida, 2024; Piccinin et al., 2024; Santos & Silva Junior, 2024).

To address this research gap, the present study employs ESG scores as proxies for sustainability performance and systematic risk as a measure of corporate risk. ESG ratings were obtained from Refinitiv Eikon™, one of the most widely used data providers in both academic research and investment practice (Avramov et al., 2022; Belli et al., 2023). Systematic risk captures a firm's sensitivity to market-wide fluctuations and has been extensively used in prior research on ESG and corporate risk (Sharpe, 1964; Albuquerque et al., 2019; Giese et al., 2019a).

The central research question guiding this study is:

"Does a higher ESG score affect systematic risk for firms in the Brazilian market?"

To investigate this question, four panel data regression models are estimated: one incorporating the overall ESG score and three examining the individual Environmental, Social, and Governance pillars. This approach allows for the assessment of both the aggregate effect of ESG performance and the specific contribution of each pillar to corporate risk.

2 REVIEW

2.1 Theoretical Framework

The first theoretical framework used to ground the research question is Stakeholder Theory, introduced by Freeman (1984). It is the most widely applied framework to support the potential positive effects of ESG and serves as an alternative to the neoclassical view (Belli et al., 2023). In Freeman's formulation, multiple groups share the risks borne by a company, and their interests must be considered by management if the firm aims to prosper. Relevant stakeholder groups include employees, customers, suppliers, governments, banks, and activist organizations (Freeman, 2010). The collaborative and holistic nature of this theory aligns with the ESG concept, providing a theoretical basis to explain how ESG investments and actions, despite not directly enhancing shareholder wealth may contribute to improved corporate financial performance (Arayssi et al., 2016; Bae et al., 2017; Kim & Li, 2021).

Investments in ESG can be interpreted as investments in product differentiation valued by investors, employees, consumers, and other stakeholders. Transparent ESG reporting facilitates risk management and improves access to capital markets, potentially reducing both the cost of capital and debt (Korinth & Lueg, 2022; Valls Martínez et al., 2022). From this perspective, ESG practices that go beyond legal requirements help build legitimacy in the eyes of investors and customers, contributing to a broader investor base and increased customer loyalty (Gupta & Aggarwal, 2024).

Godfrey et al. (2009) make an important contribution to understanding the relationship between CSR practices and risk by showing that strong CSR performance can generate moral capital, or goodwill, which produces an insurance-like effect that shields firms from legal and regulatory shocks. More recent research confirms this mechanism across multiple contexts (Gupta & Chaudhary, 2023). Firms perceived as having strong CSR performance are more likely to benefit from these effects, underscoring the importance of ESG disclosure. Visibility is essential for firms to be rewarded, and evidence from developing countries shows that stronger ESG disclosure is associated with lower risk (Krastev & Lueg, 2024; La Soa et al., 2024).

Within the stakeholder framework, several mechanisms explain how ESG practices create value and mitigate risk. By fostering trust and reducing information asymmetry, ESG strengthens relationships with key stakeholders, lowering transaction costs and reducing the likelihood of conflict (Deng et al., 2013; Donaldson & Preston, 1995). Alignment with stakeholder interests also enhances resilience during adverse events, generating an insurance-like effect that protects firms from reputational and financial harm (Gillan et al., 2021). In addition, stronger stakeholder relations reduce perceived risk among investors, contributing to a lower cost of capital for firms with robust ESG performance (El Ghoul et al., 2011). Taken together, these dynamics position ESG not only as a social responsibility mechanism but also as a strategic tool for value creation and risk mitigation.

Stakeholder Theory is not the only framework relevant to ESG analysis. The shareholder value maximization perspective of neoclassical theory is less directly aligned with ESG, as scarce financial resources must be allocated to sustainability initiatives. Nevertheless, it remains useful, and prior research has sought to reconcile shareholder interests with ESG investing. ESG initiatives can support strategic, operational, and financial decisions, reducing risk and enhancing firm value, while ignoring social and environmental factors may expose firms to severe negative outcomes and missed opportunities. The neoclassical perspective also helps explain why certain ESG investments may destroy value, particularly when they are poorly designed, non-strategic, or inefficient (Danielson, Hogan & Olson, 2023).

Agency Theory, proposed by Jensen and Meckling (1976), is also relevant, particularly with respect to the governance pillar of ESG. When combined with the neoclassical perspective, it offers explanations for cases in which ESG investments lead to weaker performance. Managers

may overinvest in ESG to pursue personal preferences at the expense of shareholders or use ESG initiatives as a form of entrenchment (Devie et al., 2020; Feng et al., 2015).

2.2 ESG and Systematic Risk: Empirical Evidence

2.2.1 Research in Developed Countries: Aggregate ESG Performance and Risk

Studies in the U.S. market suggest that higher CSR performance is associated with lower risk profiles. Empirical research employs risk metrics such as cost of capital, systematic risk, and private loan spreads, with results consistently indicating that firms with stronger CSR performance exhibit lower risk (Albuquerque et al., 2019; Bae et al., 2017; Benlemlih et al., 2018; El Ghoul et al., 2011).

Research focusing on European countries reports results similar to those found in the United States, reinforcing the risk-reducing role of strong sustainability performance. These studies use measures such as cost of equity, systematic risk, idiosyncratic risk, total risk, and return volatility, generally finding reductions in risk associated with higher CSR or ESG performance. This convergence of findings suggests that mature markets, with longer experience in CSR adoption, tend to internalize its risk-mitigating effects more consistently (Arayssi et al., 2016; Sassen et al., 2016; Reverte, 2012).

Several studies also highlight that the relationship between CSR/ESG ratings and risk is contingent on contextual factors. Market maturity regarding CSR adoption emerges as a key moderator, with evidence indicating that more developed markets benefit more clearly from risk reduction effects, while less mature contexts may not exhibit the same patterns (Feng et al., 2015). This finding reinforces the importance of the macro-institutional context in shaping the ESG–risk relationship.

Firm-specific characteristics further condition these effects. Firm size remains a relevant factor, as it is a standard control variable in models using risk as a dependent variable (Saci et al., 2024). Board composition also plays a significant role, with more diverse boards associated with lower return volatility and systematic risk (Arayssi et al., 2016). Regarding the impact of sustainability performance on loan spreads, evidence suggests that firms without credit ratings benefit the most, as ESG information reduces information asymmetry in the absence of formal ratings (Bae et al., 2017). These mechanisms align with governance-based explanations and stakeholder-oriented perspectives, through which improved transparency and broader stakeholder representation contribute to lower perceived risk.

Some authors argue that sustainability performance may not affect risk directly but rather through indirect channels. CSR engagement can function as a form of product differentiation, enhancing firm value and, in turn, reducing exposure to risk (Albuquerque et al., 2019).

Finally, recent studies point to a nonlinear relationship between CSR and risk, suggesting the existence of optimal ESG investment levels that maximize firm value while minimizing risk (Korinth & Lueg, 2022; Oga et al., 2024; Pistolesi & Teti, 2024).

Overall, the empirical literature in developed markets largely supports the hypothesis that ESG practices mitigate systematic risk. However, the magnitude and direction of these effects depend on industry characteristics, ESG dimensions, and contextual moderators (Albuquerque et al., 2019; Benlemlih & Girerd-Potin, 2017; Chollet & Sandwidi, 2018; Giese et al., 2019b; Kim, 2010; Sassen et al., 2016).

2.2.2 Research in Brazil and Other Developing Countries: Aggregate ESG Performance and Risk

Earlier studies primarily compared socially responsible portfolios with conventional benchmarks (Ortas et al., 2012; Teixeira et al., 2011). These analyses found that sustainable portfolios exhibited significantly lower systematic risk and more favorable debt metrics, although this advantage tended to weaken during periods of market instability. A more recent study adopted a similar portfolio-level approach by comparing socially responsible and benchmark portfolios

across BRICS and developed markets. In the Brazilian case, sustainable portfolios again displayed lower systematic risk, but also lower returns. Taken together, these findings suggest that, at the portfolio level, the Brazilian market may resemble developed markets under favorable macroeconomic conditions, while remaining more vulnerable during adverse periods.

At the firm level, however, the evidence is more heterogeneous. Several studies indicate that stronger ESG performance is associated with reductions in different risk dimensions, such as credit risk, insolvency risk, and default probability (Dandaro, 2019; Santos & Silva Junior, 2024; Useche et al., 2024). In contrast, other studies report non-significant relationships between ESG performance and volatility, while more recent research extending earlier Brazilian analyses to Latin America identifies a positive relationship between ESG performance and credit risk (Dandaro & Lima, 2023; Farias & Almeida, 2024). This divergence suggests that, in developing contexts, ESG practices may be more effective as a hedge against downside or firm-specific risk than against broader market risk.

Although developing countries are often expected to exhibit risk-reducing effects from ESG, albeit moderated by institutional and market characteristics, the Brazilian and Latin American evidence remains notably mixed. This inconsistency may largely reflect differences in macroeconomic conditions, as well as firm- and country-specific factors such as lower market maturity, limited board diversity, and weaker investor demand for ESG information. These contextual constraints may limit the extent to which ESG practices are fully priced as risk-reducing mechanisms in these markets.

Finally, cross-study comparisons are further complicated by three recurring issues: the presence of non-linear ESG–risk relationships (Korinth & Lueg, 2022; Oga et al., 2024; Pistolesi & Teti, 2024), structural differences in how ESG relates to risk in developed versus developing markets (Siddiqui et al., 2024), and substantial discrepancies across ESG rating providers (Berg et al., 2022).

2.2.3 Isolated ESG Pillars

Compared to aggregate ESG measures, fewer studies examine the isolated effects of the environmental, social, and governance pillars on risk, even in developed markets. The existing evidence suggests that pillar-level effects are heterogeneous and highly context dependent, reinforcing the need for disaggregated analysis.

In developed markets, Sassen et al. (2016) showed that while aggregate ESG performance reduced idiosyncratic and total risk, pillar-level effects varied. The social dimension consistently reduced systematic, idiosyncratic, and total risk; environmental effects depended on industry sensitivity; and governance showed no significant impact. Chollet and Sandwidi (2018) also reported heterogeneous results, with environmental and social pillars reducing risk and governance increasing it, whereas Djoutsa Wamba et al. (2018) found that only governance significantly reduced risk. More recently, Gupta and Aggarwal (2024) showed that, in India, governance influenced the cost of capital, while all three pillars reduced systematic risk, further underscoring the lack of consensus even in relatively mature markets.

Evidence from Brazil and other developing countries is equally mixed. Dandaro (2019) found that ESG performance reduced credit risk in Brazilian firms, with the social pillar playing the most prominent role. Piccinin et al. (2024) reported similar results for social disclosure, which reduced systematic risk, while environmental disclosure was non-significant and gender diversity increased risk. Santos and Silva Junior (2024), by contrast, found that all three ESG pillars negatively predicted insolvency risk, suggesting broader risk-reducing effects. However, Farias and Almeida (2024) found no significant effects for any pillar once volatility controls were included, indicating that pillar-level impacts may be sensitive to model specification and the choice of risk measures.

Taken together, these findings suggest that the social pillar tends to exhibit the most robust association with risk reduction, particularly in developing contexts. Environmental and governance effects appear more contingent on industry characteristics, institutional maturity, and market perceptions. The lack of consistent results across studies supports the adoption of exploratory hypotheses that test the individual effects of ESG pillars on systematic risk, especially in emerging markets where institutional and informational conditions differ from those in developed economies.

2.3 Hypotheses

Considering the theoretical frameworks and empirical evidence from both developed and developing contexts, it is reasonable to expect a significant and negative relationship between ESG performance and risk in Brazil (Albuquerque et al., 2019; Arayssi et al., 2016; Bae et al., 2017; Dandaro, 2019; El Ghoul et al., 2011; Piccinin et al., 2024; Useche, 2024; Santos & Silva Junior, 2024). Nevertheless, this relationship is not unequivocal, as prior findings remain inconclusive and often show statistical significance only for specific ESG pillars (Dandaro & Lima, 2023; Farias & Almeida, 2024; Piccinin et al., 2024). These mixed outcomes are influenced by institutional maturity, legal frameworks, and managerial and investor perceptions in developing markets, which are typically characterized by higher volatility (Gupta & Chaudhary, 2023; Janah & Sassi, 2021). Given the heterogeneous and context-dependent nature of the evidence, particularly at the pillar level, the following hypotheses are formulated in an exploratory manner.

H1: The overall ESG score has a statistically significant relationship with the systematic risk of companies in Brazil.
H2: The Environmental pillar of ESG has a statistically significant relationship with systematic risk in Brazil.
H3: The Social pillar of ESG has a statistically significant relationship with systematic risk in Brazil.
H4: The Governance pillar of ESG has a statistically significant relationship with systematic risk in Brazil.

3 METHODOLOGY

3.1 Data collection and sample

3.1.1 The Database

To operationalize this research, a relational quantitative approach is adopted, using LSEG Refinitiv Eikon™ to gather both financial variables and ESG scores. The database began operations in 2002 by evaluating firms from the Russell 1000 and, ten years later, expanded to include more than 4,000 scored firms. Information is collected through multiple channels and used to calculate scores across four categories and their subcategories.

The first three categories correspond to the ESG pillars: Environmental (resource use, emissions, and innovation), Social (workforce, human rights, community, and product responsibility), and Governance (management, shareholders, and CSR strategy). The fourth category is the Controversies Score, which tracks ESG-related scandals reported by the media and is used to adjust downward the ESG Combined Score of each firm (Dorfleitner et al., 2015; Kim & Li, 2021; Refinitiv, 2019).

Refinitiv Eikon™ is one of the most widely used ESG databases outside the United States, as documented in previous literature reviews (Belli et al., 2023). Its main advantage for this study lies in the availability of both the combined ESG score and the individual pillar scores, which are essential to meet the research objectives. Additionally, Refinitiv provides detailed methodological documentation on score construction, which enhances transparency and reliability (Refinitiv, 2019).

3.1.2 The Sample

From the 421 firms listed on B3, Brazil's stock exchange, only 57 had ESG scores sufficiently populated for the period between 2015 and 2023. This selection was driven by longitudinal data availability constraints and resulted in a final sample of 456 firm-year observations. A small number of missing values within these firms were replaced using variable means to avoid further reductions in sample size.

Due to the limited number of firms with complete ESG data over the eight-year period, industry-specific analyses were not conducted, as they would lack sufficient statistical power. The reduced availability of longitudinal ESG data highlights the relative immaturity of the Brazilian market with respect to socially responsible investment and ESG disclosure practices.

Table 1
Companies by sector

Industry	Count of companies
Electric Utilities	8
Metals & Mining	5
Food Products	5
Oil, Gas & Consumable Fuels	4
Household Durables	4
Specialty Retail	3
Water Utilities	3
Health Care Providers & Services	3
Diversified Consumer Services	2
Renewable Electricity Producers	2
Ground Transportation	2
Consumer Staples Distribution & Retail	2
Transportation Infrastructure	2
Electrical Equipment	1
Containers & Packaging	1
Software	1
Insurance	1
Capital Markets	1
Paper & Forest Products	1
Banks	1
Real Estate Management & Development	1
Machinery	1
Diversified Telecommunication Services	1
Pharmaceuticals	1
Beverages	1

Source: the author.

3.2 Statistical Tool

Panel data analysis combines cross-sectional and longitudinal observations, allowing researchers to track changes in individual units over time (Baltagi, 2021; Torres-Reyna, 2007). This approach is particularly useful in economic analysis, as it enables the control of unobserved heterogeneity, individual characteristics that affect regression outcomes but are difficult to

measure directly. Panel data also allows for the observation of variables that change over time but are common across entities (Baltagi, 2021; Torres-Reyna, 2007).

Two estimators are commonly used in panel data models with samples similar to that of this study: Fixed Effects (FE) and Random Effects (RE). The FE estimator is appropriate when unobserved, time-invariant characteristics of the entities affect the dependent variable and are correlated with the independent variables. In this case, FE removes these invariant effects by focusing solely on within-entity variation. While this ensures consistent estimation, it also results in a loss of degrees of freedom, as time-invariant variables are excluded from the model (Baltagi, 2021; Torres-Reyna, 2007).

In contrast, the RE estimator assumes that variation across entities is random and uncorrelated with the independent variables. Under this assumption, RE produces consistent and more efficient estimates and allows for the inclusion of time-invariant variables (Baltagi, 2021; Torres-Reyna, 2007). As noted by Torres-Reyna (2007), the key distinction between FE and RE lies in whether the individual error term is correlated with the regressors.

The Hausman test is employed to determine the appropriate estimator. The test evaluates whether the FE and RE estimators differ systematically, with the null hypothesis assuming no significant difference between them (Gujarati, 2004). If the null hypothesis is rejected, the RE estimator is deemed inconsistent, and the FE model is preferred (Gujarati, 2004; Nossa et al., 2009; Torres-Reyna, 2007).

3.3 Variables and Models

The dependent variable is the systematic risk of Brazilian firms in the sample, commonly denoted as β. This measure captures an asset's sensitivity to market-wide fluctuations and macroeconomic uncertainty. Assets with β close to zero exhibit lower volatility than the market, a β of one indicates market-level volatility, and values above one reflect higher volatility. Systematic risk is widely used in asset pricing and valuation models, including Sharpe (1964) Capital Asset Pricing Model (CAPM) and the Fama and French (1996) three-factor model (Brealey et al., 2011).

The main independent variable in the first model is the ESG Combined Score from Refinitiv Eikon™. In the remaining three models, each ESG pillar score, Environmental, Social, and Governance, is included separately as the key explanatory variable.

Firm size is a standard control variable in studies examining the relationship between ESG and systematic risk. It is typically proxied by the logarithm of total assets or sales. Larger firms are generally expected to exhibit lower systematic risk due to greater diversification and operational stability (Albuquerque et al., 2019; Arayssi et al., 2016; Saci et al., 2024).

Financial leverage is another important control variable, as higher leverage can amplify returns but also increase risk exposure. Leverage is measured as the ratio of long-term debt to equity, and prior studies generally expect a positive relationship between leverage and systematic risk (Albuquerque et al., 2019; El Ghoul et al., 2011; Gregory et al., 2014; Lueg et al., 2019). Nevertheless, empirical evidence on the relationship between leverage, firm size, and β remains mixed (Valls Martínez et al., 2022).

Profitability is also commonly included as a control variable in ESG–risk studies. The most frequently used proxies are Return on Assets (ROA) and Return on Equity (ROE). ROA is calculated as net income divided by average total assets, while ROE is net income divided by average equity. Prior research generally finds that higher profitability is associated with lower risk (Bae et al., 2017; Sassen et al., 2016; Utz, 2018). In line with this literature, this study includes ROA as the profitability control variable.

Table 2
Variables contained in the statistical model

Variable	Type	Proxy
β	Dependent	Annual β - 5 years.
ESG Combined	Independent	Score of all ESG pillars on Refinitiv™ subtracted by the controversy score.
Environmental Pillar	Independent	Environmental pillar score on Refinitiv™.
Social Pillar	Independent	Social pillar score on Refinitiv™.
Governance Pillar	Independent	Governance pillar score on Refinitiv™.
Size	Control	Total assets logarithm
Leverage	Control	Total long-term debt divided by total equity
Profitability	Control	ROA
Price-to-Book Ratio	Control	Price To Book Value Per Share (Daily Time Series Ratio)

Font: the authors.

The statistical models were estimated using Stata 14.2. The data were winsorized at the 0.1% level to reduce the influence of extreme values that could distort the analysis. Winsorization replaces outliers with the nearest values within a defined percentile range while keeping the sample size unchanged. As noted by Wilcox (2012), this procedure improves the robustness and reliability of statistical results, which is particularly relevant for financial data that are often affected by high volatility.

None of the models exhibited multicollinearity, as indicated by Variance Inflation Factor (VIF) values below 2. The ov-test confirmed the absence of omitted variable bias. After applying logarithmic and Box–Cox transformations where appropriate, no evidence of heteroskedasticity was detected in the estimated models (Gujarati, 2004).

Model 1 – Combined ESG and beta
$\beta = \alpha + ESG + Lev + ROA + Size + P/B\ Ratio$

Where:
β = CAPM Beta, systematic risk;
ESG = ESG Combined score measured by Refinitiv™;
Lev = ratio total long-term debt by the company's equity;
ROA = Profitability measured by ROA;
Size = Natural logarithm of the total value of companies' assets; &
P/B Ratio = Price To Book Value Per Share (Daily Time Series Ratio).

Model 2 – Environmental pillar and beta
$\beta = \alpha + Envp + Lev + ROA + Size + P/B\ Ratio$

Where:
Envp = Companies' environmental pillar score measured by Refinitiv™;

Model 3 – Social pillar and beta
$\beta = \alpha + Socp + Lev + ROA + Size + P/B\ Ratio$

Where:
Socp = Companies' social pillar score measured by Refinitiv™;

Model 4 – Governance pillar and beta
$\beta = \alpha + Govp + Lev + ROA + Size + P/B\ Ratio$

Where:
Govp = Company governance pillar score measured by Refinitiv™;

4 RESULTS

Table 3 presents the descriptive statistics of the variables. The mean beta is close to one, indicating that most firms exhibit market-level risk, although values range from defensive to highly volatile firms. The ESG Combined score averages 52.4 and displays substantial variation across companies, with the environmental pillar showing the greatest dispersion. Control variables also reveal heterogeneity: while firm size is relatively stable, leverage and price-to-book ratios are highly skewed, indicating that some firms operate under extreme financial structures. Overall, these statistics highlight the diversity of Brazilian firms in both financial characteristics and ESG practices, which is relevant for examining their relationship with systematic risk.

The dispersion observed in the ESG Combined score and its pillars suggests a degree of market immaturity, as some companies are highly engaged in sustainable practices while others lag considerably in adoption. Another relevant aspect is the wide variation in financing structures, with some firms exhibiting very high leverage levels, which may blur the relationship between ESG performance and risk (Atan et al., 2018).

Table 4 presents the correlation matrix. The highest correlations are observed between the ESG Combined score and its pillars, particularly the social (.8193) and environmental (.7231) dimensions, which is expected given the index construction. Although these correlations are relatively high, Variance Inflation Factor (VIF) tests confirm the absence of multicollinearity, with all values below 2. The remaining correlations are modest, suggesting that the independent and control variables do not introduce significant redundancy into the regression models.

Table 3
Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
β	456	.9777734	.5260476	.0553753	3.364439
ESG	456	52.39979	17.8410	2.280246	91.08206
Envp	456	51.36587	24.52657	.94161959	96.07231
Socp	456	57.80383	21.28583	.8730159	95.59625
Govp	456	55.74392	20.69677	4.665091	93.9472
Size	456	23.9204	.9232578	22.42615	25.36422
P/B Ratio	456	2.334549	3.149732	.0511392	39.81682
Lev	456	1.424146	6.061522	.005005	122.7547
ROA	456	.6226176	.6239581	.070082	4.413671

Source: the author.

Table 4
Correlation matrix

	β	ESG	ENV	SOC	GOV	LTASS	PTB	LEV	ROA
β	1.000								
ESG	-.1590	1.000							
Envp	-.0220	.7231	1.000						
Socp	.0098	.8193	.6951	1.000					

Govp	.0984	.5528	.2333	.4387	1.000				
Size	.1232	.2913	.4781	.4792	.1099	1.000			
P/B Ratio	-.1590	.0049	.0273	-.0520	-.0537	-.1681	1.000		
Lev	-.0846	.0075	.0189	.0138	-.0611	.0282	-.0352	1.000	
ROA	-.0954	.0679	.1259	.0670	.1314	.0437	.1758	-.0258	1.000

Source: the author.

The Hausman test was performed for each model to determine the appropriate estimator. Table 5 reports the resulting chi² statistics for each model estimated in Stata. As discussed in the previous section, statistical significance in this test indicates that the Fixed Effects (FE) estimator should be used, as the individual error terms are correlated with the independent variables. All models were estimated using robust standard errors to address group heteroskedasticity (Torres-Reyna, 2007).

Table 5
Hausman test results

Model	Chi²	Estimator
ESG	0,00	FE
Envp	0,02	FE
Socp	0,00	FE
Govp	0,02	FE

Source: the author.

Model 1, presented in Table 6, shows a good overall fit, as indicated by the "Prob > F" value below 0.05, suggesting that the set of coefficients is jointly different from zero (Torres-Reyna, 2007). The independent variable, ESG Combined, is non-significant and presents a negative coefficient, which contrasts with part of the prior literature and leads to the rejection of H1. All control variables are statistically significant, except leverage, which is non-significant. The crisis dummy is positive and significant, indicating an increase in systematic risk during the pandemic period.

Table 6
Model 1 Results - FE

Variables	Coef.	P
ESG	-.1000102	0.343
Lev	-.0057975	0.560
ROA	-.2014617	0.051
Size	.2228977	0.001
P/B Ratio	-.0860524	0.046
Constant	-5.228229	0.000
		Prob>F = 0.000

Source: the author.

Table 7 reports the results for Model 2, in which the environmental pillar is isolated. The environmental score shows a statistically significant relationship with systematic risk, supporting H2, while the control variables maintain results similar to those observed in Model 1. This finding contributes to the limited literature that examines the environmental pillar separately, where

evidence remains mixed (Antunes et al., 2023; Chollet & Sandwidi, 2018; Gupta & Aggarwal, 2024; Ok & Kim, 2019).

Table 7
Model 2 Results - FE

Variables	Coef.	P
Envp	-.0003225	0.058
Lev	-.0088989	0.441
ROA	-.2182862	0,033
Size	.2012047	0,000
P/B Ratio	-.0933772	0,025
Cons	-4.912268	0,000
		Prob>F = 0.000

Source: the author.

Model 3 presents the results for the social pillar. The coefficient remains negative but is not statistically significant, leading to the rejection of H3. The control variables display coefficients comparable to those in previous models. While Antunes et al. (2023) report similar findings, most studies document a negative and significant relationship between the social pillar and risk (Chollet & Sandwidi, 2018; Dandaro, 2019; Gupta & Aggarwal, 2024; Ok & Kim, 2019; Sassen et al., 2016).

Table 8
Model 3 Results - FE

Variables	Coef.	P
Socp	-.1132494	0,229
Lev	-.0058082	0.001
ROA	-.2117866	0.038
Size	.225917	0.556
P/B Ratio	-.0842866	0.055
Constant	-5.246938	0.000
		Prob>F = 0.000

Source: the author.

The results for Model 4 indicate that the governance pillar is also non-significant and presents a positive coefficient, leading to the rejection of H4. The behavior of the control variables remains consistent with earlier models. As with the environmental pillar, prior literature reports non-convergent results for governance, with both positive and negative associations documented across studies (Antunes et al., 2023; Sassen et al., 2016; Shafer & Szado, 2019).

Table 9
Model 4 Results - FE

Variables	Coef.	P
Govp	.0001081	0.724
Lev	-.0080125	0.489
ROA	-.2372982	0.019

Size	.1611633	0.004
P/B Ratio	-.0866574	0.044
Constant	-4.124745	0.001
		Prob>F = 0.000

Source: the author.

Table 10 summarizes the coefficients and p-values for Models 1 through 4. Overall, only the environmental pillar exhibits a statistically significant relationship with systematic risk. This result is further discussed in the following section.

Table 10
Summary of results

Independent Variable	Coef.	P
ESG	-.1000102	0.343
Envp	-.0003225	0.058
Socp	-.1132494	0,229
Govp	.0001081	0.724

Source: the author.

5 DISCUSSION

Returning to this study's research question, whether a higher ESG score affects systematic risk for firms in the Brazilian market, the results indicate a partial effect, as only the environmental pillar shows a statistically significant relationship with firm risk.

Hypotheses H1, H3, and H4 were rejected, indicating that, within this sample, the combined ESG score and the social and governance pillars do not present a significant relationship with systematic risk. This outcome contrasts with much of the evidence from developed markets and with several earlier studies focused on Brazil. Nevertheless, it is not unexpected. The literature on developing economies frequently reports non-convergent findings, reflecting the limited number of studies, heterogeneous methodologies, and strong contextual differences across markets (Atan et al., 2018; Belli et al., 2023; Bodhanwala & Bodhanwala, 2020; Dandaro, 2019; Gupta & Aggarwal, 2024; Ortas et al., 2012; Teixeira et al., 2011).

Several mechanisms may help explain these results. One relates to the relative immaturity of developing markets in pricing sustainable investments, where ESG initiatives may not yet be efficiently incorporated into risk assessments. From a neoclassical perspective, when ESG investments fail to generate observable shareholder value, they may divert scarce corporate resources away from profit-maximizing activities, increasing perceived inefficiency rather than reducing risk (Devie et al., 2020; Feng et al., 2015; Goss & Roberts, 2011).

Additionally, ESG overinvestment may arise from managerial incentives. Managers may pursue sustainability initiatives to enhance personal reputation, entrench themselves, or advance individual preferences, thereby creating agency problems that can destroy, rather than create, value (Devie et al., 2020; Feng et al., 2015; Goss & Roberts, 2011; Jensen & Meckling, 1976).

With respect to Hypotheses H3 and H4, the social and governance pillars may be more difficult for investors to evaluate, making their potential benefits less visible and, consequently, less likely to be priced. This increases the importance of disclosure quality, as transparent communication of ESG actions is essential for markets to recognize and reward such practices. Evidence from developing countries suggests that the effects of ESG performance are often

conditional on disclosure quality and institutional context (Lavin & Montecinos-Pearce, 2021). Moreover, genuine investments in social and environmental practices typically increase operational complexity and contractual costs. In such settings, stronger governance structures may be necessary to manage expanded stakeholder relationships, although governance improvements alone may not directly translate into lower risk (Monteiro et al., 2021).

In contrast, Hypothesis H2 is supported, as the environmental pillar shows a significant negative relationship with systematic risk. This finding aligns with the theoretical framework adopted in this study, particularly the "insurance-like" effect proposed by Godfrey et al. (2009). Strong environmental performance can reduce firms' exposure to environmental disasters, regulatory changes, and climate-related risks (Avramov et al., 2022; Gupta & Chaudhary, 2023; Korinth & Lueg, 2022; Valls Martínez et al., 2022). Environmental issues such as climate change and pollution are also highly salient, which may make this pillar more visible and more readily priced by investors (Agranat, 2023).

Although the estimated effect size is small in absolute terms (–0.00032), this reflects the 0–100 scale of ESG scores. A 10-point increase in the environmental score reduces beta by 0.0032, while a 30-point improvement corresponds to a reduction of approximately 0.01, or about 1% relative to the average firm's systematic risk. Thus, incremental improvements in environmental performance can accumulate into economically meaningful risk reductions over time.

Additional evidence supports this interpretation. Fdez-Galiano and Feria-Domínguez (2024) show that stronger ESG disclosure helped insulate Brazilian mining firms from spillover effects during major environmental disasters such as Samarco (2015) and Brumadinho (2019). Miralles-Quirós et al. (2018) also document positive environmental effects in Brazil, although their focus is on firm value rather than risk.

While relatively few studies examine ESG pillars separately, existing evidence suggests mixed results for environmental and governance dimensions, whereas the social pillar is often associated with risk mitigation, an effect not observed in this study (Chollet & Sandwidi, 2018; Dandaro, 2019; Ok & Kim, 2019; Sassen et al., 2016). Finally, sector-specific characteristics remain critical, as the relevance of each ESG pillar varies according to industry exposure to environmental, social, and governance risks (Miralles-Quirós et al., 2018).

6 CONCLUSION

This study contributes to the literature on corporate sustainability and risk by examining a developing economy, an underexplored context in ESG research (Janah & Sassi, 2021). Using panel data models for Brazilian companies between 2015 and 2023, the results indicate that only the environmental pillar is significantly and negatively associated with systematic risk. In contrast, the ESG Combined Score, as well as the social and governance pillars, show no significant effect on risk.

These findings diverge from evidence in developed economies, where ESG performance is more consistently associated with lower risk (Albuquerque et al., 2019; Arayssi et al., 2016; Sassen et al., 2016). They suggest that, in Brazil, environmental practices are more visible and more readily priced by the market, whereas social and governance dimensions have not yet been fully incorporated into investment decision-making. The limited availability of ESG data, only 57 firms with consistent reporting over the period, also reflects the relative immaturity of the Brazilian market and may help explain why the results differ from those observed in more consolidated contexts.

From a theoretical perspective, as discussed earlier, the ESG–risk relationship is commonly interpreted through stakeholder theory and neoclassical economic theory. From a stakeholder perspective, the significant effect of the environmental pillar is consistent with expectations: investments in environmental performance signal responsibility toward stakeholders and reduce exposure to environmental, regulatory, and climate-related risks. By contrast, the rejection of the remaining hypotheses aligns more closely with neoclassical and agency-based arguments, which

suggest that sustainability investments may fail to generate shareholder value or may reflect managerial preferences and overinvestment, thereby offsetting potential risk-reduction effects associated with social and governance actions (Devie et al., 2020; Feng et al., 2015; Goss & Roberts, 2011; Utz, 2018). An additional empirical explanation is that Brazilian firms still exhibit relatively weak ESG disclosure practices, and the social and governance pillars depend heavily on transparency for their benefits to be recognized and priced by the market (Lavin & Montecinos-Pearce, 2021).

At the same time, this study contributes to the still-emerging and fragmented literature on ESG and risk in developing markets, where results remain inconclusive across regions and methodologies (Teixeira et al., 2011; Atan et al., 2018; Belli et al., 2023; Dandaro, 2019; Janah & Sassi, 2021). Future research could expand comparisons across Latin America and other developing economies, explore sectoral heterogeneity as more comprehensive data become available, and examine whether firms with greater international exposure, such as those issuing American Depositary Receipts (ADRs), exhibit different ESG–risk dynamics. Additional avenues include assessing how disclosure quality and governance mechanisms moderate the effects of environmental and social practices on risk and financial performance, as well as testing for potential nonlinear relationships between ESG performance and financial risk measures.

This study has limitations. The use of systematic risk as the dependent variable and Refinitiv™ ESG scores as proxies represents only one possible empirical specification, and the results cannot be generalized beyond the Brazilian context.

In sum, this study provides original evidence that, unlike in developed economies, only the environmental pillar of ESG mitigates systematic risk in Brazil. The findings highlight both the challenges of ESG integration in Latin American markets and the opportunities for future research to deepen understanding of the institutional and market conditions shaping the ESG–risk relationship.

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CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest regarding this submitted work.

DATA AVAILABILITY

The dataset supporting the results of this study is not publicly available.

AUTHOR CONTRIBUTIONS

Roles	1st author	2nd author	3rd author
Conceptualization	♦	♦	
Data Curation	♦	♦	♦
Formal Analysis	♦	♦	
Funding Acquisition	♦	♦	
Investigation	♦	♦	
Methodology	♦	♦	♦
Project Administration	♦	♦	♦
Resources	♦	♦	
Software	♦	♦	♦
Supervision	♦	♦	
Validation	♦	♦	♦
Visualization	♦	♦	
Writing – Original Draft	♦		
Writing – Review and Editing	♦	♦	♦