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Does the effectiveness of board and audit committees influence the environmental and sustainability performance: A Comparative study of developed and developing countries

Ali Thabit Yahya[1], Sheena Rehman[2], Najib H.S. Farhan[3], Faozi A. Almaqtari[4*]

[1]*Dep. of International Business Aljand University for Science and Technology, Yemen.*
[2]*School of Management, IMS Unison University, Dehradun, Uttarakhand, India.*
[3]*Faculty of Business Studies, Arab Open University, KSA.*
[4]*College of Business Administration, A'Sharqiyah University (ASU), Oman.*

Corresponding author: Faozi A. Almaqtari (*Email: Faozi.almaqtari@asu.edu.om*)

Abstract

This study examines the impact of board and audit committee attributes on the sustainability and environmental performance of 3,752 firms from Europe and Asia. Using this panel dataset spanning from 2016 to 2021, the study applies fixed and random effects models. Findings revealed a substantial influence of board size, independence, expertise, and diversity on sustainability performance, with board diversity exhibiting the highest influence in cultivating environmental responsibility. In addition, the independence and expertise of the audit committee are positively significant in enhancing sustainability performance, upholding the prominence of governance oversight. These findings highlight the importance of corporate governance in strengthening their board and audit committee structures to foster sustainability performance and environmental initiatives. The study contributes to the existing literature by providing cross-country empirical evidence and offering insights for corporates, environmentalists, policymakers, investors, and shareholders on enhancing corporate governance standards to improve sustainability performance. The implications of this study highlight the importance of regulatory frameworks that promote diverse and knowledgeable boards and audit committees, thereby ensuring the sustainability of corporate initiatives and strategies.

Keywords: Audit committee attributes, Board characteristics, Environmental performance, Sustainability performance.

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1. Introduction

Corporate governance has emerged as a pivotal mechanism to drive environmental initiatives since global environmental deterioration has caught the attention of regulatory agencies [1]. Environmental initiatives cannot be taken in silos, rather significant amount of investment, long-term strategic implications and multilevel coordination among various corporate stakeholders (i.e., board, owners, management, and employees) are required [2]. Therefore, corporate governance becomes indispensable for allocating rights and responsibilities among these stakeholders to define corporate behaviors and strategies that minimize the corporation's footprint on the planetary environment [3]. Nevertheless, the effectiveness of corporate governance depends on the characteristics of corporate boards and audit committees [4-6]. The corporate board's size, independence, industry expertise, financial and accounting expertise, meetings, diversity, audit committee independence, and audit committee expertise have been regarded as influential attributes in determining the environmental and sustainability performance of firms [7, 8].

Large boards with diverse perspectives demonstrate a high commitment to sustainability [3, 6]. Independent board members integrate environmental concerns into corporate strategies and alleviate managerial entrenchment to ensure that sustainable firm performance is duly considered [6, 7, 9]. Board members with industry, financial, and accounting expertise possess the ability to implement cost-effective and risk-management strategies that help firms achieve their financial goals by ensuring compliance with environmental regulations [3]. Regular board meetings equip board members with a continuous assessment of the sustainable and environmental performance of firms. Diverse boards, which include female members, improve the environmental and sustainable performance of firms by adopting fair and ethical business practices, resulting in greater transparency [4, 10]. Further, the audit committee's independence ensures the accuracy and comprehensiveness of sustainability reporting [1, 8]. In addition, financial and industry-experienced members of audit committee are proficient in evaluating the sustainability-related risks by integrating environmental considerations into corporate strategies [1, 2, 5].

Despite the growing number of studies on corporate governance and sustainability [3, 8], no specific study has examined the characteristics of boards and audit committees in relation to their impact on the environmental and sustainable performance of firms. Second, the existing studies have provided the country-specific results of listed firms [1, 11], leaving a void for comprehensive regional, multinational, and continental analysis. Third, the ambiguity surrounding the crucial role of board and audit committee characteristics in determining environmental and sustainability practices presents a significant challenge. This study proposes to address these challenges by presenting concrete findings on the elements of corporate governance that contribute to enhancing corporate environmental responsibility. Fourth, while the extant literature has evaluated the impact of individual governance attributes, the collective influence of board and audit committee attributes remains unexplored [2, 12]. Therefore, to fill these research gaps, the study aims to analyze the influence of board and audit committee attributes on the sustainability and environmental performance of firms in Asia and Europe. In this context, this study mainly aims to identify the significant environmental responsibility and sustainability reporting attributes. In particular, the size of the board, its independence, expertise in accounting and finance, gender diversity, frequency of meetings, and the expertise and independence of the audit committee are examined to analyze their impact on the environmental and sustainable performance of European and Asian-based firms.

The article makes several contributions to the literature. This study offers practical insights for firms operating in both developing and developed markets, highlighting the impact of board and audit committee characteristics on environmental and sustainable performance. Considering that 3,752 firms from Asia and Europe are crucial for formulating corporate policies to enhance their sustainable and environmental performance, the collective influence of both board and audit committee attributes in the context of sustainability has provided evidence that corporate governance plays a pivotal role in steering corporations to foster sustainability through the composition of diverse, independent, and expert board and audit committees. In addition, this study presents an in-depth discussion for corporations, investors, and other relevant stakeholders to foster and promote environmentally responsible behavior worldwide. Furthermore, this study underscores the significance of corporate governance during the era of climate change. Considering the multifaceted influence of board and audit committee attributes, it was necessary to reanalyze their impact on sustainable and environmental performance to understand the crucial role of corporate governance. These contributions aim to highlight the collective impact of board and audit committee characteristics in enhancing environmental sustainability.

The subsequent sections present various discussions, with Section 2 providing a comprehensive overview of the pertinent literature. Section 3 provides details on the data and study methodology, while Section 4 explains the data analysis. Sections 5 and 6 present the discussion of the results and conclusions, respectively.

2. Literature Review

Corporate governance procedures, particularly internal governance frameworks, are crucial in promoting adherence to environmentally sustainable practices [3]. The structure and composition of the board are critical components of the Corporate Governance framework, and numerous studies have sought to examine the impact of board composition variables on sustainability performance [6, 7]. In this regard, Aksoy et al. [13] highlighted the positive and significant association between board size and ESG performance. García Martín and Herrero [4] found that having women on business boards improves environmental performance, as a higher share of gender diversity on a company's board can enhance its sensitivity

to social and environmental issues. Disli et al. [14] demonstrated that regular board meetings substantially mitigate ESG controversies. Pozzoli et al. [15] observed that Board and audit committee expertise is significantly and positively linked with ESG performance. Consequently, it can be argued that the board's ability to influence and report on stakeholder acceptance is enhanced by sustainable development activities, which aim to help enterprises achieve a sustainable competitive advantage [16]. The board and audit committees serve as a protective entity for investors, and proficient boards must consider the diverse stakeholder groups and their respective environments [11]. Accordingly, different attributes of the audit committee and board structure are presumed to influence sustainability and environmental performance. Thus, a summary of the recently published studies on the relevant variables has been provided in Table 1.

Table 1.
Studies relevant to board and audit committee attributes and environmental performance.

Author	Sample size and period of the study	Key Factors	Research Technique	Findings
Özparlak and Gürol [10]	US and Europe-based 166 listed companies (2008 to 2021)	Board's size and gender diversity	Regression Analysis	The findings revealed a positive relationship between the board's diversity and size and the firm's long-term environmental performance.
Almaqtari, et al. [3]	Listed companies of Asia and Europe (2016 to 2021)	Corporate board's size, independence, diligence, expertise, diversity, tenure, and environmental teams	Panel Regression Analysis	The study's findings demonstrated the positive influence of corporate board size, independence, and industry expertise on environmentally friendly production. However, this influence varies in Asian and European-based companies.
Gavana, et al. [17]	Listed non-financial firms of 5 European Countries (2014 to 2021)	Corporate board's independence, CEO non-duality, gender diversity, and tenure	Tobit Regression Analysis	The study's findings highlighted the positive significance of women's presence on boards in relation to the environmental performance of family firms. In contrast, independence has a greater impact on non-family firms. However, board tenure negatively moderates the relationship between board diversity and environmental performance.
Al-Jaifi, et al. [6]	Listed firms of 11 Asia-Pacific Countries (2011 to 2020)	Corporate board's age, tenure, gender, size, independence, leverage, return on investment	Panel Regression Analysis	The findings demonstrated the moderating role of corporate board members' independence on the relationship between gender and tenure diversity, as well as environmental performance.
Nguyen and Thanh [7]	Manufacturing Firms of Emerging East Asian Markets (2011 to 2016)	Size, independence and leadership structure of corporate board, environmental performance	Fixed-effects analysis	The findings revealed an inverse U-shaped relationship between board size and environmental performance. In contrast, the presence of independent directors has a positive influence on the firm's environmental performance. Nonetheless, the division of CEO and board chair roles remains insignificant in influencing the environmental performance of manufacturing firms.
Elsayih, et al. [9]	Australian listed firms (2010 to 2018)	Board independence, meeting frequency, gender diversity, environmental committee, and ownership concentration	Fixed-effects analysis	The study's findings demonstrated that higher board independence, frequency of board meetings, gender diversity, and the presence of an environmental committee all lead to improvements in Carbon Emissions Performance.
Khan, et al. [16]	Chinese firms (2010 to 2019)	Corporate board's independence, size, CEO duality, and gender diversity	System GMM Regression Model	The findings highlighted that the board's independence, size, gender diversity, and CEO duality have a positive influence on environmental performance, and that CEO characteristics moderate the relationship between corporate governance and the social and environmental aspects of the Academy.

García Martín and Herrero [4]	Nonfinancial European Union–based firms (2002 to 2017)	Board characteristics, waste and CO_2 emissions, water and energy consumption, and Pillar E, environmental index	Panel Regression Analysis	The findings revealed the positive impact of gender diversity, board members' affiliations with other boards, and the presence of a corporate social responsibility committee on a firm's environmental performance.
Abdullah [11]	Nonfinancial ADX listed UAE based firms (2008 to 2022)	Audit committee expertise, CSR practices, financial performance	Regression Analysis	The findings revealed that CSR initiatives have a negative influence on the financial performance of UAE firms. However, the audit committee plays a crucial role in improving this influence.
Wang and Sun [1]	Chinese energy firms (2012 to 2018)	Audit committee's independence, size, meeting frequency, female representation, financial expertise, education levels, local directorship, other dictatorship	Fixed effect regression analysis	The findings demonstrated that the independence and expertise of a Chinese firm's audit committee have no significant impact on social responsibility and environmental disclosures.
Seth and Saxena [8]	Listed Indian firms (2018 to 2024)	Independence, expertise, and tenure of audit committee	Regression Analysis	The study's findings revealed that the independence and expertise of the audit committee are crucial for achieving sustainable performance.
Zaman, et al. [2]	Top-listed companies of Australia and New Zealand (2017 to 2019)	Audit committee's independence, meeting frequency and industry/market expertise, size	Regression Analysis	The findings showed that the Audit Committee's independence, meeting frequency, and industry/market expertise positively enhance the quality of sustainability assurance.
Jibril, et al. [12]	Listed nonfinancial firms of Nigeria (2016 to 2020)	Audit Committee's independence, diversity, and meetings	Regression Analysis	The findings revealed that independence, diversity, and frequency of meetings of audit committees positively enhance their energy disclosure.
Alhababsah and Yekini [5]	Listed non-financial firms of Jordan (2009 to 2017)	Audit committee's industry expertise, legal expertise, gender diversity	Regression Analysis	The findings suggest that the industry expertise of the audit committee is associated with high audit quality, whereas legal expertise and gender diversity appear to have no significant impact.

3. Methodology

3.1. Data and Sample

The data for this study were obtained from the Refinitiv Eikon database, which comprises 22,512 publicly listed companies from Asia and Europe, spanning the period from 2016 to 2021. Following data collection, a rigorous selection procedure was adopted to refine the final sample. The entities with missing data for the study period were eliminated from the sample. Additionally, the availability of relevant variables was verified, resulting in a final sample of 3,752 firms. Finally, the sample comprises 2,541 companies from developed countries and 1,211 from developing countries.

3.2. Variable Measurements

This study examines a set of dependent, independent, and control variables. The dependent variables include environmental sustainability and sustainability performance. The independent variables are categorized into two groups. The first group pertains to board effectiveness and comprises board size, board independence, board expertise, board diversity, board meetings, and board-specific skills. The second group includes audit committee attributes represented by audit committee independence and audit committee expertise. Additionally, control variables are included, representing firm-specific characteristics such as firm size (measured by total assets), market capitalization, revenue growth, and profitability. The following is Table 2, which defines the variables:

Table 2.
Operational definition of the variables of the study.

Variable	Symbol	Formula
Dependent Variables		
Environmental PERFORMANCE	$ENVP$	The environmental pillar measures a company's impact on living and non-living natural systems, including air, land, water, and complete ecosystems. It reflects how well a company utilizes best management practices to mitigate environmental risks and capitalize on environmental opportunities, thereby generating long-term shareholder value.
Sustainability performance	$SUSP$	Is it an overall company score based on the reported information in the environmental, social, and corporate governance (CG) pillars?
Independent Variables		
Board Size	$BSIZE$	"The total number of board members at the end of the fiscal year"
Board independent	$BIND$	"Percentage of independent board members, as reported by the company."
Board Expertise	$BEXP$	"Percentage of board-expert members in accounting and finance areas."
Board Diversity	$BDIV$	"Percentage of females on the board"
Board Meeting	$BMEET$	"The average overall attendance percentage of board meetings as reported by the company. Overall, board members conduct regular meetings during the year. The average attendance is provided, detailing the number of members who attended versus the total number of board meetings held."
Board Specific Skill	$BSKILL$	"Expertise of board members relevant to the firm."
Audit committee independence	$ACIND$	Proportion of independent audit committee members.
Audit committee expertise	$ACEXP$	Audit committee members' financial or industry knowledge.
Control Variables		
Firm Size	$SIZE$	Total assets of a firm
Market Capitalization	CAP	The market capitalization of a firm at the end of a year.
Revenue Growth	REV	The year-over-year change in revenue
Firms' Profitability	$PROF$	The net profit after tax of a firm

3.3. Econometrics and analysis tools

In line with previous studies utilizing cross-country data [18-21]. This research employs a panel data approach, incorporating both fixed-effects and random-effects models. To determine the most suitable methodology, an initial analysis was conducted comparing pooled and panel data structures. The redundant fixed effects model was employed to evaluate the appropriateness of using panel data. The results indicated that fixed and random effects models were more suitable for estimating the study's findings. Subsequently, the Hausman test was applied, confirming that the fixed effects model was the optimal choice, as indicated by a p-value of less than 0.05. The research aims to explore the impact of board and audit committee attributes and firm-specific factors through the following model formulation:

$$\boldsymbol{S}USP = \alpha + \beta_1 BSIZE_{it} + \beta_2 BIND_{it} + \beta_3 BEXP_{it} + \beta_4 BDIV_{it} + \beta_5 BMEET_{it} + \beta_6 BSKILL_{it} + \beta_7 ACIND_{it} + \beta_8 ACEXP_{it} + \beta_9 SIZE_{it} + \beta_{10} CAP_{it} + \beta_{11} REV_{it} + \beta_{12} PROF_{it} + \varepsilon_{it}$$

Model 1

$$ENVP_{it} = \alpha + \beta_1 BSIZE_{it} + \beta_2 BIND_{it} + \beta_3 BEXP_{it} + \beta_4 BDIV_{it} + \beta_5 BMEET_{it} + \beta_6 BSKILL_{it} + \beta_7 ACIND_{it} + \beta_8 ACEXP_{it} + \beta_9 SIZE_{it} + \beta_{10} CAP_{it} + \beta_{11} REV_{it} + \beta_{12} PROF_{it} + \varepsilon_{it}$$

Model 2

4. Data Analysis

4.1. Descriptive Statistics

The analysis provides insightful findings on the impact of board characteristics and audit committee effectiveness on environmental and sustainability performance. The descriptive statistics in Table 2 reveal substantial variation in key variables, with ESG scores ranging from 0 to 94.48. Board size (BSIZE) varies significantly across firms, with a mean of 3.68 and a standard deviation of 5.26. The high standard deviation in board diversity (BDIV) and audit committee expertise (ACEXP) indicates heterogeneity in governance structures across firms.

Table 3.
Descriptive statistics.

Variables	Mean	Std.	Min.	Max.
SUSP	17.80894	25.80053	0	94.47655
ENVP	16.55983	27.1826	0	99.2021
BSIZE	3.682193	5.263716	7	41
BIND	18.0339	29.11464	0	99.91857
BMEET	26.18946	42.83135	0	100
BSKILL	15.48835	28.12252	0	99.88789
BDIV	18.55017	29.55119	0	99.93386
BEXP	18.52291	24.64252	0	85
ACIND	15.09965	26.78974	0	98.80952
ACEXP	15.57357	28.83232	0	75.94363
REV	3,700	14,100	9,090	431,000
SIZE	18,900	140,000	1,155.893	5620,000
CAP	61,300	582,000	188,000	31,800,000
PROF	269	1,550	-21,500	111,000

Variables are defined in Table 2.
Values for REV, SIZE, CAP, and PROF are in (000,000)

4.2. Correlation Analysis

The correlation matrix in Table 3 indicates that ESG performance (SUSP) is positively associated with board size (BSIZE, $r = 0.251$, $p < 0.01$), board independence (BIND, $r = 0.520$, $p < 0.01$), and board diversity (BDIV, $r = 0.561$, $p < 0.01$). Additionally, audit committee independence (ACIND, $r = 0.124$, $p < 0.01$) and audit committee expertise (ACEXP, $r = 0.85$, $p < 0.01$) exhibit strong associations with ESG performance, suggesting that governance mechanisms play a crucial role in achieving sustainability outcomes.

Table 4.
Correlation Matrix.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) SUSP	1.000													
(2) ENVP	0.928	1.000												
	***													
(3) BSIZE	0.251	0.574	1.000											
	***	***												
(4) BIND	0.520	0.675	0.617	1.000										
	***	***	***											
(5) BMEET	0.473	0.656	0.624	0.675	1.000									
	***	***	***	***										
(6) BSKILL	0.233	0.553	0.660	0.541	0.565	1.000								
	***	***	***	***	***									
(7) BDIV	0.561	0.669	0.563	0.512	0.671	0.579	1.000							
	***	***	***	***	***	***								
(8) BEXP	0.532	0.560	0.488	0.594	0.584	0.609	0.602	1.000						
	***	***	***	***	***	***	***							
(9) ACIND	0.124	0.618	0.674	0.623	0.633	0.552	0.629	0.623	1.000					
	***	***	***	***	***	***	***	***						
(10) ACEXP	0.85	0.606	0.657	0.591	0.679	0.575	0.604	0.695	0.686	1.000				
	***	***	***	***	***	***	***	***	***					
(11) REV	0.298	0.349	0.310	0.249	0.223	0.206	0.225	0.255	0.225	0.195	1.000			
	***	***	***	***	***	***	***	***	***	***				
(12) SIZE	0.132	0.153	0.175	0.123	0.120	0.082	0.130	0.115	0.114	0.116	0.177	1.000		
	***	***	***	***	***	***	***	***	***	***	***			
(13) CAP	0.100	0.131	0.121	0.085	0.073	0.069	0.077	0.077	0.084	0.071	0.278	0.125	1.000	
	***	***	***	***	***	***	***	***	***	***	***	***		

(14) PROF	0.152	0.171	0.168	0.131	0.126	0.109	0.130	0.131	0.114	0.099	0.449	0.559	0.231	1.000
	***	***	***	***	***	***	***	***	***	***	***	***	***	

5. Results and Discussion

5.1. The Impact of Board and Audit Committee Attributes on Environmental and Sustainability Performance

The regression results in Table 4 further validate these relationships. Board size (BSIZE) has a significant positive effect on both environmental performance (ENVP, B = 0.798, p<0.01) and ESG scores (SUSP, B = 0.636, p<0.01), indicating that larger boards are more effective in driving sustainability initiatives. This finding corroborates the results of Almaqtari et al. [3] and Özparlak and Gürol [10]. However, it contradicts those of Nguyen and Thanh [7], who found an inverse relationship between board size and environmental performance. Similarly, board independence (BIND) contributes positively to ESG performance (B = 0.057, p < 0.01), reinforcing the role of independent oversight in enhancing corporate sustainability, as argued by Nguyen and Thanh [7] and Al-Jaifi et al. [6]. However, board-specific skills (BSKILL) exhibit a negative impact on both ENVP (B = -0.038, p < 0.01) and SUSP (B = -0.015, p < 0.01), implying that while expertise is essential, excessive specialization may limit broader strategic sustainability perspectives.

Table 5.
The impact on environmental and sustainability performance.

Variables		
	ENVP	SUSP
BSIZE	0.798***	0.636***
	(22.949)	(21.836)
BIND	0.015***	0.057***
	(3.815)	(16.842)
BMEET	0.051***	0.066***
	(23.004)	(35.531)
BSKILL	-0.038***	-0.015***
	(-13.762)	(-6.587)
BDIV	0.047***	0.070***
	(12.088)	(21.409)
BEXP	0.206***	0.260***
	(28.964)	(43.796)
ACIND	0.051***	0.084***
	(12.383)	(24.276)
ACEXP	0.064***	0.067***
	(18.151)	(22.861)
REV	0.000***	0.000***
	(16.959)	(13.299)
SIZE	0.000**	0.000***
	(2.019)	(4.331)
CAP	0.000	-0.000**
	(0.678)	(-2.273)
PROF	-0.000***	-0.000***
	(-4.690)	(-3.909)
_cons	5.166***	3.824***
	(53.458)	(47.287)
N	22512.000	22512.000
r2	0.413	0.617
r2_a	0.296	0.540

F	2376.784	5434.823
p	0.000	0.000

Note: t statistics in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Board diversity (BDIV) emerges as a strong determinant of sustainability performance, with positive coefficients for both ENVP (B = 0.047, P < 0.01) and SUSP (B = 0.070, P < 0.01), suggesting that gender diversity enhances firms' environmental strategies. These results align with the studies of García Martín and Herrero [4]; Gavana et al. [17] and Özparlak and Gürol [10], which have highlighted the positive influence of gender diversity on the environmental performance of European Union-based firms.

Likewise, board expertise (BEXP) has a significant influence on SUSP (B = 0.260, P < 0.01), underscoring the importance of financial and accounting knowledge in sustainable decision-making. Given this, the study corroborates the findings of Almaqtari et al. [3] regarding the crucial role that industry expertise plays on corporate boards in environmentally friendly production.

Audit committee effectiveness plays a crucial role, with audit committee independence (ACIND, B = 0.051, P < 0.01) and expertise (ACEXP, B = 0.064, P < 0.01) significantly enhancing sustainability outcomes. These findings are consistent with previous studies by Zaman et al. [2]; Alhababsah and Yekini [5]; Abdullah [11]; Jibril et al. [12] and Seth and Saxena [8]. However, these findings contradict the study of Wang & Sun (2021), which demonstrated that independence and expertise of Chinese firm's audit committee are insignificant in affecting social responsibility and environmental disclosures.

The control variables indicate that firm revenue (REV) and size (SIZE) have a positive contribution to ESG performance, while profitability (PROF) exhibits a negative association (B = -0.000, p < 0.01), suggesting that highly profitable firms may not always prioritize sustainability.

5.1.1. Environmental And Sustainability Performance in Developed and Developing Countries

Tables 5 and 6 further disaggregate the analysis by distinguishing between developed and developing countries. The results indicate that board size has a greater impact on SUSP in developing countries (B = 0.974, P < 0.01) than in developed countries (B = 0.506, P < 0.01). Similarly, board independence (BIND) and board diversity (BDIV) exhibit stronger effects in developing nations, highlighting the critical role of governance structures in emerging markets. Interestingly, audit committee independence (ACIND) and expertise (ACEXP) continue to exert a positive influence on sustainability outcomes across both regions, reaffirming their importance in corporate governance.

Environmental performance (ENVP) follows a similar trend, with board size (BSIZE) having a stronger influence in developing countries (B = 1.185, p < 0.01) than in developed economies (B = 0.653, p < 0.01). However, board-specific skills demonstrate a negative relation with ENVP in both developing and developed countries, underscoring the adverse impact of excessive specialization on environmental initiatives. Furthermore, profitability (PROF) has a negative influence on environmental performance, reinforcing the preconceived notion that financial objectives are highly prioritized by firms compared to sustainability targets.

Table 6.
The impact on sustainability performance in developed and developing.

Variables	**Developed countries**	**Developing countries**
	SUSP	SUSP
BSIZE	0.506***	0.974***
	(13.120)	(17.057)
BIND	0.050***	0.075***
	(11.348)	(10.773)
BMEET	0.068***	0.065***
	(27.716)	(17.268)
BSKILL	-0.017***	-0.015***
	(-5.505)	(-3.422)
BDIV	0.066***	0.077***
	(14.828)	(12.662)
BEXP	0.270***	0.237***
	(33.516)	(20.867)
ACIND	0.083***	0.077***
	(17.935)	(11.282)
ACEXP	0.072***	0.047***

	(18.042)	(8.190)
REV	0.000***	0.000***
	(10.749)	(6.329)
SIZE	0.000***	0.000***
	(3.007)	(5.056)
CAP	-0.000	-0.000***
	(-0.169)	(-3.099)
PROF	-0.000***	-0.000***
	(-2.883)	(-3.347)
_cons	3.811***	3.339***
	(36.190)	(18.376)
N	15246.000	7266.000
r2	0.599	0.646
r2_a	0.459	0.409
F	2843.515	1612.277
p	0.000	0.000

Note: t statistics in parentheses
* p<0.10, ** p<0.05, *** p<0.01.

Table 7.
The impact on environmental performance in developed and developing.

	Developed Countries	**Developing Countries**
Variables	ENVP	ENVP
BSIZE	0.653***	1.185***
	(14.138)	(17.521)
BIND	0.003	0.049***
	(0.635)	(5.870)
BMEET	0.054***	0.045***
	(18.293)	(10.100)
BSKILL	-0.044***	-0.035***
	(-11.993)	(-6.683)
BDIV	0.038***	0.061***
	(7.121)	(8.391)
BEXP	0.234***	0.154***
	(24.315)	(11.441)
ACIND	0.050***	0.045***
	(9.014)	(5.565)
ACEXP	0.069***	0.051***
	(14.477)	(7.531)
REV	0.000***	0.000***
	(15.454)	(4.214)
SIZE	-0.000	0.000***
	(-0.030)	(6.408)
CAP	0.000	-0.000
	(0.771)	(-0.673)

PROF	-0.000***	-0.000*
	(-4.407)	(-1.890)
_cons	4.914***	4.702***
	(38.998)	(21.841)
N	15246.000	7266.000
r2	0.398	0.453
r2_a	0.187	0.087
F	1259.507	731.909
p	0.000	0.000

Note: t statistics in parentheses
* p<0.10, ** p<0.05, *** p<0.01.

6. Conclusion

The effectiveness of board and audit committees in mitigating climate vulnerability has been acknowledged in recent times; although there is a paucity of literature on this subject. Hence, this study is primarily concerned with investigating the effectiveness of boards and audit committees in influencing the sustainable and environmental performance of companies in Europe and Asia for the period 2016–2021. Applying fixed and random effect analysis, we find a positive influence of the board's size, independence, diversity, meetings, and expertise in determining the sustainability performance of the investigated firms. Among all board characteristics, board diversity was found to be highly significant and positively influences this effect. Additionally, the independence and expertise of the audit committee emerged as fundamental elements in enhancing environmental reporting.

According to these results, it can be argued that corporate governance plays a pivotal role in steering corporations toward adopting environmentally responsible behavior and fostering sustainability. A well-structured board with an independent and expert audit committee is more likely to adopt sustainable strategies, resulting in improved ESG performance. Therefore, this study contributes to extending the current knowledge regarding the relationship between corporate governance and sustainability by presenting empirical evidence from a cross-country analysis. In addition, the distinct analysis of Asia- and Europe-based companies provided evidence of the varied influence of corporate board and audit committee attributes on their sustainable and environmental performance. In this way, the study offered a comprehensive and in-depth discussion on the mechanism of corporate governance and its significance in the era of climate vulnerability.

The study has various implications for diverse stakeholders, including corporations, policymakers, investors, shareholders, and other interested parties. Although this study confirms the critical role of corporate boards in enhancing sustainability performance, there is always room for improvement. By taking additional initiatives, corporate boards can enhance the influence of corporate governance. Policymakers can utilize these findings to implement corrective strategies while formulating policies for climate action. Investors and shareholders can leverage the findings of this study in tracking the sustainability performance of their portfolio companies and make informed decisions.

Like any other study, this research also has its own set of caveats. First, the study explored the influence of limited attributes of corporate boards and audit committees. Considering this limitation, future studies can incorporate other attributes into the model, such as tenure, audit committee diversity, and shareholder activism. Second, this study did not conduct a sector-wise analysis of the sustainable and environmental performance of the investigated firms. Future studies can proceed with an in-depth analysis of the sustainable and environmental performance of the selected firms, considering their respective sectors. Finally, the study employed panel regression analysis only; future studies can perform additional analyses for more robust findings.

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