From Education to Sustainability: Can STEM CEOs Drive ESG Performance? Evidence from Top-Sustainable Companies

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Article

From Education to Sustainability: Can STEM CEOs Drive ESG Performance? Evidence from Top-Sustainable Companies

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Abstract: Considered as innovation-oriented, this research is conducted to examine the does the STEM-educated CEOs drive better ESG performance. Using OLS regression, this research is conducted using listed companies assessed their ESG performance on Sustainalytics on the period of 2022 identified as "top sustainable companies" encompassing 1,039 observations. The findings of this research reveal that STEM-educated CEOs is negatively associate with ESG performance in top sustainable companies. Robustness analysis also conducted to prevent endogeneity issues. This study introduces the novel idea of strategic trade-offs in ESG leadership. While STEM leaders drive innovation, their focus might lead to underinvestment in other crucial ESG aspects within already sustainable firms. In addition on offering contribution of governance and ESG research, this research bring new insight in selecting CEOs for top ESG companies which should consider a balanced skillset beyond technological solutions.

Keywords: governance; STEM CEO; ESG rating; top-sustainable; sustainalytics

1. Introduction

Awareness toward business to consider sustainability is getting more pronounce. In response, several countries take this awareness as the pressure to mandate companies to publish sustainability reporting annually (Li & Jia, 2022). KPMG, (2024) survey reveals that over past few year, the number of companies that report their sustainability increased to 96%. This number indicates that sustainability commitment is getting more recognition as the company leaders announced their company to create new focus on sustainability goals. Sustainability reporting is crucial first step yet merely focusing on the reporting cannot guarantee Environmental, Social, and Governance (ESG) performance of the companies. To provide a standardized and forward-looking assessment of this performance providing investors and stakeholders with a comparable metric of a company's inherent ESG performance (Charlin et al., 2022; Jámbor & Zanócz, 2023; Walter, 2020). Bell, (2021) survey found that out of the 98% of investors surveyed who assess ESG, a significant 72% carry out a structured review of ESG performance, shows the increase of 32% from prior year. Running through the ESG performance is growing trend to the companies. This clear trend highlights that investors are not only paying attention to ESG but are also increasingly employing structured and rigorous methods to evaluate companies' ESG performance.

With the complexity of considering sustainability goals to the business strategy, companies face increasing pressure from diverse stakeholders (Koch & Sauer, 2024). These pressures create such challenge to align long-term environmental and social objectives with short-term financial targets, thus navigating this landscape requires strong leadership at the top (Shu et al., 2024). Chief Executive Officer (CEO) as the top management is in charge of making optimal decision for the companies (Aryani et al., 2025; Jaggia & Thosar, 2021; Putra & Setiawan, 2024). Their leadership also sets the tone for the organization's culture and future direction (Naaman & Sun, 2022; Yao, 2023). Having the ability to define the clear goals and keep the companies running on the track is required .

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Creating sustainable solution is undeniably required innovation. As the driver of corporate sustainability, CEO need to have those nature of innovation nature to better create the innovation culture in the companies. According to Siepel et al., (2021) and Cahyono et al., (2024) those nature can be found in CEOs who having Science, Technology, Engineering, and Mathematics (STEM) degree. These leaders are more likely to engage in technological investments, pursue research-driven strategies, and lead firms toward innovation-oriented outcomes. However, while STEM-educated CEOs may be well-equipped to drive technological innovation, scientific evidence on STEM-educated CEOs as the driver of ESG performance still unclear. The question raised on "does the innovation-oriented CEOs suitable to maintain good ESG performance?" remain unsolved. Therefore, this research is conducted to examine the does the STEM-educated CEOs drive better ESG performance.

Hypothesize based on upper echelon perspective which posits that top management's background, such as their education, experience, and values could shape their decision, this research expects that the STEM-educated CEOs have association with ESG performance. To examine the hypothesis, this research is conducted using listed companies assessed their ESG performance on Sustainalytics on the period of 2022 and receive negligible and low risk, which we identified as "top sustainable companies" encompassing 1,039 observations. By selecting companies that have already demonstrated a strong commitment to and effective management of ESG risks, this research aims to explore whether STEM-educated CEO can contribute to further enhancing or maintaining this high level of performance. The findings of this research reveals that STEM-educated CEOs is negatively associate with ESG performance in top sustainable companies. This indicates that within the cohort of top sustainable companies, the presence of a STEM-educated CEO is associated with a statistically significant higher ESG risk rating as assessed by Sustainalytics, suggesting potentially less effective management of ESG risks compared to their non-STEM counterparts in this high-performing group. The findings align with trade-off perspective which suggests that STEM-focused leaders strategic prioritization could inadvertently lead to a relatively higher ESG risk rating compared to companies with leadership prioritizing ESG enhancements. This results is ensured to free from endogeneity issues as robustness tests conducted.

This research offers some contributions. This research introduces the idea of strategic trade-offs at the leadership level which can contribute to a more sophisticated understanding of the factors influencing ESG performance beyond just the cognitive abilities of the CEO. This research could be the reference for the companies when selecting CEOs, often consider their strategic priorities. This research could also be insight for companies to maintain their top companies status which requires continuous effort which highlights the importance of embedding ESG goals across the organization, not solely relying on the CEO's individual background.

The remaining sections of the paper are organized to present a comprehensive exploration of the research topic as follows. Section 2 explains the relevant literature and theoretical frameworks, establishing the foundation for the research hypothesis. Then, the research methodology and variable measurements are explained in section 3, followed by the empirical results, analysis, and discussions in section 4. Finally, section 5 presents the conclusion of this study.

2. Literature Review and Hypothesis Development

2.1. STEM-Educated CEO

CEO is the leader of the board of executives (Putra & Setiawan, 2024). CEO sits at the apex of an organization, wielding significant influence over its strategic direction, resource allocation, and overall culture (Aryani et al., 2025; Harymawan et al., 2023; Hrazdil et al., 2021; Jaggia & Thosar, 2024; Setiawan et al., 2024; Z. Xu & Hou, 2021). In top-performing companies, particularly those recognized for their sustainability leadership, the CEO's role extends beyond traditional financial metrics to encompass commitment to ESG principles. These leaders in top companies often set ambitious sustainability targets, champion ESG integration across all business functions, and ensure accountability for achieving these goals. Their leadership is characterized by a long-term vision that

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recognizes the interconnectedness of financial success and responsible corporate citizenship (Yi et al., 2021; Zaman et al., 2020), often driving a proactive approach to risk management and the pursuit of innovative solutions for a sustainable future.

Recognizing that achieving strong ESG performance increasingly demands innovation (Setiawan et al., 2024; J. Xu et al., 2021), this research focuses on CEOs with a Science, Technology, Engineering, and Mathematics (STEM) educational background. STEM-educated CEO is defined as CEO with a degree in one or more of these disciplines. Prior research conducted by Rizki et al., (2024); Siepel et al., (2021); Alderman et al., (2022); Cahyono et al., (2024); Rodríguez-Becerra & Pernaa, (2023); S&P Global, (2023) evaluate how acquiring a STEM degree can offer several key benefits for a CEO seeking to lead a company towards enhanced sustainability. Firstly, STEM CEO cultivates strong analytical and problem-solving skills, enabling a deeper understanding of complex challenges and the ability to critically evaluate potential solutions. Secondly, STEM education often fosters a data-driven and evidence-based decision-making approach, crucial for measuring. Thirdly, it installs a mindset geared towards innovation and technological advancement, which can be invaluable in identifying and implementing cutting-edge business practices. Fourthly, a STEM background can provide a foundational understanding of the scientific and technical aspects, potentially leading to more informed and effective strategic choices.

2.2. ESG Performance

Prior studies have assessed ESG performance primarily through company disclosures (Harymawan et al., 2021; Mohammad & Wasiuzzaman, 2021; Pulino et al., 2022; Saha et al., 2023). However, this approach has limitations, as disclosures may not accurately reflect a company's true ESG performance and can be susceptible to greenwashing practices (Jámbor & Zanócz, 2023). To address these concerns, this study employs a performance measurement approach that utilizes third-party ESG ratings. ESG ratings offer a more condensed and analytical assessment, making them a valuable tool for evaluating companies' ESG performance (Khandelwal et al., 2023; White, 2015). Numerous rating agencies, such as Bloomberg, MSCI, Sustainalytics, CDP, ISS, RobecoSAM, and Corporate Knights, each with their criteria and standards, evaluate companies' ESG performance (Charlin et al., 2022; Madison & Schiehll, 2021).

Identifying and understanding their material ESG issues specifically the environmental, social, and governance risks they are exposed to, is crucial for companies (Eccles & Serafeim, 2013). By effectively managing these risks, companies can significantly improve their operational efficiency, effectiveness, and overall ESG performance. This targeted approach aligns well with the strengths of Sustainalytics' ESG Risk Score. This rating, offered by Sustainalytics by Morningstar, was chosen as the primary ESG rating agency for this research due to its comprehensive approach (Mandas et al., 2023). Sustainalytics assesses both a company's susceptibility to material, industry-specific ESG risks and the effectiveness of its risk management practices. This two-pronged approach provides valuable insights for investors. Their ESG Risk Rating specifically measures a company's ability to manage its exposure to ESG risks, resulting in a comprehensive company score that reflects how effectively a company addresses its potential ESG risks.

Sustainalytics' ESG Risk Rating goes beyond a simple numerical score (Walter, 2020). It also categorizes companies based on their risk profile into five categories, ranging from the best to the worst (Zioło et al., 2023). Companies with negligible risk (score 0-10) face minimal ESG-related challenges. Those with low risk (score 10-20) have a relatively low level of exposure. The medium risk category (score 20-30) indicates a moderate level of ESG risks that require attention. Companies with a high-risk rating (score 30-40) face significant ESG-related challenges, while those in the severe risk category (score above 40) encounter very high levels of ESG risk. This categorization system by Sustainalytics provides valuable insights for companies to understand their ESG risk exposure and prioritize improvement efforts.

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2.3. Hypothesis Development

The relationship of STEM-educated CEOs and ESG performance can be theoretically grounded in several organizational perspectives. To begin with, this research initially draws upon the upper echelon perspective. This theory posits that the strategic choices and performance outcomes of an organization are a direct reflection of the cognitive bases, values, and experiences of its top management team, particularly the CEO (Hambrick & Mason, 1984). Applying this lens, we posit that a CEO's educational background, as a fundamental aspect of their cognitive base and expertise, will shape their strategic orientation towards sustainability and, consequently, the company's ESG performance, as assessed by Sustainalytics' ESG Risk Rating.

CEOs with STEM education are likely to acquire a unique set of skills as they are trained in analytical thinking, problem-solving, and scientific inquiry can foster a more rigorous and data-driven approach. STEM disciplines also inherently emphasize innovation and the application of technological solutions (Hsieh et al., 2022; Kong et al., 2023). Given that mitigating ESG risks often necessitates the adoption of novel technologies, processes, and business models (Charlin et al., 2022; Gillan et al., 2021). STEM-educated CEO may be more inclined to champion and invest in such innovation-oriented strategies that could support reducing the company's ESG risk profile, thereby potentially leading to a better Sustainalytics ESG risk rating score. While STEM background equips CEOs with valuable analytical and innovation-driving skills, certain aspects of this training and professional focus could inadvertently lead to less comprehensive or potentially weaker overall ESG risk rating score. Visnjic et al., (2025) reveals that one of the successful keys in achieving sustainability goals is through the openness to external collaboration along with maintaining strong internal integration. Trust and highly value internal innovation is indeed good steps, however, this also may create less open to collaborate with external business and community stakeholders. Based on the above, the hypothesis is derived as follows:

Hypothesis. *STEM-educated CEO is associated with corporate ESG performance.*

3. Research Methodology

3.1. Sample Selection

The research sample consists of listed top sustainable companies according to Sustainalytics during period of 2022. These top ratings correspond to companies deemed "negligible risk" and "low risk" by Sustainalytics. This specific year was chosen due to being the most recent publicly available data at the time of data collection. Initially, we gathered a sample of 2,045 observations. However, following a rigorous data-cleaning process to remove entries with missing values, the final sample size for analysis was reduced to 1,039 observations. Details of the criteria applicable to obtain the final sample are provided in Table 1.

Table 1. Sample Selection Criteria.

Description	Total
Top-rated Listed companies rated by Sustainalytics in 2022	2045 observations
Less:	
Missing data: STEM	520 observations
Missing data: CEOAGE	228 observations
Missing data: FSIZE	65 observations
Missing data: BSIZE	85 observations
Missing data: FAGE	30 observations
Missing data: ROA	27 observations
Missing data: LIQUIDITY	51 observations

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Final Sample	1039 observations

Table 2 Panel A presents sample distribution of CEO education, specifically STEM majors by each industry, showing a notable disparity in the representation of STEM and non-STEM CEOs. Of the total 1,039 observations as the final sample, 675 observations (64%) are classified as non-STEM, while 377 observations (36%) fall under the STEM category. This indicates that non-STEM backgrounds remain dominant among corporate leaders. The table also highlights the varying levels of STEM-educated CEO representation across different industries. Precious Metals leads the pack with an impressive 83% of STEM CEOs, followed by Homebuilders at 80% and Semiconductors at 77%. These findings align with the expectation that industries heavily reliant on technological innovation would favor STEM CEOs' leadership. In contrast, certain industries exhibit a lower proportion of STEM CEOs. Transportation holds such a low percentage at 18%, followed by Textiles & Apparel at 17%, and the lowest at 0% by Automobiles, Household Products, Insurance, Refiners & Pipelines, and Pharmaceuticals.

Sample distribution of risk category across the continent of top-sustainable companies is presented in Table 2 panel B. Out of 1,039 observations, 10% of the sample (100 observations) is having negligible risk. On the other hand, 90% of the sample (939 observations) is having low risk. From 5 continents of top companies headquarters location, continent that have highest percentage of negligible risk is Africa with 67% of the companies in this continent have negligible risk. Followed by Oceania and Europe with the percentage of 12% and 15% respectively. Meanwhile, for low risk, America and Asia exhibit the highest concentration, with 92% and 91% of their respective top sustainable companies falling into this category. Europe and Oceania also show a significant majority of their top sustainable companies classified as low risk, with 88% and 85% respectively. Notably, Africa has the lowest percentage of companies in the low-risk category at 33%, which is a direct inverse of its high proportion of negligible-risk companies.

Table 2. Data Tabulation.

Panel A: Data Tabulation of STEM CEO across industry

	Industry	non-STEM		STEM		Total	
		N	%	N	%	N	%
1	Precious Metals	1	17%	5	83%	6	100%
2	Homebuilders	1	20%	4	80%	5	100%
3	Semiconductors	7	23%	24	77%	31	100%
4	Technology Hardware	43	39%	68	61%	111	100%
5	Paper & Forestry	2	40%	3	60%	5	100%
6	Software & Services	54	46%	63	54%	117	100%
7	Machinery	9	47%	10	53%	19	100%
8	Utilities	9	50%	9	50%	18	100%
9	Chemicals	7	50%	7	50%	14	100%
10	Electrical Equipment	7	50%	7	50%	14	100%
11	Construction & Engineering	2	50%	2	50%	4	100%
12	Oil & Gas Producers	1	50%	1	50%	2	100%
13	Containers & Packaging	9	53%	8	47%	17	100%
14	Traders & Distributors	9	53%	8	47%	17	100%
15	Pharmaceuticals	19	54%	16	46%	35	100%
16	Building Products	7	58%	5	42%	12	100%
17	Healthcare	29	63%	17	37%	46	100%

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18	Auto Components	19	63%	11	37%	30	100%
19	Energy Services	2	67%	1	33%	3	100%
20	Real Estate	78	68%	36	32%	114	100%
21	Food Retailers	11	69%	5	31%	16	100%
22	Telecommunication Services	12	75%	4	25%	16	100%
23	Consumer Durables	33	80%	8	20%	41	100%
24	Commercial Services	57	81%	13	19%	70	100%
25	Transportation	18	82%	4	18%	22	100%
26	Media	50	83%	10	17%	60	100%
27	Textiles & Apparel	30	83%	6	17%	36	100%
28	Consumer Services	21	84%	4	16%	25	100%
29	Retailing	76	85%	13	15%	89	100%
30	Transportation Infrastructure	11	85%	2	15%	13	100%
31	Food Products	8	89%	1	11%	9	100%
32	Diversified Financials	18	90%	2	10%	20	100%
33	Automobiles	4	100%	0	0%	4	100%
34	Household Products	3	100%	0	0%	3	100%
35	Insurance	3	100%	0	0%	3	100%
36	Refiners & Pipelines	2	100%	0	0%	2	100%
37	Pharmaceuticals	3	100%	0	0%	3	100%
Total		**675**	**64%**	**377**	**36%**	**1052**	**100%**

Panel B: Data Tabulation of Risk category across continent

Continent	Risk Category					
	Negligible Risk		Low Risk		Total	
	N	%	N	%	N	%
America	37	8%	454	92%	491	100%
Asia	12	9%	128	91%	140	100%
Africa	2	67%	1	33%	3	100%
Europe	45	12%	334	88%	379	100%
Oceania	4	15%	22	85%	26	100%
Total	**100**	**10%**	**939**	**90%**	**1039**	**100%**

3.2. Variable Definition and Measurement

Dependent variable. In this study, we employ ESG risk rating as a dependent variable (RATING). ESG risk rating is determined using the ESG risk score developed by Sustainalytics. The higher the ESG risk rating companies have, the greater portion of their unmanaged ESG risk remains, and the lower the ESG risk score, the better the management is at handling the risks. For easier interpretation, we multiplied the score by negative 1 (-1). As Sustainalytics classifies risk rating into 5 categories based on the assessed score and the aim of this study is to analyze top-rated firms' scores, we solely include firms that had negligible and low risk from the company assessed by Sustainalytics in 2022.

Independent variable. The independent variable in this research is STEM CEOs (STEM), measured from the educational background of CEOs. To determine whether a company's CEO possesses a STEM background, we manually gathered data from two primary sources: company annual reports and the LinkedIn website. Borrowing the approach from Alderman et al., (2022); Hsieh et al., (2022); Kong et al., (2023), once the educational background of each CEO was ascertained, a dummy variable

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was created to represent STEM CEO status (Alderman et al., 2022; Hsieh et al., 2022; Kong et al., 2023). This dummy variable assigned a value of 1 to CEOs with STEM degrees and a value of 0 if otherwise.

Control Variable. Various controls were added to account for CEO, auditor, firm, governance, and finance factors that could affect the relationship between STEM and RATING. In response, there are several control variables employed such as natural logarithm of CEOs' age (CEOAGE) to represent CEO characteristics, external auditors of the firm (BIG4), number of boards in the company (BSIZE), board tier system (TIER), natural logarithm of firm age (FAGE), ratio of EBIT to Total assets (ROA), ratio of current assets to current liabilities (LIQUIDITY), and gross domestic product (GDP). The operational variables used in this study are summarized in Table 3.

Table 3. Variable definition and measurement.

Variable	Definition	Measurement	Source
Independent Variable			
ESG Rating	RISK_SCORE	ESG Risk Rating Score then multiplied it with (-1)	Sustainalytics
Dependent Variable			
STEM CEOs	STEM	Dummy variable of CEOs' educational background set to 1 if CEOs obtained one or more degree from STEM major and 0 otherwise.	Annual report and Companies website
Control Variable			
CEOs' age	CEOAGE	Natural logarithm of CEOs' AGE	Annual report and Companies website
Board Size	BSIZE	Natural logarithm of number of Board in the firm	Bloomberg
Firm age	FAGE	Natural logarithm of firm age calculated from the point of the company's initial public offering	Bloomberg
Firm size	FSIZE	Natural logarithm of total assets	Bloomberg
Return of assets	ROA	Ratio of EBIT to total assets	Bloomberg
Liquidity ratio	LIQUIDITY	Ratio of current assets to current liabilities	Bloomberg
Gross Domestic Product	GDP	Natural logarithm of Gross Domestic Product	World Bank

3.3. Model Specification

This research employs a range of statistical techniques to analyze the relationship between STEM CEOs and ESG risk rating. These techniques include descriptive statistics, univariate analysis, and least squares regression analysis. Before conducting these analyses, the data undergoes winsorization to address potential outliers that could distort the results. Winsorization involves capping extreme values within a specified range to minimize their influence on the overall data distribution. This

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ensures that the analyses are conducted on a more robust and representative dataset (Reifman & Garrett, 2010). After winsorizing the data to 1% and 99%, the regression test was conducted. The equation model used in this study is shown below:

$$SCORE_i = \alpha + \beta_1 STEM_i + \beta_2 CEOAGE_i + \beta_4 BSIZE_i + \beta_5 FAGE_i + \beta_6 FSIZE_i + \beta_7 ROA_i + \beta_8 LIQUIDITY_i + \beta_9 GDP_i + \varepsilon$$

4. Findings and Discussions

4.1. Descriptive Statistics and Correlation Analysis

Table 5 presents a descriptive summary of the variables used in the regression model. The dependent variable, ESG risk rating (RISK_SCORE), has a mean of 15.154. This indicates an average risk rating across the top-rated companies in our sample. However, the minimum value of 4.3 suggests that even these top companies haven't entirely eliminated ESG-related risks. The maximum value is capped at 20, reflecting our selection criteria of "top-rated" companies. Turning to the independent variable, the STEM CEOs (STEM) variable has a mean of 0.336. In other words, approximately 33.6% of the top-sustainable companies have CEOs with a STEM background (science, technology, engineering, or mathematics). This finding sets the stage for our regression analysis, which will investigate the potential association between a CEO's STEM education and ESG performance specifically within the context of these top-sustainable companies. Strong focus on innovation, technological advancement, and rapid growth lead to a relatively lower emphasis on further incremental improvements in ESG, especially in companies that already have a good baseline.

Table 4. Descriptive Statistics.

Variable	Mean	Standard Deviation	Minimum	Median	Maximum
RISK_SCORE	15.065	3.367	4.300	15.500	20.000
STEM	0.357	0.479	0.000	0.000	1.000
CEOAGE	4.030	0.132	3.367	4.043	4.500
BSIZE	20.565	10.298	2.000	19.000	111.000
FAGE	2.812	1.000	0.000	3.045	4.804
FSIZE	14.938	2.820	6.987	15.232	21.882
ROA	0.216	1.937	-2.780	0.070	59.404
LIQUIDITY	3.408	48.992	0.000	0.677	1564.748
GDP	15.343	1.621	8.704	15.220	17.053

Table 6 presents the correlation matrix for the entire sample, summarizing the relationships between variables. This table allows us to assess the potential linear associations between variables before conducting further analysis. The correlation coefficient between STEM and SCORE is 0.045 and t-value of 0.080, indicating a potential association between CEOs with STEM backgrounds and higher ESG risk rating scores. However, correlation does not imply causation, and further investigation is required to understand the underlying mechanisms.

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Table 5. Pearson correlation.

		[1]	[2]	[3]	[4]	[5]
[1]	RISK_SCORE	1.000				
[2]	STEM	-0.052*	1.000			
		(0.097)				
[3]	CEOAGE	0.028	0.031	1.000		
		(0.372)	(0.311)			
[4]	BSIZE	-0.139***	-0.017	0.107***	1.000	
		(0.000)	(0.586)	(0.001)		
[5]	FAGE	0.111***	0.031	0.133***	0.124***	1.000
		(0.000)	(0.316)	(0.000)	(0.000)	
[6]	FSIZE	0.056*	-0.005	-0.041	-0.138***	0.003
		(0.072)	(0.865)	(0.190)	(0.000)	(0.928)
[7]	ROA	-0.044	-0.010	0.036	-0.011	-0.055*
		(0.160)	(0.748)	(0.248)	(0.713)	(0.076)
[8]	LIQUIDITY	0.059*	-0.025	-0.016	0.005	-0.016
		(0.058)	(0.412)	(0.612)	(0.883)	(0.609)
[9]	GDP	-0.101***	-0.066**	0.100***	0.254***	0.065**
		(0.001)	(0.033)	(0.001)	(0.000)	(0.035)
		[6]	[7]	[8]		[9]
[6]	FSIZE	1.000				
[7]	ROA	-0.053*	1.000			
		(0.090)				
[8]	LIQUIDITY	0.016	-0.004	1.000		
		(0.603)	(0.898)			
[9]	GDP	-0.508***	-0.004	0.024		1.000
		(0.000)	(0.907)	(0.443)		

p-values in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Independent samples t-test is conducted in order to compare the average value of the used variables in companies led by CEOs with STEM backgrounds and non STEM-educated CEOs. This analysis aims to investigate potential differences in ESG performance score based on the CEO's educational background. The results as shown in Table 6 reveals that on average companies with STEM CEOs have higher ESG risk score than companies with non-STEM CEOs (-15.298). The mean difference is considered to be significant.

Table 6. Independent t-test.

	MEAN		Coeff	t-value
	STEM CEO	Non-STEM CEO		
RISK_SCORE	-15.298	-14.936	-0.362*	-1.662
CEOAGE	4.037	4.026	0.011	1.280

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BSIZE	20.332	20.695	-0.363	-0.544
FAGE	2.854	2.789	0.065	1.004
FSIZE	14.918	14.949	-0.031	-0.170
ROA	0.190	0.231	-0.040	-0.322
LIQUIDITY	1.733	4.338	-2.605	-0.821
GDP	15.199	15.423	-0.224**	-2.139

4.2. Baseline Regression Analysis

In examining the sample and obtain the result for the hypothesis, OLS regression is employed. Table 7 Present the results of the regression analysis. Column (1) present the regression result for STEM and RISK_SCORE. The findings show negative association between STEM and RISK_SCORE at the significance level of 10% (coeff = -0.362, t = -1.71); Column (2) shows the consistent result after control variables is employed at the significance level of 5% (coeff = -0.451, t = -2.14); Column (3) shows the regression result after including industry fixed effect and country fixed effect. The result shows the negative significance at the level of 10% (coeff = -0.361, t = -1.70).

All column of regression models show consistency results of negative relationship between STEM-educated CEO and ESG performance. Thus, the result is supporting the hypothesis that there is an association between STEM-educated CEO and ESG performance. This negative result indicates that within the context of top sustainable companies, having an innovation-oriented CEO with a STEM background is associated with a higher ESG risk rating, in other word, worse performance. This finding aligns with trade-off perspective, suggesting that the strategic focus on technological innovation and advancement, often prioritized by STEM leaders, might lead to less emphasis on other crucial aspects of ESG management in companies that have already established a strong baseline (Truant et al., 2023). This result also supporting Visnjic et al., (2025) highlight on potential inclination towards internally driven innovation, which in this case is fostered by STEM expertise, inadvertently create less openness to valuable external partnerships with businesses and community stakeholders, hindering the comprehensive management of diverse ESG risks.

Table 7. Baseline Regression Analysis.

	(1) RISK_SCORE	(2) RISK_SCORE	(3) RISK_SCORE
STEM	-0.362*	-0.451**	-0.361*
	(-1.71)	(-2.14)	(-1.70)
CEOAGE		0.963	0.829
		(1.20)	(1.03)
BSIZE		-0.046***	-0.048***
		(-4.09)	(-4.13)
FAGE		0.438***	0.330***
		(4.49)	(3.32)
FSIZE		-0.013	-0.050
		(-0.33)	(-1.02)
ROA		-0.071***	-0.062***
		(-4.79)	(-3.85)
LIQUIDITY		0.004***	0.004***
		(6.92)	(5.20)
GDP		-0.186**	-0.532**

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		(-2.45)	(-2.32)
_cons	-14.936***	-16.024***	-9.524*
	(-110.73)	(-4.69)	(-1.91)
Industry FE	No	No	Yes
Country FE	No	No	Yes
r2	0.003	0.052	0.153
r2_a	0.002	0.045	0.106
N	1039	1039	1039

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4.3. Robustness Test

Ensuring that the correlation between STEM-educated CEOs and ESG risk score are free from endogeneity issues that might exist. For endogeneity testing, first Wu-Hausman test is conducted. The aim is to validate the use of fixed-effect as the regression model instead of using random-effect model. Table 7 shows the result of Wu-Hausman test. It shows that the value of p-value of chi square is 0.0092. As the value is less than 0.05, the null hypothesis is rejected which means that the use of fixed effect model is consistent and more reliable compare to using random-effect model.

Second, Coarsened Exact Matching (CEM) analysis is conducted. This test is conducted by making the treatment and control groups as similar as possible on important characteristics by temporarily simplifying those characteristics and then finding exact matches. The observations that is unmatched to the other group created led to reduction of the sample selection. Table 8 presents the result of CEM analysis.

Table 8. Wu-Hausman Test.

	RISK_SCORE	
	(1)	(2)
	Fixed-effect	Random-Effect
STEM	-0.347	-0.451**
	(-1.587)	(-2.108)
CEOAGE	0.957	0.963
	(1.220)	(1.225)
BSIZE	-0.042***	-0.046***
	(-4.038)	(-4.412)
FAGE	0.391***	0.438***
	(3.707)	(4.213)
FSIZE	-0.041	-0.013
	(-0.953)	(-0.310)
ROA	-0.064	-0.071
	(-1.218)	(-1.340)
LIQUIDITY	0.003	0.004**
	(1.595)	(2.061)
GDP	-0.131*	-0.186**
	(-1.703)	(-2.466)

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_cons	-16.416***	-16.024***
	(-4.826)	(-4.705)
N	1039	
chi2(8)	20.33	
Prob>chi2	0.0092	

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

In panel A, it shows the CEM observation sample. During this stage, the sample distribution is clustered across three groups. Consequently, 667 companies with non-STEM CEOs in matched and have similar characteristics with STEM CEOs. Meanwhile the 1 company remains unmatched with companies of similar characteristics that have STEM CEOs. On the other hand, 370 companies with STEM CEOs are included in matching process, leaving 1 company in unmatched condition. Subsequently, panel B displays the regression result in the condition where the observations of CEM is matched. The results show the negative association at the significant level of 10% (coeff = -0.358, t-value = -1.69). This result is consistent with the baseline regression results which indicates that after controlling for potential confounding factors through the matching process, the negative relationship between having a STEM-educated CEO and ESG performance in top sustainable companies remains statistically significant.

Table 9. Coarsened Exact Matching.

Panel A: CEM Observation Sample		
	Non-STEM	STEM
All	668	371
Matched	667	370
Unmatched	1	1
Panel B: CEM Regression		
	(1)	
	RISK_SCORE	
STEM	-0.358*	
	(-1.69)	
CEOAGE	0.830	
	(1.03)	
BSIZE	-0.049***	
	(-4.18)	
FAGE	0.349***	
	(3.50)	
FSIZE	-0.050	
	(-1.02)	
ROA	-0.412	
	(-1.49)	
LIQUIDITY	-0.023**	
	(-2.22)	

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GDP	-0.525**
	(-2.31)
_cons	-9.463*
	(-1.92)
Industry FE	Yes
Country FE	Yes
r2	0.153
r2_a	0.106
N	1037

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4.4. Additional Analysis

4.4.1. Early Adopter Countries

Being an early adopter and had developed comprehensive sustainability policies and regulations, European countries have established a significant lead in fostering strong ESG practices among their domestic companies (Iamandi et al., 2019). This proactive regulation has likely cultivated a distinct environment where ESG considerations are deeply embedded in corporate strategy and operations. To understand whether the relationship between STEM-educated CEOs and ESG performance is consistent across different regulatory and market contexts, a sub-sample analysis comparing European and non-European companies is conducted. Table 10 displays the results of sub sampling European and non-European countries. It shows that in the European countries, the relationship between STEM CEOs and ESG Performance indeed reveals negative association (coeff = -0.841, t-value = -2.43) which indicate that within this mature and regulated ESG landscape, the presence of a STEM-educated CEO is associated with a statistically significant with worse ESG performance among top sustainable European companies. On the other hand in non-European countries, the result shows no association between STEM-educated CEOs and ESG performance.

Table 10. Sub sample – European and non-European countries.

	RISK_SCORE	
	(1)	(2)
	EU	Non-EU
STEM	-0.841**	-0.086
	(-2.43)	(-0.32)
CEOAGE	-0.870	1.504
	(-0.58)	(1.58)
BSIZE	-0.075***	-0.039***
	(-3.55)	(-2.78)
FAGE	0.016	0.521***
	(0.09)	(4.05)
FSIZE	-0.069	-0.031
	(-0.82)	(-0.52)
ROA	-0.065***	-0.403

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	(-3.65)	(-1.59)
LIQUIDITY	-0.022	0.004***
	(-1.22)	(6.28)
GDP	1.394***	-0.489**
	(4.15)	(-2.09)
_cons	-31.477***	-12.417**
	(-3.66)	(-2.36)
Industry FE	Yes	Yes
Country FE	Yes	Yes
r2	0.169	0.154
r2_a	0.084	0.108
N	379	660

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4.4.2. Developed and Developing Countries

The global emphasis on corporate sustainability and ESG performance is not uniformly experienced across different stages of economic development (Lozano, 2015). Having different on environmental regulations, stakeholder awareness, and established institutional frameworks for corporate governance, may lead to different ESG performance (Mooneeapen et al., 2022). Understanding these differences is crucial for analysis of the relationship between leadership attributes and corporate sustainability outcomes on a global scale. Thus, the sub sample of developing and developed countries is employed.

Table 11 displays the result of the sub sample analysis. Column (1) present the result for developed countries. It shows the negative association of STEM-educated CEOs and ESG performance which align with baseline regression. This association might happen because in developed economies, where ESG pressures are more pronounced and sophisticated sustainability practices are already widespread, the strategic focus of STEM-educated CEOs on radical innovation and technological advancements might inadvertently lead to a relative neglect of the more nuanced and comprehensive aspects of ESG management required to further improve performance and reduce risk, as assessed by stringent third-party ratings. This prioritization could result in a higher ESG risk rating compared to leaders with a broader strategic focus on all ESG pillars. Meanwhile, for developing countries as shows in column (2) there is no association between STEM-educated CEOs and ESG performance.

Table 11. Sub sample - Developing and developed countries.

	RISK_SCORE	
	(1)	(2)
	Developed countries	Developing countries
STEM	-0.414*	0.126
	(-1.85)	(0.18)
CEOAGE	0.687	0.839
	(0.77)	(0.36)
BSIZE	-0.047***	-0.021

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	(-3.92)	(-0.54)
FAGE	0.368***	0.060
	(3.55)	(0.14)
FSIZE	-0.038	-0.363
	(-0.76)	(-1.20)
ROA	-0.058***	-0.567
	(-3.65)	(-0.39)
LIQUIDITY	-0.024	0.038
	(-0.93)	(0.95)
GDP	-0.452**	1.330
	(-2.02)	(1.57)
_cons	-11.080**	-32.801*
	(-2.11)	(-1.98)
Industry FE	Yes	Yes
Country FE	Yes	Yes
r2	0.142	0.312
r2_a	0.102	0.067
N	935	104

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4.4.3. CEO's Gender

Due to evolutionary and societal factors, women tend to be more empathetic and nurturing, which could lead to better ESG scores when they are in leadership positions (Aabo & Cristina, 2022). By referring to the result of these research, further analysis is conducted. These traits could translate into more effective leadership, particularly in the context of ESG principles. To further explore this potential connection, researchers investigated the influence of STEM CEOs gender on company ESG performance. Main analysis is expanded to whether and to what extent gender of STEM CEOs influence a company's ESG performance, as measured by the rating score from Sustainalytics. As displayed in Table 9, Female STEM CEOs have a negative relationship with ESG risk rating score at the level of 10% (coeff = -1.542, t = -1.912). Meanwhile, Male STEM CEOs doesn't show significant relationship with ESG risk rating score. This suggests a potential gender dimension in the relationship between CEO background and ESG performance, requiring further exploration.

Table 12. Sub sample – CEO gender.

	RISK_SCORE	
	(1)	(2)
	Female CEO	Male CEO
STEM	-1.542*	-0.295
	(-1.91)	(-1.35)
CEOAGE	1.809	0.840
	(0.53)	(1.01)
BSIZE	-0.018	-0.049***

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	(-0.34)	(-4.11)
FAGE	0.264	0.356***
	(0.67)	(3.46)
FSIZE	0.161	-0.067
	(0.75)	(-1.31)
ROA	-0.310	-0.065***
	(-0.70)	(-3.91)
LIQUIDITY	-0.033	0.004***
	(-0.78)	(4.97)
GDP	-1.011	-0.505**
	(-1.25)	(-2.18)
_cons	-11.385	-9.620*
	(-0.68)	(-1.89)
Industry FE	Yes	Yes
Country FE	Yes	Yes
r2	0.410	0.166
r2_a	0.088	0.115
N	86	953

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

5. Conclusions

This study investigated the association between STEM-educated CEOs and ESG performance within a sample of top sustainable companies. Our findings, derived from OLS regression reveals negative association between having a STEM-educated CEO and ESG performance which indicates that contrary to initial assumptions rooted in the innovation-oriented nature often attributed to STEM leadership, companies with STEM-educated CEOs within this high-performing sustainability cohort tend to exhibit worse ESG performance compared to their non-STEM counterparts. Robustness test conducted supports the primary findings and hypothesis.

This research offers several implications. To the growing body of literature examining the influence of CEO characteristics on corporate sustainability. By uncovering a negative association between STEM-educated CEOs and ESG performance in top sustainable companies, this study introduces the concept of strategic trade-offs at the leadership level as a crucial factor influencing ESG performance, moving beyond a sole focus on cognitive abilities. This research also serves as a valuable reference point for companies when considering their strategic priorities in CEO selection, highlighting that a singular focus on innovation-oriented leaders might not be sufficient for sustaining top-tier ESG performance.

We acknowledge the limitation in our study, particularly the utilization of Sustainalytics data as the proxy for ESG performance that could only be carried out for 2022 due to limited public availability and historical database. Further research could expand the data by using other third party ESG performance assessors.

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