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Influence of Board Characteristics on Carbon Emission Disclosure: Evidence from the Nigerian Oil and Gas Sector

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ABSTRACT

This study investigates whether board characteristics influence a firm's carbon emission disclosure, in the context of the Nigerian listed oil and gas companies. Board characteristics is divided into board composition (board size, board independence and board structure) and board diversity (board gender diversity, ethnicity and background). The study assessed data from 22 quoted oil and gas companies for the fifteen-year period (2009-2023). The study adopted ordered regression for data analysis and concludes that board structure, board independence, board gender diversity and board ethnicity significantly influence the likelihood of high-quality carbon emission disclosure. The findings established the significant roles of the board in allocating resources to environmentally friendly activities, monitoring managerial activities, and ensuring that firms meet its obligation to operate in a climate friendly manner.

Keywords: Board Characteristics, Carbon Emission Disclosure Quality, Board Gender Diversity, Board Ethnic Diversity
JEL Classifications: C32, 013, 047

1. INTRODUCTION

Climate change and environmental protection are part of the current debate among the captains of industry and are also attracting the required attention in scholarly discourse The effort in forestalling climate change lies with the sustainable and rapid elimination of climate-mutilating greenhouse gases. This process was a topical issue at the Paris environmental protection agreement in 2015 (Mardani et al, 2019) and communique of many academic conferences between 2015 and 2022, as its success depends largely on corporation strategic decision, amid other factors. To advance existing evidence on this important topic, we analyzed whether board characteristics influence a firm's carbon emission disclosure. Board characteristics is divided into board composition (board size, board independence and board structure) and board diversity (gender diversity, ethnicity and background).

According to Ararat and Sayedy (2019), the board of a listed company serves dual purposes: first, from the agency theory point of view, is the provision of oversight in form of monitoring of the management activities about shareholders' interest. Second, the board provides advice and expertise in accordance with resource dependence theory. Due to the campaign for environmental protection as well as the sanctions on environmental violations, there is need for an enhancement of the director's responsibilities, in order to promote adequate disclosure of carbon emission in listed companies (Mardani et al., 2019).

The desire for provision of transparency to stakeholders is one of the motivations for carbon emission disclosure (Akhiroh and Kiswanto, 2016). The concept of carbon emission disclosure is about ensuring stakeholders' social responsibility information needs and concern relating to environmental protection of companies are supplied in adequate quality and quantity

(Oluwagbemiga, 2021, Oyerogba et al, 2024). However, these concerns can be addressed through firm's sustainability initiatives and by signaling credible carbon emission information in the financial statements (Faisal et al., 2018).

This investigation of carbon emission disclosure is essential within the Nigerian context, particularly the oil and gas sector because of the environmental management and pollution issues such as the occurrences of oil spills, increased level of greenhouse gas emissions and environmental dilapidation (Moses et al., 2019; Mohammed, 2019). To address these issues, the Central Bank of Nigeria (CBN) published her sustainability guidelines in 2020. The guideline among many other issues emphasizes the need for adequate carbon emission disclosure in the annual financial statements (Daruwala, 2023). Therefore, it is important to investigate the critical factors that may influence strict compliance with the requirements of the sustainability guidelines such as the structure and composition of the board.

The dander for neglecting the effect of firm's environmental hazard can be seen in the case of Deepwater Horizon oil spill that resulted into about $ 65 billion losses for the company and the country. In the existing literature, a group of scholars analyzes the relationship between corporate governance and sustainability reporting (Oyerogba et al., 2024, Erin et al., 2022, Ali and Fatima, 2023). Following the panel regression analysis of Kallmuenzer and Peters (2018), several studies reported a positive relationship (Oyerogba and Ogungbade, 2020; Kanagaraj and Gouwsigan, 2021; Kumar, 2019; Baidoo, 2022) while some fine negative and insignificant relationship (Ali and Shaik, 2022; Daruwala, 2023: Oluwagbemiga, 2021, Ogungbade and Oyerogba, 2020).

Another stream of literature ascertained the influence of board structure and composition on firm's environmental performance (Alhassan and Islam, 2021: Elgayar et al., 2024; Ararat and Sayedy, 2019; Hadya and Susanto, 2018). These literatures reported a significant influence of board independence, gender diversity, ethnicity and size. However, in analyzing their methodologies the proxies for environment performance consists of only the donation and other corporate social responsibility in form of distribution of relief materials to the host communities (Oluwagbemiga, 2021). Thus, environmentally harmful practices may be covered under the disguise of corporate social responsibility (Ogungbade and Oyerogba, 2020; Alawi, 2024; Chu et al., 2013). Therefore, it can be misleading to admit the practices of corporate social responsibilities to host communities blindly to firms' efforts to reduce carbon emissions.

To the best of our knowledge, we are not aware of any study in Nigeria that analyze how board composition and diversity such as board size, board independence, board structure, gender diversity, ethnicity and background influences firm's carbon emission disclosure. Drawing from existing literature (Hollindale et al., 2019; Choi et al., 2013; Ararat and Sayedy, 2019; Amayreh et al., 2024), we posit that certain board characteristics will influence a company's carbon emission disclosure. Concerning the size of the board, existing literature shows a positive relationship between board size and environmental accounting practices (Daruwala, 2023; Kumar, 2019). The possible explanation for this relationship is that, to fulfill the two functions of the board (Oversight and strategic decision making), the board should be sufficiently large. In other word, the ability of a smaller board to fulfill these functions is limited.

Since carbon emission disclosure is a component part of the environmental accounting practices and disclosure, a negative relationship between board size and carBon emission disclosure can be expected. By contrast, larger boards may face problem of coordination and conflicting schedule (Adwally, 2015; Moses et al., 2019), which may hinder timely and effective decision-making process. As touching board independence, previous studies focus on the link between non-executive director and financial and environmental accounting (Mardani et al., 2019; Naseem et al., 2017; Oyerogba et al., 2024; Oluwagbemiga, 2021) with conflicting and difficult to reconcile results. Some literature reported a negative result (Grigore et al., 2021; Ghobakhloo et al., 2021), while others find a positive relationship (Hollindale et al., 2019; Ararat and Sayedy, 2019)

In addition to board composition, we also investigate board diversity in terms of gender, ethnicity and background. Besides board skills. Consistent with Oyerogba and Ogungbade, 2020, board diversity improves board effectiveness in monitoring and decision-making process, which significantly impact ESG performance. Furthermore, since women behave risk aversely than men, we anticipate gender diversity to be negatively correlated with carbon emission which constitutes a risk to the environment and the company generating it. In this regard, existing literature investigates the relationship between female CEO and environmental accounting disclosure (Mardani et al., 2019; Naseem et al., 2017; Nasih et al., 2019; Syam et al., 2024) and reported largely a negative relationship. Thus, it appears plausible that firms with a gender balance board show lower carbon emission by committing more resources to environmental protection and this may improve disclosure on carbon emission as people are naturally inclined to signaling positive information.

From our analysis, we find a significant relationship between board characteristics and carbon emission disclosure. Specifically, board with larger size (not beyond the threshold of 15 members), larger proportion of non-executive directors, high gender and ethnic sensitivity have higher disclosure of carbon emission. Unexpectedly, firms with high profitability ratio (ROCE and EPS) have inadequate disclosure on carbon emission. Furthermore, we find an upward trend in carbon emission disclosure in the period after the implementation of CBN guidelines on environmental sustainability. The paper is organized into 5 sections. Section one presents introduction, section 2 presents the literature review while methodology adopted for the study was discussed in section 3. Results and discussion of findings were done in section4 while conclusion was presented in section 5.

2. LITERATURE REVIEW

2.1. Board Size and Carbon Emission Disclosure Quality

The board's influence on carbon emission disclosure depends largely on how large the size of board is (Ahmad et al., 2018).

A firm's disclosure and competitive edge are significantly influenced by the number and varieties of directors on their board (Aladwey et al., 2022). A dynamic board provides effective oversight in curbing opportunistic action and decisions of the management and thus promotes company's sustainable activities including environmental protection and reduction of carbon emission (Al-Matari, 2022). A large board benefits from the diversity of experiences and backgrounds (Al-Qahtani and Elgharbawy, 2020), which increases a firm disclosure and reduces information symmetry between management and other stakeholders (Oluwagbemiga). On the contrary, a larger board faces communication and coordination problems that could slow than decision making process and compromise information disclosures (Ogungbade and Oyerogba, 2020).

According to Oyerogba et al. (2024), the issue of coordination prevalent among firms with larger board often results in weak managerial control, higher agency costs and inefficiency, potentially reducing firm's commitment to environmental issues. Although, drawing from the legitimacy theory, agency theory, and stakeholder theory, the relationship between board size carbon emission disclosure quality is subject to different viewpoints. From the agency theory perspective, larger boards will have difficulties coordinating and engaging in timely decision making, which may reduce the degree of oversight functions on the financial reporting process that may result in inadequate disclosure (Bektur and Arzova, 2020). By contrast, from the viewpoint of stakeholders' theory, larger board reflects a wider range of stakeholder's interests, leading to higher concentrations on environmental related issues and concerns (Beji et al., 2021). This is consistent with the existing literature that established a significant and positive relationship between large board size and carbon emission disclosure (Oyerogba and Ogungbade, 2020; Kanagaraj and Gouwsigan, 2021; Kumar, 2019; Baidoo, 2022).

These studies emphasize that larger board promotes ethical disclosure and carbon emission reduction oversight and strikes a balance between the shareholders' interests and interest of other stakeholders and improved carbon emission disclosure. For legitimacy theory, larger board can be viewed as a more legitimate in their reporting process since they are perceived to represents more of the public interests (Oluwagbemiga, 2021). The views are contrary to that of (Alhassan and Islam, 2021: Elgayar et al., 2024; Ararat and Sayedy, 2019; Hadya and Susanto, 2018). where smaller boards disclose higher carbon emission related information due to faster decision-making than large boards. In some studies, (Hollindale et al., 2019; Ararat and Sayedy, 2019) smaller boards have been found to be more receptive to environmental and social concerns and better address the stakeholders' concerns, that may increase carbon emission disclosure. Therefore, we hypothesize.

Ho1: The size of the board has no statistically significant influence on carbon emission disclosure quality of the Nigerian listed oil and gas companies.

2.2. Board Independence and Carbon Emission Disclosure Quality

Independent directors are saddled with the responsibility of preserving companies' reputation through internal control and strong oversight over the managerial activities and behavior including reduction of information symmetry (Oyerogba, 2018). This type of directors is selected to represent the companies' external stakeholders and act as a crucial liaison, subordinating both sides' interests (Daruwala, 2023; Kumar, 2019). Board with higher number of independent directors supervises management more effectively, supporting higher transparency to foreign investors, motivating the firm to be responsible and more open. The interest of the minority shareholders can only be protected by the independent directors that contributes to efficient oversight and adherence to rules and regulations (Kumar, 2019).

According to the Organization for Economic Corporation and Development code of corporate governance (OECD, 2019), independent board members should comprise one-third of the total number of directors on the board (Araissi et al., 2016; Elgayar et al., 2024). Alhassan and Islam (2021) reported a statistically significant relationship between board independence and carbon emission disclosures, stating that non-executive directors are likely to understand the important of disclosing the measures put in place for risk assessment and mitigation. Their finding mirrors the results of Ararat and Sayedy (2019), that reported a positive and significant influence of board independence on carbon emission disclosures. Other literatures (Oyerogba and Ogungbade, 2020; Kanagaraj and Gouwsigan, 2021; Kumar, 2019; Baidoo, 2022; Mering, 2024), posit that companies with large non-executive directors are more inclined to prioritizing corporate social responsibility issues such as carbon emission reduction.

This suggests that the degree of independence of the board determines a firm's commitment to carbon emission disclosure by motivating the company to operate in acceptable manner. On the other hand, several studies (Amoako et al., 2017; Beji et al., 2021; Ali, 2020; Bektur and Arzova, 2020), reported contradictory results stressing that higher number of non-executive directors on the board enables the companies to focus on shareholders' value maximization, viewing commitment to carbon emission reduction as a cost rather than a benefit. Similarly, Bhatia and Tuli (2017), established an insignificant relationship between board independence and carbon emission disclosure quality. Therefore, we hypothesize:

Ho2: Board independence has no statistically significant influence on carbon emission disclosure of the Nigerian listed oil and gas companies.

2.3. Board Gender Diversity and Carbon Emission Disclosure

The recent advocacy for inclusiveness of women in numerous spheres of corporate and social life is being widely debated and now forming part of the consideration for selection of companies' representatives and leadership on the board. Board gender diversity offers several advantages, such as increased innovation, creativity, competitive edge, and value creation, despite its associated challenges (Oluwagbemiga, 2021). In some literature, gender diversity has been recognized as an important factor influencing firm strategies (Jamil et al., 2020) especially on issues associated with environmental protection and information disclosures (Al-Shaer and Zaman, 2016). Specifically,

women generally possess unique feminine character including generosity, spontaneity, and compassion, hence more sensitive to environmental and social issues, in turn improving carbon emission disclosure quality (Ali, 2022). In other word, women seem to be more sympathetic to environmental pollution related issues than men; hence, their inclusion on the board enhances quality of carbon emission disclosure (Beji et al., 2021).

As previously emphasized by Oyerogba and Ogungbade (2020), women on the board provides a variety of dynamism, values and experiences that enables them to be more receptive and prioritize environmentally friendly activities. Drawing from agency theory perspective, board gender diversity influences carbon emission disclosure through enhanced board independence, hence improved the board oversight functions (Moses et al., 2019; Mohammed, 2019). It is evident that women prioritize stakeholders more often than males do, exhibiting empathy for the concerns of stakeholders (Jamil et al., 2020). Contrarily, from the stakeholder's theory viewpoint, women prudency suggests that female board members bring certain suggestion to boards, that prioritizes the shareholders' interests (Kanagaraj and Gouwsigan, 2021; Kumar, 2019; Baidoo, 2022). Either way women are important to boards since they advance and promotes transparency, while taking shareholders and stakeholders' interests into cognizance.

The presence of female directors on boards indicates efficient corporate governance and acts as a catalyst to more transparency and accountability regarding carbon emission disclosure (Ali, 2022). Furthermore, the legitimacy theory emphasizes the need for company's activities to be conducted in line with community expectations, standards, and social values (Ali and Shaik, 2022; Daruwala, 2023; Oluwagbemiga, 2021, Ogungbade and Oyerogba, 2020). A gender diverse board, with an acceptable percentage of women enhances the legitimacy of firms which conveys an important message to the society about a company's adherence to societal norms and expectations (Ali and Shaik, 2022; Mohammed, 2019) Existing literature documented a positive and significant correlation between board gender diversity and carbon emission disclosure (Amoako et al., 2017; Hassan et al., 2020; Bektur and Arzova, 2020). The finding affirms (Beji et al., 2021) and Jamil et al. (2020) that established that companies with adequate female directors have higher disclosure in climate related issues highlighted in ISSB guidelines.

Similarly, Daruwala (2023) reported that boards with at least three female directors have a positive influence on carbon emission disclosure. The result implies that environmental protection activities and initiatives can be easily approved by a gender sensitive board, especially when women are in top leadership positions. However, there are other empirical literature that reported a negative relationship between gender independence and carbon emission disclosure on the ground that women sensitivity to the need to save for the future may prevent a firm from committing huge resources to social activities such as environmental protection (Elgayar et al., 2024; Ararat and Sayedy, 2019; Hadya and Susanto, 2018). Therefore, we hypothesize.

Ho3: Board gender diversity has no statistically significant influence on carbon emission disclosure quality.

2.4. Board Meetings and Sustainability Reporting

Board ethnic diversity implies having individuals from different culture, values, norms, language, beliefs, religion, and ethical rules (Ali and Shaik, 2022). Striking a balance between protecting the shareholders and stakeholders' interests in line with the ISSB's requirements on climate related disclosure requires wholistic discussion of the issue at the board meeting, involving different ethnic groups (Aladwey et al., 2022). However, existing literature shows that ethnic diversity impacts company's activities in diverse ways. According to Dhingra and Dev (2016), an ethnically diverse board will have substantial capital from board members, that can accelerate the company's growth and ability to ability to generate higher return to shareholders and other stakeholders in form of social responsibility. Other scholars (Aladwey et al., 2022; Adwalley, 2015, Oluwagbemiga, 2021) in social science disciplines strongly supports this argument.

Similarly, Beji et al. (2021) demonstrated that ethnic diversity of board members is a company's important resources through which a company can gain competitive edge over competitors in the same market. A board with diverse ethnicity should be able to understand the requirements and needs of different stakeholders (Aladwey et al., 2022). Furthermore, board that is ethnically diverse will disclose quality information on both financial and non-financial activities of a company, including information on carbon emission and prevention (Oluwagbemiga, et al., 2021; Ali and Shaik, 2022; Adwally, 2015).

On the contrary Alhassan and Islam (2021), posited that an ethnically diverse board may be susceptible to emotional and social conflict, which could hinder firms' commitment and investment in environment protection. In Nigeria, Ogungbade and Oyerogba (2013) reported that firms with all the three major tribes on the board have disclosed insufficient information on carbon emission. Therefore, we hypothesize.

Ho4: Board ethnic diversity has no statistically significant influence on carbon emission disclosure quality.

3. METHODOLOGY

3.1. Population and Study Sample

The population for this study consists of the 24 oil and gas companies listed on the Nigeria Exchange Group (NEG) for a 15-year period from 2009 to 2023. Data for all the variables were collected from various sources such as Central Bank of Nigeria statistical bulletin, Stock Exchange Factbooks and audited financial statements of the companies. The final sample for the study is made up of balanced panel of 330 firm-year observations for 22 quoted oil and gas companies for the 15-year period. The details are presented in Table 1. As can be seen Table 1, two companies which brings the sample to 22 companies. One company had qualified audit report while the second company does not have stand-alone sustainability report. Having a qualified audit report brings to question, the reliability of information coming from such a company, and this necessitates the exclusion of this company from the sample. Secondly, data for carbon emission disclosure were extracted from the stand-alone sustainability report. Therefore, it is difficult accessing data for a company without a stand-alone sustainability report.

3.2. Measurement of Carbon Emission Disclosure Quality (CEDQ)

To determine the CEDQ, we relied on information in the following documents:

i. International Sustainability Standard Board (ISSB) climate related disclosure checklist
ii. Nigerian Sustainable Banking Principles (NSBP) guidelines issued by Central Bank of Nigeria
iii. existing literature on carbon emission disclosure (Oluwagbemiga, 2021; Kanagaraj and Gouwsigan, 2021; Kumar, 2019; Baidoo, 2022).

The documents specified information on peculiar features that represent the carbon emission disclosure quality. The features are classified into 5 categories as follows (1) climate change: risk and opportunities (CC), (2) greenhouse gas emission (GHG), (3) energy consumption (EC), (4) reduction of greenhouse gas and cost (RC), and (5) accountability of carbon emissions. ISSB checklist also provides detail information on the specific information to disclose in each category. On the presumption that objective of carbon emission disclosure is to enable the general-purpose financial statement users make informed decision as to the governance processes, controls and procedures an entity uses to manage, monitor, and oversee climate-related risks and opportunities, the provision of independent assurance report either by an audit firm or non-audit firm is essential (Hollindale et al., 2019; Ararat and Sayedy, 2019).

Following the literature on carbon emission disclosure (Kumar, 2019, Baidoo, 2022, Hollindale et al., 2019), we extracted categorical data based on the aforementioned criteria. A score of 1-7 was assigned for the measurement of CED quality. A CEDQ score of 1 implies that the company have adequate disclosure on only climate change: risk and opportunities and inadequate disclosure on other four categories, CEDQ score 2 implies adequate disclosure on the first two categories, CEDQ score 3 means the company have adequate disclosure on the first three categories, CEDQ score 4 implies that the company have adequate disclosure on the first four categories, CEDQ 5 implies that the company has adequate disclosure on all the five categories, CEDQ score 6 implies that the company have adequate disclosure on all the 5 categories with assurance report from a non-audit company while CEDQ score 7 means that the company have adequate disclosure on all the 5 categories with assurance report from an audit company.

This scale was applied in measuring the quality of carbon emissions reduction activities of the selected companies reported in their stand-alone sustainability reports. The details of the measurement scales can be seen in Table 2. In addition to the base line analysis, we conducted some sensitivity analysis in this study.

First, we deployed two alternative scales for measuring the CEDQ using a dichotomous variable. In this regard, the level of assurance was ascertained based on whether verification of the sustainability report was done by an audit firm. Second, we computed Two-Steps System GMM estimation approach due to several advantages it has over ordered and binary logistic regression.

3.3. Estimation Model

Considering the SRQ indices used in this study, it is important to state that using OLS for a variable with binary or categorical data- may produce a linear probability model. However, the errors (residuals) arising from such a linear probability model undermine the normality and homoscedasticity assumptions, which are basic assumptions of classical OLS regression. This eventually produces invalid standard errors and spurious regression estimates (Ogungba and Oyerogba, 2020). Hence,

Consistent with Amoa-Gyarteng (2021), we adopted an ordered logistic regression model to ascertain the influence of board characteristics on carbon emission disclosure of the Nigerian oil and gas companies. Seven-point scale was adopted in evaluating CEDQ (i.e. Poor, Low, fair, moderate, good, high, and excellent), which indicates the CEDQ level.

The dependent variable for the equation is CEDQ molded as a function of the board characteristics proxies among a set of firm-specific control variables drawn in line with the existing literature. The details of these variables are presented in Table 3. To determine the influence of the board characteristics on CEDQ, we used the following equation.

$$CEDQ = \beta_0 + \beta_1 BS_{it} + \beta_{2it} BIND + \beta_3 BSTR_{it} + \beta_4 BGEN_{it} + \beta_5 BETY_{it} + \beta_6 BGRD_{it} + \beta_7 PROF_{it} + \beta_8 AQUA_{it} + \beta_9 CGEAR_{it} + \beta_{10} FGRW_{it} + \varepsilon_{it} \quad (1)$$

where CEDQ represents carbon emission disclosure quality of firm i at time t; BS is the board size, BIND is board independence, BSTR is board structure, BGEN is gender of the board, BETY is board ethnicity, BGRD board background, ROCE is return on capital employed, FGRW represents firm growth, CGEAR is capital gearing, and AQUA denotes audit quality.

4. RESULTS AND DISCUSSION

4.1. Descriptive Statistics

Table 4 presents the descriptive statistics for all the variables for this study. Panel A presents the frequency and percentage for carbon emission disclosure quality across all the seven categories. Panel B presents the frequency and percentage for the binary data measuring the assurance level while panel C presents the mean, minimum, maximum, standard deviation and observation for all variables.

The results in Panel A indicates that a relatively proportion of the oil and gas companies have satisfactory carbon emission disclosure in their annual reports. Specifically, 51(15.5%) of the companies had low carbon emission disclosure quality, indicating that the companies engaged in just 2 aspects out of the 5 component parts of the carbon emission reduction activities. Also, 39 about (11.8%) of the companies had fair carbon emission disclosure quality which implies that those companies engage only in climate change: risk and opportunities assessment and mitigation and greenhouse gas emission control only while the remaining 2 carbon emission reduction activities were neglected. We equally report that 80 (24.2%) of the companies their commitment to 4 aspects

Table 1: Population and sample size for the study

Sample frame	Number of companies	Number of firm year observation	% of the target population
Listed oil and gas as at end of 2023	24	360	100
Less: firm with qualified audit Rep	(1)	(15)	(4.2)
Less: firm without sustainability Rep	(1)	(15)	(4.2)
Listed oil and gas company in final sample	22	330	91.6

Table 2: Measurement of carbon emission disclosure quality

Score	Measurement	Interpretation	Results
1	There is adequate disclosure of CC only	CC-1 Assessment and description of risks related to climate change and the actions taken to mitigate these risks. CC-2 Current and future assessment and description of the finance, business and opportunity implications of climate change	Poor
2	There is adequate disclosure on CC and GHG only	GHG1 Disclosure on methodology for calculation GHG2 Disclosure on external verification GHG3 Disclosure on total emissions GHG4 Disclosure by scope GHG5 Disclosure by source GHG6 Disclosure by segment or facility GHG7 Historical comparison of emission	Low
3	There is adequate disclosure on CC, GHG and EC only	EC1 Disclosure on total energy consumed EC2 Disclosure on consumption from renewable source EC3 Disclosure by segment, type, and facility	Fair
4	There is adequate disclosure on CC, GHG, EC and RC only	RC1 Disclosure on plans to reduce GHG emissions RC2 Disclosure on targets for GHG emissions RC3 Disclosure on reduction of GHG achieved to date RC4 Disclosure of costs of future emissions factored in capital budgeting	Moderate
5	There is adequate disclosure on CC, GHG, EC, RC and AEC	AEC1 Report provides explanation of where responsibility lies for climate change policy and action AEC2 Report provides information on mechanism by which board reviews company progress on climate change actions.	Good
6	There is adequate disclosure on CC, GHG, EC, RC and AEC	A non-audit firm provided assurance on carbon emission disclosure	High
7	There is adequate disclosure on CC, GHG, EC, RC and AEC	An audit firm provided assurance on carbon emission disclosure	Excellent

Table 3: Variable measurement and definitions

Variable Type	Definition	Measurement
Dependent Variable		
CEDQ	Carbon emission disclosure quality	Measured using a scale of 1-7
Independent Variable		
BS	Board size	Total number of directors
BIND	Board independence	% of non-executive directors
BSTR	Board structure	Separation of CEO from Chairman
BGEN	Gender diversity	% of women on the board
BETY	Ethnic diversity	No of different tribes on the board
BGRD	Board background	% of directors with accounting background
Control Variables		
PROF	Return on capital employed	PBIT/CE
FGRW	Firm growth	% change in sales revenue
CGEAR	Firm gearing ratio	Debt/Equity ratio
AQUA	Audit quality	=1 if audit by big, 0 if otherwise

of carbon emission disclosure in the audited financial statements while 59 (17.9%) of the companied show full commitment to all the whole activities that make up the carbon emission reduction in accordance with the guidelines by the International Sustainability Standard Boards (ISSB). Concerning the level of assurance, 74 (73.3%) had their carbon emission disclosure report reviewed by a non-audit firm while an audit firm provided assurance on carbon emission disclore report from the remaining 27 (26.7%).

In Panel C, the mean of board size is 9.94. The board size is significantly higher than the 6.15 reported by Oluwagbemiga (2021) for listed companies in Nigeria over the period of 2006-2015 but it is within the threshold of 5-15 recommended for the listed companies in Nigeria under the SEC code of corporate governance. There is only one year where a company in our sample had a board size above the regulatory limit of 15 members (17 members). The minimum figure of 7 indicates that none of the

Table 4: Descriptive statistics results

Scale	1	2	3	4	5	6	7
Panel A: Frequency and Percentage for Carbon Emission Disclosure using Categorical Data							
CEDQ	-	51 (15.5%)	39 (11.8%)	80 (24.2%)	59 (17.9%)	74 (22.4%)	27 (8.2%)
Panel B: Binary data							
Assurance	74 (73.3%)	27 (26.7%)					
Panel C: All variables							
Variable	**Mean**	**Min**	**Max**	**SD**	**OBS**		
Dependent							
CEDQ	3.79	1.00	7.00	1.08	330		
Assurance	6.22	6.00	7.00	0.36	101		
Independent Variables							
Board size	9.94	7.00	17.0	0.51	330		
Board Independence	68.6	60.0	84.5	4.39	330		
Board Structure	100	100	100	0.00	330		
Gender Diversity	30.0	25.15	35.0	0.86	330		
Ethnic Diversity	2.05	2.00	4.00	0.74	330		
Board Educ. Diversity	4.25	1.00	5.00	0.99	330		
Control variables							
ROCE	14.27	11.18	25.96	1.55	330		
FGRW	20.88	17.75	25.25	0.92	330		
CGEAR	0.17	0.14	0.26	0.11	330		
AQUA	0.89	0.00	1.00	0.07	330		

companies in our sample had less than the minimum regulatory number of 5 members on the board. The reported board size of 9.94 is higher than 6.5 reported by Ali (2022) for the listed firms in India, 7.26 for Ghana (Baidoo, 2022), and 6.00 for listed firms in China (Kumar, 2019).

The results in Panel C also reveals that companies in our sample seems to have independent board with approximately 69% non-executive directors. This figure is significantly higher than 47% reported for listed companies in Indonesia (Faisal et al., 2018) and 53% reported for listed companies in Australia (Biswas et al., 2018). In many of the companies the chief executive officer, chief financial officer and chief risk officer are the executive directors on the board while the remaining members are non-executive directors. In terms of board structure, notably, the entire companies in our sample had the office of the board chairman and Chief Executive Officer (CEO) separated with board being headed by a non-executive director.

The results for gender diversity shows that on the average, the percentage of women on the board of listed oil and gas company is 30, which is slightly lower than the 35% highlight in the SEC code of corporate governance. There are only 3 companies that have up to 35% female representation on the board while majority of the companies are between 25% -33%. The standard deviation of 0.85 reflects a relatively normal distribution of data across the study sample. It appears that ethnicity has not been given full consideration in the selection of board members as only 9 companies have all the three major ethnic group represented on their board. For educational diversity, the result in Panel C shows that majority of the companies (mean = 4.25) have a degree in social science related disciplines (accounting, business administration, economics, banking and finance and actuarial science).

For the control variables, the mean for ROCE is about 14% which implies that the companies in our sample are in a good financial position. Informatively, only one company reported a ROCE of 11% that is below the industry average in one year. The companies also exhibited about 20% growth rate during the year under consideration, which is about the highest in the developing economies, higher than the 12% reported for listed companies in Ghane (Baidoo, 2022), 14% for Kenya listed manufacturing firms (Oyerogba, 2024) and Tehran stock exchange (Ghafoorifard et al., 2014). For capital gearing, the result show that companies in our sample demonstrate a relatively high liquidity as the debt-to-equity ratio is about 17% which far below the threshold of 25% recommended for the industry (Oluwagbemiga, 2021). About 89% of the companies are being audited by the Big 4audit firms.

4.2. Estimation Results

Table 5 presents the results of ordered logistic regression analysis. As shown below, Table 5 contains seven columns. Column 1 shows the results of baseline regression model. In the baseline model, all variables are tested simultaneously using the complete data set for all the companies. Interpretation of the results in column 1 may be done from the signs of the beta coefficient based on the type of regression model adopted for the study and nature of the data extracted for this analysis. The results in column 2-7 shows the differential results for the marginal effects of the categorical data which enables the interpretation of the results using the signs of the coefficients together with the marginal effects at the mean, suggesting the likelihood that carbon emission disclosure is of greater or lesser quality in line with the board characteristics and firm specific control variables.

The results in Column 1 shows that CEDQ is positively correlated with all board characteristics variables, with the exemption of board size and educational diversity. Hence the study established that oil and gas company with independent board, well-structured board, adequate gender diversity and appropriate ethnic diversity are very likely to devote resources to reduction of carbon emission

Table 5: Ordered logistic regression for board characteristics and CEDQ

Variables	Baseline	Categorical data for marginal effects					
		Low	Fair	Moderate	Good	High	Excellent
BS	0.014	0.007	0.009	0.016	0.011	0.017	0.003
BIND	0.379**	0.244**	0.277**	0.281**	0.293**	0.295**	0.217*
BSTR	0.511**	0.175***	0.179***	0.175**	0.173***	0.181**	0.147**
BGED	0.488**	0.493**	0.508**	0.498**	0.477***	0.458**	-0.604**
BETY	0.621***	−0.165***	0.159**	0.164**	0.169**	0.170**	0.139**
BGRD	0.473***	−0.147***	0.162**	0.167**	0.175**	0.177**	0.158*
PROF	0.538**	0.209***	0.211***	0.207**	0.220***	0.234**	0.247**
FGRW	0.988**	0.821**	0.825**	0.841**	−0.843***	−0.838**	−0.704**
AQUA	0.127	0.197	0.201	0.236	0.239**	0.241**	0.239
CGEAR	−4.182***	−1.085	−2.085**	−2.217**	−1.944**	−2.116**	−2.252**

which may result in higher carbon emission disclosure. By contrast, the result suggests that companies with extremely large board size with different educational background are less likely to commit the company resources to environmental protection in form of carbon emission reduction and as such are not likely to have better disclosure for carbon emission in the annual report.

Specifically, for board independence we obtained a beta coefficient of 0.379, indicating that a unit increase in board independence may result in an approximately 38% increase in carbon emission disclosure quality. According to OECD code of corporate governance, independent directors are the board members not engaged in the routine activities of the company, not former employees, don't have close personal relationships with key employees, and have not worked with major customers, suppliers, or service providers, associated with the company (OECD, 2019). Looking at this definition, the presence of independent directors on the board can influence higher carbon emission disclosure. First, because independent directors are not employees of the company, they tend to be more objective. This objectivity is critical in evaluating the environmental impact of the company's activities on the host community and the entire ecosystem. Second, it should be noted that carbon emission disclosure has to do with risk assessment and mitigation. Independence of the board enables them to evaluate potential risks and challenges without undue influence from the management. This is essential in the development of effective risk management mechanisms. Lastly, since independent directors often possess diverse managerial and industry experience, they are better position to guide the organization in strategic decision making, including conducting the company's activities in an environmentally friendly manner.

For board structure, we report that having the board headed by an independent chairman result in a significant improvement in carbon emission disclosure quality (coefficient = 0.511, t = 11.727, P = 0.000). There are conflicting results on the link between board structure and carbon emission disclosure quality. A strand of literature suggests that companies with separated chairman and CEO responsibilities are more transparent than firms where a single individual occupy the two offices (Oluwagbemiga, 2021; Oyerogba, 2018; Black et al., 2017). In addition, a very recent study by Oyerogba et al. (2024) for the listed banks in Nigeria shows that an independent chairman can curb conflict of interest, promotes risk oversight, ensure cordial relationship among different stakeholders. By contrast, other studies reported that separating the offices of CEO and chairman would have negligible or negative influence on carbon emission disclosure by emphasizing that separating the two offices can make the board to be ignorant of the full length of the environment impact of the firm activities (Aliyu, 2019; Hamad et al., 2020; Mahmood et al., 2018). While the two sides of the divide seem to provide valid arguments, it is important to note that there are several ways in which independence of the board chairman can influence carbon emission disclosure. First, the presence of an independent chairman enriches the establishment of a dynamic and thoughtful board, less dominated by the opinions of top management and may enforce transparency and accountability. Second, it is likely that the separation of these critical responsibilities reduces the conflict of interest prevalent in firms where a chief executive officer is responsible for self-oversight. Hence, there is a growing agitation for the separation of these two offices (Ogungbade and Oyerogba, 2020).

Next, our results show that the presence of women on the board helps compel the management to show higher commitment to environmental protection activities and disclosure. The beta coefficient and t-statistics for board gender diversity are 0.488 and 4.781 respectively, indicating that board gender diversity is positively correlated with carbon emission disclosure quality. Audit's committee financial expertise is associated with higher sustainability reporting quality. The results reinforce the importance of gender balance on the board which has been advocated for in several instances. The argument of Oyerogba and Ogungbade (2020) was that women possess a unique ability in preserving the values, legacy and traditions of any organization. Drawing from this argument, it can be inferred that, a company that is seeking to preserve a value system is very likely to conduct its activities in an environmentally friendly manner. Some scholars believe that women possess natural leadership skills, and they are masters of opportunity management (Dieste et al., 2022; Schneider and Kokshagina, 2021). while some thinks that female directors are better positioned to serve consumer's markets, dominated by women and this may prompt them to advocate more information to be signal to the market they represent (Oluwagbemiga, 2021).

Similarly, our findings show a positive and highly significant relationship between ethnic diversity and carbon emission disclosure quality (coefficient = 0.621, T = statistics = 9.473). The significant and positive relationship between ethnic diversity and CEDQ reiterates the importance of having people from different

ethnic group on the board of oil and gas company and not limit the board membership to people from the large shareholders ethnic group. The argument in support of this result is that gender diversity increases board independence and effectiveness because people from different ethnic groups, or cultural background will ask questions that will not be asked by directors the same traditional background or ethic group. Therefore, diverse board can be an activist board because outside directors with different ethnicity could be considered the absolute independent director (Oluwagbemiga, 2021).

Regarding the firm specific variables, we find that profitable (high return on capital employed) oil and gas companies have higher likelihood of quality disclosure on carbon emission. This result is not unexpected as it is reasonable to believe that profitable companies will be prone to revealing their activities to the public in other to attract more patronage. We also document a significant relationship between firm growth and carbon emission disclosure quality. this result is consistent across all categories of carbon emission disclosure quality and mirrors the findings of Aliyu (2019). For audit quality, our findings establish that a significant relationship exists between audit quality and medium, good, and high carbon emission disclosure quality, and the result is consistent with Oyerogba et al (2024). Lastly, we report an inverse relationship between the liquidity variable (capital gearing) and carbon emission disclosure, which implies that firms with higher proportion of debt in their capital structure are less likely to commit adequate resources to carbon emission reduction activities probably because of the need to prioritize loan repayment and interest on loan over other responsibilities.

4.3. Sensitivity Analysis

Assurance Level: Literature on carbon emission disclosure have established external verification of reports as an important exercise in enhancing the reliability and credibility of data being reported and improving environmental management. Consistent with Oluwagbemiga (2021), we ascertained the assurance level based on whether carbon emission disclosure was reviewed by either an audit or non-audit firm. Based on the nature of the data (dummy of 1 and 0), we conducted binary logistic regression using a dichotomous variable. The findings presented in Table 6 are consistent with previous results except that the coefficient for board size shows a significant positive relationship for both audit and non-audit assurance. The result implies that board size influences the carbon emission disclosures quality through external verification. However, it does not matter whether verification is done by audit or non-audit firm. What is important is that carbon emission disclosure of the oil and gas companies should be verified by an external body in order to increase the credibility of these disclosures.

Table 6: Binary logistic regression for board characteristics and CEDQ

Variables	Baseline	Assurance Level	
		Audit	Non-audit
BS	0.014	0.038**	0.022**
BIND	0.379**	0.621**	0.432**
BSTR	0.511**	0.927***	0.677***
BGED	0.488**	0.730**	0.692**
BETY	0.621***	0.485***	0.594**
BGRD	−0.473***	−0.782**	0.562**
PROF	0.538**	0.526**	0.488**
FGRW	0.988**	0.711**	0.902**
AQUA	0.127	0.166**	0.187**
CGEAR	−4.182**	−3.374**	−4.083**

In addition, audit quality is significantly correlated with approximately 17% increase in carbon emission disclosure quality through external assurance by an audit firm, and about 19% increase in carbon emission disclosure through external assurance by a non-audit firm and this is consistent with many of the previous findings (Nehme et al., 2015; Tauringana et al., 2008; Ghaf Sultana et al., 2015; Agrawal & Chadha, 2015; Ghafran & Yasmin, 2017). All other results are as previously reported.

5. CONCLUSION AND RECOMMENDATIONS

This study investigates whether board characteristics influence a firm's carbon emission disclosure, in the context of the Nigerian listed oil and gas companies. Board characteristics is divided into board composition (board size, board independence and board structure) and board diversity (board gender diversity, ethnicity and background). The study assessed data from 22 quoted oil and gas companies for the fifteen-year period (2009-2023). The study adopted ordered regression for data analysis and concludes that board structure, board independence, board gender diversity and board ethnicity significantly influence the likelihood of high-quality carbon emission disclosure. The findings established the significant roles of the board in allocating resources to environmentally friendly activities, monitoring managerial activities, and ensuring that firms meet its obligation to operate in a climate friendly manner.

Premised on the agency theory, legitimacy theory and stakeholder theory viewpoints; the study established the viabilities of these theories in the context of the listed oil and gas companies in Nigeria. First, from the perspective of the agency theory, high level of board independence, high gender diversity, large board sizes, high ethnic diversity, high board structure and higher board educational diversity suggests improved oversight functions and internal monitoring within companies, that mitigates agency conflicts between management and shareholders. The legitimacy theory believes that firms have a social responsibility regarding the preservation of the ecosystem and well-being of the environment where they conduct their businesses and to establish their legitimacy by signaling accurate and up-to-date climate related information. Based on the principles of legitimacy theory, comprehensive carbon emission information shows that a company have adequate disclosure on climate change: risk and opportunities, methodology for calculation of carbon emission, amount of greenhouse gases generated and so on and addressing these issues enables the companies uphold their legitimacy. From the stakeholder theory assertion, companies are required to satisfy the information needs of individual stakeholder and the

entire stakeholders at large so as to enhance their competitiveness through environmentally friendly practices. This theory posits that high quality carbon emission disclosure is achievable through strong monitoring of managerial activities.

Therefore, listed oil and gas companies should strive to select more non-executive directors on the board to promote strong oversight function and higher disclosure. The importance of board independence for adequate carbon emission disclosure underscores the need of unbiased oversight and corporate governance guidelines. The selection of independent board members that can promote objectivity in carbon emission risk assessment and mitigation should be emphasized in policy documents. A quota for independent directors on the board should be stated by regulatory organizations, especially for directors with adequate experience in carbon emission regulation disciplines. Lastly, we advocate for the inclusion of substantives percentage of female directors on the boards to enhance the board's gender diversity, which strengthens carbon emission disclosure

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