ESG, Returns and Volatility in Brazilian Stock Market

CAMILA GUEDES DE FARIAS
Universidade Federal do Rio Grande do Norte - UFRN
profacamilaguedes@gmail.com

VINICIO DE SOUZA E ALMEIDA
Universidade Federal do Rio Grande do Norte - UFRN
vinicio.almeida@ufrn.br

Abstract
As global awareness of sustainability challenges grows, investors are increasingly integrating ESG considerations into their strategies, seeking not only financial returns but also positive societal impact, or, trying to link ESG assets characteristics to their own expectations. The Brazilian market presents an environment to develop these studies. This paper contributes to the existing literature by providing empirical evidence on the impact of ESG factors on financial markets within the Brazilian context. Specifically, it explores how firms' ESG scores, derived from comprehensive data on environmental impact, social policies, and governance practices, correlate with their market performance and risk profiles. By leveraging a dataset encompassing diverse sectors and ESG metrics, this research aims to inform investors, policymakers, and corporate leaders about the implications of ESG integration for market dynamics and investor decision. This research analyses Brazilian firms' characteristics and its assets capital market behavior. We collected data available in Refinitiv Eikon database with regards to firm level characteristics related to environmental, social and governance practices. We also collected market data from the same source for returns and volatility. We conduct the ordinary least squares regression to analyze cross-sectional data. Exploratory regressions found no significant relationship between Returns and ESG Score. On the other hand, regressing Volatility against ESG Score we found negative and significant relationship at 5% level. This study provides insights into the integration of Environmental, Social, and Governance (ESG) factors within investment strategies in the Brazilian market. The findings reveal a nuanced relationship between ESG scores and financial outcomes, reflecting both challenges and opportunities for investors. While the direct impact on stock returns shows variability across sectors and time periods, the consistent negative association between ESG scores and stock volatility suggests that companies with higher ESG ratings tend to exhibit lower risk profiles.

Keywords: Climate Change, ESG, Investments.

1. Introduction

In recent years, Environmental, Social, and Governance (ESG) factors have gained significant attention in the area of finance, particularly in the context of investment decision-making, portfolio management and policy shaping (Galletta et al., 2022). As global awareness of sustainability challenges grows, investorsare increasingly integrating ESG considerations into their strategies, seeking not only financial returns but also positive societal impact, or, trying to link ESG assets characteristics to their own expectations. This shift reflects a broader recognition that corporate practices related to environmental stewardship, social responsibility, and effective governance can materially affect financial performance and risk outcomes.

The concept of ESG investing has evolved beyond mere ethical considerations to encompass a strategic approach aimed at enhancing long-term financial resilience and sustainable growth (Wang et al., 2022). By evaluating companies based on their ESG practices, investors aim to identify firms better equipped to deal with emerging challenges, such as climate change regulations, social inequality, and governance failures This proactive stance not only mitigates risks associated with regulatory changes and reputational harm but also positions investors to capitalize on opportunities arising from shifting consumer preferences and regulatory incentives favoring sustainable business practices (Shi et al., 2022).

The Brazilian market presents a prolific environment to develop studies in this global trend towards ESG integration. With its diversity of industries and economic sectors, Brazilian market may offer a perspective on how ESG factors influence corporate behavior and financial outcomes. By examining the Brazilian market through the lens of ESG factor investing, this study seeks to uncover insights into the relationship between ESG performance and stock market returns, volatility, and firm valuation metrics.

This paper contributes to the existing literature by providing empirical evidence on the impact of ESG factors on financial markets within the Brazilian context. Specifically, it explores how firms' ESG scores, derived from comprehensive data on environmental impact, social policies, and governance practices, correlate with their market performance and risk profiles. By leveraging a dataset encompassing diverse sectors and ESG metrics, this research aims to inform investors, policymakers, and corporate leaders about the implications of ESG integration for market dynamics and investor decision-making.

Key findings from this study include: (i) firms with higher ESG ratings tend to exhibit lower stock volatility, indicating potential risk mitigation benefits for investors; (ii) companies involved in more ESG controversies tend to have lower ESG ratings across ESG dimensions in general and in sub scores; (iii) ESG factors have potential to enhance long-term shareholder value.

This paper is organized into the following sections: the Literature Review, which provides an overview of previous research and theoretical background; the Data and Methodology, which describes the data sources and the methods used for analysis; the Results and Discussion, which presents the findings and interprets their implications; and the Conclusions, which summarize the main insights and suggest directions for future research.

2. Literature Review

Works analyzing the relationship between investment metrics and ESG practices are already well established in the field of finance. Besides professional attention, we can see the proliferation of studies testing factors to explain returns, the factor zoo discussed by Cochrane (2011) goes on many paths. One of them comprises factors related to environmental, social and governance practices (Hua Fan and Michalski, 2020).

On one hand, some studies deal with climate change issues and investment decision criteria to mitigate undesirable changes. Wu et al. (2023), for example, argued in favor of enhanced risk management in banks to prevent new sources of systemic risk. The authors say that it is of special concern to non-state-owned banks since they may be more exposed to volatility coming from climate change shocks. In connection with these results, Javadi and Masum (2021) find that climate change is a relevant factor that influences loan costs, specially to borrowers in locations which are more sensible to climate changes.

Going beyond the financial sector, Sautner et al. (2023) show that it is possible to identify firm level exposure to climate change risks. Some characteristics as job creation under disruptive green technology introduction and new green patents registration are good sources of information that may be explored to predict future behavior of these firms.

Also analyzing firm level climate change motivated potential implications, Santi (2023) proposed a measure to try to identify investors' sentiment to climate factors. The author found that investors' sentiment is related to over and under performance of stocks depending on its dependence of high or low carbon emission activities. In the study, high emission stocks underperformed low emission stocks when investors care about climate change.

Exploring price crash risk in China, Lin and Wu (2023) found that firms evidencing climate risk face less risk of drastic stock prices downturns. This result is connected with the results achieved by Song et al. (2023), who find that investor attention and analyst coverage help firms protect themselves from crash risk. The concern is shared also with institutional investors, as demonstrated by Krueger et al. (2020). Zhang et al. (2022) reinforces the importance of disclosing environmental impact information from polluting companies.

Climate risk criteria is also being treated in fixed income markets. Agliardi and Agliardi (2021) model how bond prices may be affected by shocks coming from changes in climate policies to determine risk and portfolio consequences. They find that the "greenness" of a bond may benefit issuers that may be seen as of lower risk, when compared to others. Arif et al. (2022), with data from COVID-19 period, also find that green bonds are well suited to diversify equity portfolios on the medium and the long runs. Han and Li (2022), with data from USA and European markets, point out that portfolios should have green bonds in order to have better risk-return performance. On the other hand, Reboredo and Ugolini (2020) find low level of connection between green bond markets and stock markets. In Brazil, Guimarães and Malaquias (2022) find that ESG-related funds present better risk-return relationship during periods of strong financial constraints.

Obviously, such perceptions also have branches in portfolio management. In a framework that tries to capture climate change risk and its influences to portfolio risk, Engle et al. (2020) uses ESG scores to model climate risk exposures and construct hedged portfolio against climate change news. Their work also points the importance to hedge against climate

changes, specially when it is not so easy to hedge against this kind of risk with usual instruments.

In Brazil, analyzing the impact of ESG practices on stock prices, Sverner et al. (2023) build an ESG factor and compare it stock returns. They find impacts on stock returns specially when facing rating upgrades. The authors rely their work following Fama and French (1993) to construct the ESG factor. Besides analyzing stock performance conditioning on ESG scores, they find that ESG level shifts are important to affect stock prices.

Still in Brazil, Yamahaki and Breviglieri (2022) highlight the importance of green certifications in order to attract investments and specially at lower costs. These certifications may be crucial when demanding the attention of foreign investors, which in turn may be facing regulatory requirements to abide to global best practices adoption.

Pedersen et al. (2021) develop an efficient frontier framework that considers ESG factors. In their model, which consider ESG scores, the practices disclosure help provide information on firm level to investors and may also affect investors' preferences. They find that governance practices are more relevant than environmental and social practices, making the "G" alone a good proxy for "E" and "S" levels.

Rahman et al. (2023), in an empirical work with data from 2016 to 2020, find that environmental, social and governance alone are relevant when affecting firms' ROA and Tobin's Q. These effects may guide peer firms to adopt green practices to mimic green firms procedures or to signal to investors that the top management is concerned with green practices.

Since the works of Ross (1976), Ross (1977) and Roll and Ross (1980), investors, capital market professionals and academics build up in factor investing efforts. The quest is to find factors that have explanatory power on returns and volatility (mainly of academic interest) and that may be used to forecast stock (and other assets) behavior (mainly of capital market professionals interest).

ESG practices measured in factors and scores are presented in main commercial financial databases such as the one detailed in Group (2023). There are some Brazilian experiences as sustainability indexes like the one studied in Filho and Figueiredo (2008), where the authors analyze disclosure practices. Andrade et al. (2013) explored the sustainability index and found industry-sector motivations to adopt green practices. Pereira et al. (2020) find positive relationship between corporate financial performance and corporate social performance but find no relationship between disclosure itself and financial performance.

Lioui and Tarelli (2022) depict the methodologies employed to construct ESG factors. The authors discuss the implications of data vendors' choice and find some asymmetries between their choices' results. Also in their results, media may play a central role to draw investor attention to climate and ESG related characteristics and could drive morale criteria when analyzing investment opportunities.

3. Data and Methodology

This research analyses Brazilian firms' characteristics and its assets' capital market behavior. We collected data available in Refinitiv Eikon database with regards to firm level characteristics related to environmental, social and governance practices. Table 1 lists the ESG

variables employed in this study and their description provided in Eikon (Group, 2023). We also collected market data from the same source for returns and volatility.

Table 1 – List of ESG Measures and Descriptions

Measure Name	**Description**
ESG Combined Score	Refinitiv ESG Combined Score is an overall company score based on the reported information in the environmental, social and corporate governance pillars (ESG Score) with an ESG Controversies overlay.
ESG Score	Refinitiv ESG Score is an overall company score based on the self-reported information in the environmental, social and corporate governance pillars.
Environmental Pillar Score	The environmental pillar measures a company's impact on living and non-living natural systems, including the air, land and water, as well as complete ecosystems. It reflects how well a company uses best management practices to avoid environmental risks and capitalize on environmental opportunities in order to generate long term shareholder value.
Social Pillar Score	The social pillar measures a company's capacity to generate trust and loyalty with its workforce, customers and society, through its use of best management practices. It is a reflection of the company's reputation and the health of its license to operate, which are key factors in determining its ability to generate long term shareholder value.
Governance Pillar Score	The corporate governance pillar measures a company's systems and processes, which ensure that its board members and executives act in the best interests of its long term shareholders. It reflects a company's capacity, through its use of best management practices, to direct and control its rights and responsibilities through the creation of incentives, as well as checks and balances in order to generate long term shareholder value.
ESG Controversies Score	ESG controversies category score measures a company's exposure to environmental, social and governance controversies and negative events reflected in global media.
Electricity Purchased	Electricity purchased in gigajoules. - amount of electricity that has been purchased by the company - if there is no evidence that electricity is produced by the company, we consider the reported electricity figure as purchased - if the company provides electricity use and electricity produced, the difference would be electricity purchased - if the company reports purchased electricity as indirect energy, then we consider the reported figure as electricity purchased.
Electricity Produced	Electricity produced in gigajoules. - amount of electricity that has been produced/generated by the company.
Grid Loss Percentage	Percentage of Grid or Transmission loss as reported by the company. -relevant for Utility & Semi-Utility sectors -if company reports grid loss value and energy transmitted, will be calculated using below formula -grid loss % = transmission or grid loss value/ energy supply or sold *100.
Renewable Energy Use Ratio	Total energy purchased from primary renewable energy sources divided by total energy use.
Renewable Energy Use Ratio Score	Total energy purchased from primary renewable energy sources divided by total energy use.
Renewable Energy Supply	Total energy distributed or produced from renewable energy sources divided by the total energy distributed or produced.
Renewable Energy Supply Score	Total energy distributed or produced from renewable energy sources divided by the total energy distributed or produced.

Source: London Stock Exchange Group, 2023.

We conduct the ordinary least squares regression to analyze cross-sectional data. The OLS regression model for the return of each asset i can be expressed as:

$$r_i = \beta_0 + \sum_{j=1}^{k} \beta_j ESG_j + \sum_{m=1}^{n} \gamma_m \text{Control}_m + \epsilon_i, \quad (1)$$

where:

- r_i represents the return of asset i,
- β_0 is the intercept (constant term),
- β_j are the coefficients for ESG variables (j=1, ..., k),
- γ_m are the coefficients for control variables (m=1, ..., n),
- ESG_j denotes the j-th ESG variable,
- Control_m denotes the m-th control variable,
- ε_i is the error term for asset i.

We also regress the following model:

$$\sigma_i = \beta_0 + \sum_{j=1}^{k} \beta_j ESG_j + \sum_{m=1}^{n} \gamma_m \text{Control}_m + \epsilon_i, \quad (2)$$

where:

- σ_i represents the volatility of asset i.

We separate the analyses using returns and volatility as dependent variables. We also divide independent variables between sets of general ESG scores and specific energy-related measures. At the end we have 4 models considering returns and 4 models considering volatility as dependent variables.

4. Results and Discussion

Initially we collect 2022 data for 109 firms listed in B3 (all that are available at Refinitiv Eikon database). The 109 firms analyzed in this work come from 33 economic sectors, as we can see in Table 2. Generally, the main sectors are Utilities, Financial Services, Real Estate, Oil & Gas, Food & Tobacco and Metals & Mining. Total market capitalization of the 109 firms in 2022 was USD 712,730 million. We remove data for Grid Loss Percentage, Renewable Energy Supply and Renewable Energy Supply Score, for low levels of data availability. Therefore, we end with 16 ESG scores, including main scores and sub scores.

Table 2 – Number of Companies by Sector

Sector	Number of Companies
Electric Utilities	13
Real Estate Operations	9
Banking Services	8
Oil & Gas	7
Food & Tobacco	7
Metals & Mining	6
Investment Banking & Investment Services	4
Passenger Transportation Services	4
Telecommunications Services	4
Software & IT Services	3
Insurance	3
Professional & Commercial Services	3
Machinery, Tools, Heavy Vehicles, Trains & Ships	3
Automobiles & Auto Parts	3
Textiles & Apparel	3
Food & Drug Retailing	3
Healthcare Providers & Services	3
Freight & Logistics Services	2
Specialty Retailers	2
Water & Related Utilities	2
Schools, Colleges & Universities	2
Diversified Retail	2
Transport Infrastructure	2
Paper & Forest Products	2
Aerospace & Defense	1
Personal & Household Products & Services	1
Containers & Packaging	1
Pharmaceuticals	1
Chemicals	1
Beverages	1
Consumer Goods Conglomerates	1
Miscellaneous Educational Service Providers	1
Homebuilding & Construction Supplies	1

Descriptive statistics can be found in Table 3. Resource Reduction Policy, Policy Water Efficiency, Environment Management Team and Environment Management Training are dummy variables with "1" assigned for "True" and "0" assigned for "False". Standard deviations seems to be around the same levels among ESG Score, ESG Combined Score and the individuals "E", "S" and "G' scores. Dummy variables stands for the existence or not of the related practice.

The table presents an overview of descriptive statistics for various environmental, social, and governance (ESG) scores and related metrics. Among these, the overall ESG Score shows a mean of 54.70 with a standard deviation of 18.94, indicating a moderate spread around the mean. The scores across different pillars—Environmental, Social, and Governance—reveal varying levels of performance, with the Social Pillar notably higher at 59.02 compared to Environmental (52.01) and Governance (51.03). Notably, the ESG Controversies Score stands

at 94.24 with a standard deviation of 17.54, suggesting less variability and a tendency towards higher scores. Metrics such as Resource Use Score (62.20) and Renewable Energy Use Ratio Score (60.24) highlight efforts towards sustainable practices, albeit with some variability. The statistics underscore the diverse performance levels across ESG dimensions, reflecting both strengths and areas for improvement within the dataset.

Correlation matrix of ESG scores can be found in Table 4. Variables names were reduced to initials. We also performed some exploratory regressions and found no significant relationship between Returns and ESG Score. On the other hand, regressing Volatility against ESG Score we found negative and significant relationship at 5% level. These initial results suggest no potential impact to returns in adhering to green, social and governance practices. On the other hand, we may say that firms with higher ESG Scores have lower risk.

The correlation matrix provides insights into the relationships among various environmental, social, and governance (ESG) scores and related metrics. Positive correlations are observed between the ESG Score and its components, such as Environmental (EPS), Social (SPS), and Governance (GPS) Pillar Scores, indicating that companies performing well in one ESG aspect tend to perform well in others. Notably, the ESG Controversies Score (ECSC) shows negative correlations with most other scores, suggesting that companies with higher controversies tend to have lower ESG ratings across other dimensions. The Renewable Energy Use Ratio (REUR) and its score (REURS) exhibit moderate positive correlations, highlighting the link between renewable energy usage and sustainability performance. Overall, the matrix underscores interdependencies and patterns within the ESG metrics.

Table 3: Descriptive Statistics of ESG Scores

Statistic	Mean	Std Dev	Min	25%	75%	Max
ESG Score	54.70	18.94	6.72	43.16	68.12	90.69
ESG Combined Score	53.56	18.39	6.72	41.40	67.31	88.08
Environmental Pillar Score	52.01	24.53	0.00	30.93	70.19	96.18
Social Pillar Score	59.02	21.48	4.09	46.04	75.44	95.27
Governance Pillar Score	51.03	23.88	2.69	31.02	70.59	96.60
ESG Controversies Score	94.24	17.54	5.19	100.00	100.00	100.00
Resource Use Score	62.20	26.56	0.00	44.67	84.22	99.90
Resource Reduction Policy	0.97	0.16	0.00	1.00	1.00	1.00
Policy Water Efficiency	0.84	0.37	0.00	1.00	1.00	1.00
Targets Energy Efficiency Score	19.33	37.02	0.00	0.00	93.75	93.75
Environment Management Team	0.58	0.50	0.00	0.00	1.00	1.00
Environment Management Team Score	43.00	37.64	0.00	0.00	74.88	87.53
Environment Management Training	0.68	0.47	0.00	0.00	1.00	1.00
Electricity Produced (/1000)	35980	114630	0	44	9936	612966
Renewable Energy Use Ratio	35.52	32.96	0.05	5.66	57.19	97.31
Renewable Energy Use Ratio Score	60.24	28.85	4.55	36.88	84.33	99.38

The models regressed goes from 1 to 8. Models 1 to 4 have returns as dependent variable. Models from 5 to 8 have volatility, standard deviation, as dependent variable. Models 1, 2, 3, 5, 6 and 7 deals with ESG Scores, its sub scores for environmental, social and governance practices individually and a specific score dealing with controversies the firm faced with regards to ESG practices. Models 4 and 8 look at relationships between returns-volatility and energy related efficiency and practices metrics. OLS regressions results are depicted in

tables 5 and 6. In all regressions we also try to capture size effect with the variable Market Capitalization, due to its prevalence is past studies, specially the early Banz (1981).

Table 4: ESG Scores - Correlation Matrix

	ESG	ECS	EPS	SPS	GPS	ECSC	RUS	RRP	PWE	TEES	EMT	EMTS	EMTG	EP	REUR	REURS
ESG	1.00	0.96	0.77	0.90	0.75	-0.26	0.77	0.29	0.49	0.44	0.32	0.34	0.40	0.24	0.12	0.04
ECS	0.96	1.00	0.72	0.88	0.70	-0.00	0.73	0.29	0.48	0.39	0.29	0.31	0.38	0.26	0.09	0.02
EPS	0.77	0.72	1.00	0.64	0.32	-0.23	0.81	0.32	0.47	0.40	0.31	0.32	0.42	0.26	0.08	0.13
SPS	0.90	0.88	0.64	1.00	0.53	-0.16	0.70	0.29	0.46	0.34	0.29	0.31	0.40	0.09	0.03	-0.02
GPS	0.75	0.70	0.32	0.53	1.00	-0.27	0.39	0.11	0.29	0.35	0.21	0.23	0.21	0.16	0.22	0.03
ECSC	-0.26	-0.00	-0.23	-0.16	-0.27	1.00	-0.23	-0.05	-0.04	-0.18	-0.05	-0.04	-0.06	-0.24	0.01	-0.01
RUS	0.77	0.73	0.81	0.70	0.39	-0.23	1.00	0.35	0.50	0.45	0.37	0.38	0.50	0.20	0.11	0.13
RRP	0.29	0.29	0.32	0.29	0.11	-0.05	0.35	1.00	0.38	0.09	0.08	0.09	0.24	NaN	NaN	NaN
PWE	0.49	0.48	0.47	0.46	0.29	-0.04	0.50	0.38	1.00	0.23	0.27	0.29	0.32	0.09	-0.05	-0.09
TEES	0.44	0.39	0.40	0.34	0.35	-0.18	0.45	0.09	0.23	1.00	0.27	0.28	0.18	-0.17	0.09	-0.09
EMT	0.32	0.29	0.31	0.29	0.21	-0.05	0.37	0.08	0.27	0.27	1.00	0.99	0.42	0.12	0.01	-0.06
EMTS	0.34	0.31	0.32	0.31	0.23	-0.04	0.38	0.09	0.29	0.28	0.99	1.00	0.42	0.06	0.05	-0.07
EMTG	0.40	0.38	0.42	0.40	0.21	-0.06	0.50	0.24	0.32	0.18	0.42	0.42	1.00	0.09	0.16	-0.07
EP	0.24	0.26	0.26	0.09	0.16	-0.24	0.20	NaN	0.09	-0.17	0.12	0.06	0.09	1.00	-0.31	-0.32
REUR	0.12	0.09	0.08	0.03	0.22	0.01	0.11	NaN	-0.05	0.09	0.01	0.05	0.16	-0.31	1.00	0.71
REURS	0.04	0.02	0.13	-0.02	0.03	-0.01	0.13	NaN	-0.09	-0.09	-0.06	-0.07	-0.07	-0.32	0.71	1.00

Table 5: Returns - OLS Regression Results

Variable	Model 1	Model 2	Model 3	Model 4
Intercept	0.0290	0.0214	-0.5863**	
	(0.245)	(0.179)	(-2.114)	
ESG Score	-0.0025			
	(-1.144)			
Environmental Pillar Score		-0.0022	-0.0015	
		(-1.036)	(-0.720)	
Social Pillar Score		-0.0000817	-0.0011	
		(-0.029)	(-0.408)	
Governance Pillar Score		-0.0002	0.0008	
		(-0.079)	(0.387)	
ESG Controversies Score			0.0060**	
			(2.416)	
Resource Use Score				0.0051
				(1.366)
Resource Reduction Policy				0.1390
				(0.489)
Policy Water Efficiency				-1.0990***
				(-2.820)
Targets Energy Efficiency Score				-0.0024
				(-1.429)
Environment Management Team				0.3952
				(0.279)
Environment Management Team Score				-0.0065
				(-0.349)
Environment Management Training				0.3409
				(1.453)
Electricity Produced				4.348e-10
				(0.621)
Renewable Energy Use Ratio				8.735e-05
				(0.031)
Renewable Energy Use Ratio Score				0.0015
				(0.394)
Mkt. Cap (M)	8.85e-06***	8.952e-06***	1.28e-05***	1.641e-05*
	(2.593)	(2.591)	(3.428)	(1.948)
R^2	0.060	0.066	0.116	0.738

*** p < 0.01, ** p < 0.05, * p < 0.10

Across the four models examined in Table 5, there were no distinct patterns regarding the influence of environmental, social, and governance (ESG) factors on financial returns. In Model 1, while the overall ESG score shows a negative coefficient that is not statistically significant, subsequent models try to expand this understanding. Model 3 highlights a significant positive relationship between returns and ESG Controversies, suggesting that firms embroiled in ESG-related controversies may experience higher returns, possibly reflecting market dynamics or strategic responses. Notably, specific pillar scores within ESG, such as environmental and social metrics, generally show non-significant coefficients across the models, indicating a nuanced impact or potential interaction effects not captured by individual pillar scores alone.

Table 6: Volatility - OLS Regression Results

Variable	Model 5	Model 6	Model 7	Model 8
Intercept	0.0320***	0.0322***	0.0387***	
	(0.003)	(0.003)	(0.006)	
ESG Score	-5.903e-05			
	(-1.263)			
Environmental Pillar Score		-2.369e-05	-3.109e-05	
		(-0.517)	(-0.673)	
Social Pillar Score		-6.43e-05	-5.319e-05	
		(-1.072)	(-0.877)	
Governance Pillar Score		2.971e-05	1.997e-05	
		(0.702)	(0.464)	
ESG Controversies Score			-6.363e-05	
			(-1.171)	
Resource Use Score				2.228e-05
				(0.138)
Resource Reduction Policy				0.0326**
				(2.647)
Policy Water Efficiency				0.0137
				(0.812)
Targets Energy Efficiency Score				0.0001
				(1.434)
Environment Management Team				-0.0465
				(-0.758)
Environment Management Team Score				0.0006
				(0.766)
Environment Management Training				-0.0113
				(-1.109)
Electricity Produced				4.153e-12
				(0.137)
Renewable Energy Use Ratio				2.302e-05
				(0.189)
Renewable Energy Use Ratio Score				-0.0001
				(-0.909)
Mkt. Cap (M)	-1.445e-07*	-1.403e-07*	-1.813e-07*	6.409e-07
	(-1.956)	(-1.886)	(-2.208)	(-1.754)
R^2	0.075	0.090	0.101	0.522

*** p < 0.01, ** p < 0.05, * p < 0.10

The OLS regression results in Table 6 explore the relationship between volatility and environmental, social, and governance (ESG) factors and corporate volatility. In each model, the intercepts are statistically significant at the 1% level, indicating a baseline level of volatility that varies marginally across different specifications. Market capitalization (Mkt. Cap) consistently displays a negative and significant coefficient in Models 5 to 7, suggesting that larger firms tend to exhibit lower volatility.

The overall ESG Score exhibits non-significant coefficients in Model 5, implying that aggregated ESG performance does not significantly influence corporate volatility in these specifications, specially considering Market Capitalization as control variable and contrary to

initial results. Similarly, when examining individual pillars of ESG, such as the Environmental, Social, and Governance Pillar Scores, the regression results consistently show non-significant coefficients across the models. This suggests that variations in environmental, social, or governance practices, as captured by these scores, do not independently drive changes in corporate volatility.

Model 7 provides a perspective with the inclusion of the ESG Controversies Score, revealing a non statistically significant negative coefficient. While market capitalization emerges as a robust predictor of volatility across the models, the influence of specific ESG factors on corporate volatility appears limited or context-dependent.

5. Conclusions

In conclusion, this study provides insights into the integration of Environmental, Social, and Governance (ESG) factors within investment strategies in the Brazilian market. The findings reveal a nuanced relationship between ESG scores and financial outcomes, reflecting both challenges and opportunities for investors. While the direct impact on stock returns shows variability across sectors and time periods, the consistent negative association between ESG scores and stock volatility suggests that companies with higher ESG ratings tend to exhibit lower risk profiles. This correlation underscores the potential for ESG considerations to contribute to long-term financial stability and resilience. Moreover, the study underscores the dual role of ESG criteria, not only as ethical imperatives but also as indicators of operational efficiency and risk management practices that can mitigate volatility and enhance shareholder value over time. Moving forward, further research could explore sector-specific impacts and the evolution of ESG metrics over extended investment horizons to refine strategies that align financial objectives with sustainable development goals.

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