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Research article

Corporate governance and carbon emissions performance: International evidence on curvilinear relationships

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ABSTRACT

This study investigates the impact of corporate governance mechanisms (namely board meeting, board independence, board gender diversity, CEO duality, ESG-based compensation and ESG committee) on carbon emissions performance of multinational entities (MNEs). The study analysed international sample of 336 top MNEs operating in 42 non-financial industries from 32 countries over a 15-year period. Result shows that board gender diversity, CEO duality, and ESG committee are negatively associated with carbon emissions rate, whilst board independence and ESG-based compensation have significant positive impact. Whereas board gender diversity and CEO duality have significant negative impact on carbon emissions rate in carbon-intensive industries, the impact of board meeting, board independence and ESG-based compensation is significant and positive. In the non-carbon-intensive industries, board meeting, board gender diversity and CEO duality have significant negative impact on carbon emissions rate, whilst the impact of ESG-based compensation is positive. Further, there is a negative association between the millennium development goals (MDGs)/sustainable development goals (SDGs) era dichotomy and carbon emissions rate, implying that the United Nations agenda for sustainable development significantly affected carbon emissions performance of MNEs, with the SDGs era generally witnessing better carbon emissions management in comparison to the MDGs era in spite of the higher emissions level in the SDGs era. The study contributes to knowledge in several ways. First, it adds to the limited literature on the determinants of carbon emissions reduction within an international context. Second, the study addresses mixed result reported in prior studies. Third, the study adds to knowledge on the governance factors affecting carbon emissions performance in the MDGs and SDGs periods, thus providing evidence on progress MNEs are making towards addressing climate change challenges through carbon emissions management.

1. Introduction

Carbon emissions continue to be the dominant driver of climate change (Dong et al., 2022). The devastating consequences of climate change, triggered by high greenhouse gas emissions rate, connote that a reactive approach to managing carbon emissions is no longer sustainable. The need for organisations to address environmental pollution has been reiterated through the United Nations (UN) agenda for sustainable development, with SDG 13 (climate change action) expressly placing responsibilities on both public and private sector organisations (Banerjee et al., 2021). SDG target 13.2 requires government to "integrate climate change measures into national policies, strategies and planning" (United Nations, 2023). Similarly, SDG target 13.3 expects private sector organisations, as well as other stakeholders to "improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning" (United Nations, 2023).

Top multinational entities (MNEs) are key stakeholders in the private sector in the context of the climate change discourse. They possess certain attributes which impose ethical obligation and environmental burden on them to actively and urgently address the challenges posed by climate change by setting and achieving decarbonisation targets. First, they (MNEs) predominantly operate in environmentally sensitive and carbon-intensive industries that contribute the most to total carbon emissions (Tauringana and Moses, 2021). Second, majority of top global companies are based in wealthy nations of the world that are responsible for most carbon emissions (Dong et al., 2022). In terms of both cumulative emissions and current per capita emissions, economically prosperous countries rank high (Banerjee et al., 2021; Union of Concerned Scientists, 2022). Third, top MNEs possess power, authority and relative

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autonomy (Ruggie, 2018). They are strategically positioned to wield significant influence in reducing carbon emissions directly arising from their business operations (scope 1 emissions), as well as indirect emissions from purchased or acquired energy (scope 2 emissions), and indirect emissions from their value chain (scope 3 emissions). The large scale of their business operations all over the world presents unique opportunities to them to address climate change problems through effective carbon emissions management. Not surprisingly, therefore, stakeholders are increasingly holding top MNEs to account for environmental pollution, as the debate on what global companies are doing to address carbon emissions is yet to abate.

Considering that corporate governance is a major sustainability mechanism of organisations (Haque and Ntim, 2018; Oyewo et al., 2022), scholars have argued that one of the strategies for achieving decarbonisation targets is strengthening corporate governance mechanisms. Thus, the nexus between corporate governance and carbon emissions performance is gaining traction. However, in spite of the well acknowledged relevance of corporate governance in improving environmental sustainability practice, the review of extant literature on the association between corporate governance and carbon emissions reduction reveals some gaps.

First, there are limited studies on the impact of corporate governance on carbon emissions reduction (Konadu et al., 2021; Elsayih et al., 2021). Most of the related studies have either examined the association between corporate governance and carbon emissions disclosure (e.g., Liao et al., 2015; Tingbani et al., 2020), or how corporate governance mechanisms affect environmental sustainability performance without specifically focusing on carbon emissions reduction (e.g., Agyemang et al., 2020; Nuskiya et al., 2021). Meanwhile, carbon emissions reduction is an important and sensitive subject matter within the environmental sustainability debate, as it merits more research attention. Moreover, SDG 13 requires MNEs to actively participate in tackling climate change, given that top MNEs pre-eminently operate in high carbon emitting industries, and are based in top emitting countries. It would be important to examine how they (MNEs) are managing carbon emissions directly attributable to them (scope 1 emissions), as well as indirect emissions from their business activities (scope 2 emissions) through their corporate governance mechanisms.

Second, results on the impact of corporate governance mechanisms on carbon emissions performance, and general environmental performance has been mixed, with studies reporting positive, negative and no impact (e.g., Kassinis et al., 2016; Liu, 2018; Lu and Herremans, 2019; Elsayih et al., 2021). Inconsistencies in prior studies may be due to neglecting a possible non-linear relationship between corporate governance variables and carbon emissions performance (Nuber and Velte, 2021), as a plethora of studies have applied linear models in analysing the relationship. In the light ofa possible curvilinear relationship, there have been calls to investigate corporate governance versus carbon emissions performance relationship using sophisticated statistical techniques that could detect both linear and non-linear relationship (Fernhaber and Patel, 2012; Haans et al., 2016). However, it is only a few studies that have applied such techniques (e.g., Lee and Li, 2012; Gallego-Álvarez and Ortas, 2017; Nuskiya et al., 2021). Considering that the relationship between corporate governance and carbon emissions performance is an unresolved issue (Elsayih et al., 2021), more studies are required.

Third, most studies are either single country-based or focus on an economic or geographic region (e.g., Tingbani et al., 2020; Elsayih et al., 2021; Nuber and Velte, 2021), resulting in analysis of few industries/sectors using limited sample size. Although conducting an intra-industry study enhances internal validity, such investigation does not provide a holistic view of carbon emissions performance determinants. This informs the need to conduct inter-industry studies, whilst taking into account how emissions rate differs across industries. In this light, scholars suggest that longitudinal studies with international samples taken from several industries allow for comprehensive analysis of carbon emissions performance and, importantly, a reasonable generalisation of obtained results (Brammer and Pavelin, 2008; Zaman et al., 2020). Therefore, more inter-country studies are required to enhance generalisability of results.

Fourth, there is increasing pressure on globally visible companies in the sustainable development goals (SDGs) era to reduce greenhouse gas emissions by strengthening corporate governance (Erin et al., 2022). Whilst the millennium development goals (MDGs) laid the foundation for environmental sustainability, the SDGs expanded the horizon by setting multifarious environmental targets, including climate change action. It is conceivable, therefore, that the commitment of corporate entities to enhancing corporate governance effectiveness to reduce carbon emissions may be dissimilar in the MDGs and SDGs era. Global companies undeniably have a moral burden to address environmental pollution. However, little is known on how the agenda for sustainable development 2030 has impacted the commitment of MNEs in addressing carbon emissions through the reinvigoration of their corporate governance mechanisms. Prior studies encompassing the MDGs and SDGs periods (e.g., Nuber and Velte, 2021; Konadu et al., 2021; Elsayih et al., 2021) did not decompose the corporate governance/carbon emissions performance relationship into the MDGs and SDGs era, thus providing limited insight on how corporate governance impact carbon emissions differently on account of the agenda for sustainable development. With the 15-year SDGs set to expire in about 8 years from now by 2030, an exposition on how corporate governance has impacted carbon emissions performance is too important to be ignored. Since corporate governance is a major apparatus for achieving decarbonisation (Nadeem et al., 2020), knowledge on the extent to which governance mechanisms have impacted carbon emissions reduction can inform policy changes at organisational, country and supranational levels. Recently, corporate entities have started publishing internal deadlines for the achievement of their SDGs targets as a self-monitoring mechanism and self-regulation strategy (Nuskiya et al., 2021; Erin et al., 2022). Research into the effectiveness or otherwise of corporate governance mechanisms in enhancing carbon emissions performance is an important issue in the roadmap to achieving the SDGs targets by 2030.

In the light the foregoing discussions, the current study aims to investigate the impact of corporate governance on carbon emissions performance, with a focus on scope 1 and scope 2 emissions. Six corporate governance elements that have been well documented to affect carbon emissions performance were investigated namely board meeting, board independence, board gender diversity, CEO duality, ESG-based compensation and ESG committee (Liao et al., 2015; Tingbani et al., 2020; Nuber and Velte, 2021; Elsayih et al., 2021).

Result from the analysis of empirical data from top 500 companies on the Forbes list shows that board gender diversity, CEO duality, and ESG committee are negatively associated with carbon emissions rate, whilst board independence and ESG-based compensation have significant positive impact. Whereas board gender diversity and CEO Duality have significant negative impact on carbon emissions rate in the carbon-intensive industries, the impact of board meeting, board independence and ESG-based compensation is significant and positive. In the non-carbon-intensive industries, board meeting, board gender diversity and CEO duality have significant negative impact on carbon emissions rate, whilst the impact of ESG-based compensation is negative. Further, there is a negative association between the MDGs/SDGs era dichotomy and carbon emissions rate, implying that United Nations agenda for sustainable development significantly affected carbon emissions performance of MNEs, with the SDGs era generally witnessing better carbon emissions management in comparison to the MDGs era.

The study contributes to knowledge in several ways. First, it adds to the limited literature on the determinants of carbon emissions management in an international context. The study analysed international sample of 336 top MNEs operating in 42 non-financial industries from 32 countries over a 15-year period, thus enhancing generalisability of results. Second, the current study is also important in resolving some of

the mixed results reported by prior studies. The study uniquely addresses mixed result in two ways: (a) one, it shows that the impact of governance mechanisms on carbon emissions performance varies by industry carbon intensity and MDGs/SDGs era. Whereas prior studies generally reported the impact of governance factors on carbon emissions performance, the current study shows that the impact is dependent on industry carbon emissions level/environmental sensitivity, as well as the MDGs/SDGs periods; (b) two, it uses panel quantile regression (PQR) analysis to demonstrate that the relationship between corporate governance and carbon emissions performance is curvilinear, unlike most prior studies that have ignored the possibility of a non-linear relationship by analysing data using linear models. Third, the study adds to knowledge on the governance factors affecting carbon emissions performance in the MDGs and SDGs periods, thus presenting evidence on progress MNEs are making towards addressing climate change through carbon emissions management.

The rest of the paper is sectionalised into five (sections 2-6). Literature review and hypotheses development is covered in section 2, methodology is explained in section 3, followed by results in section 4, and discussion of findings in section 5. The paper is concluded in section 6.

2. Literature review

2.1. Theoretical framework

Generally, various theories have been developed to explain variation in carbon emissions performance of entities. While there is no comprehensive theory that can be applied, it is argued that theories such as agency theory, stakeholder theory, legitimacy theory and critical mass theory, amongst others, can be used in an integrated framework to explain determinants of carbon emissions performance (Liu, 2018; Lu and Herremans, 2019; Konadu et al., 2021). The current study applies the stakeholder-legitimacy theory as theoretical framework. Prior studies (e.g., Elsayih et al., 2021; Nuskiya et al., 2021) argue that there is a consistency between both theories. The stakeholder theory and legitimacy theory could be considered as interrelated theories in explaining the relationship between corporate governance and carbon emissions performance in the sense that carbon accounting is a governance strategy for demonstrating transparency to stakeholders and gaining legitimacy (Ghosh and Wolf, 2021).

According to the stakeholder theory, the organisation is made up of various stakeholders that affect and are affected by the organisation (García-Sánchez et al., 2019). Since stakeholders wield some level of influence, depending on their level of power and level of interest according to the Mendelow matrix, the organisation will have to consider the interest of various stakeholders in formulating plans and implementing strategies. Within the environmental sustainability discourse, negative production externalities generated by the organisation from its operations affect the society. The organisation will consider stakeholders that are both directly and indirectly affected by its carbon emissions, and would take appropriate actions to minimise environmental pollution through corporate governance (Chithambo and Tauringana, 2017).

Companies will generally seek to satisfy key stakeholders as a legitimisation strategy (Rudyanto and Veronica Siregar, 2018). Since corporate governance is documented as a potent self-regulating mechanism that improves sustainability practice (Oyewo et al., 2022), stakeholders will be monitoring the robustness or otherwise of corporate governance practice of MNEs. With this in mind, MNEs will want to strengthen corporate governance mechanisms in order to gain the acceptance of stakeholders. Considered from another standpoint, a well-constituted board in terms of gender diversity, adequate representation of independent/non-executive directors (NEDs), and diversity of nationalities on the board of directors is likely to protect the interest of various stakeholders (Liao et al., 2015). A board that meets regularly to discuss issues affecting the environment and society will likely be well reckoned with by stakeholders. Further, a board that checkmates the opportunistic tendencies of executive board members through strategies such as the separation of the function of the CEO from that of the Chairperson (Zhang et al., 2021), and the linkage of executive compensation to sustainability performance (Malik and Shim, 2022) is likely to have better board performance, and gain the acceptance of stakeholders.

Going by the legitimacy theory, there is an implied social contract between the society and the organisation (Elsayih et al., 2021). The society provides the resources and the enabling environment for the organisation to conduct its business. This resonates with the PESTEL (political, economic, social, technological, ecological and legal) model which explains the environmental factors that interplay in determining the survival of business organisations. In return for the economic resources provided by the society, the organisation contributes to the wellbeing of the society by addressing environmental, social and economic sustainability issues (Oyewo et al., 2022). There is, thus, a symbiotic relationship between the society and business organisations. Since the society views the relationship with the organisation as a social contract, the burden of proof is upon the company to demonstrate its commitment to environmental and social sustainability issues so that the society's perception of the company changes. Suchman (1995, p. 500) points that legitimacy is "a generalised perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definition". Companies often gain and maintain their legitimacy by attempting to ensure the environment, society and economic systems are sustainable (Rudyanto and Veronica Siregar, 2018).

Considering that climate change, triggered substantially by human activities through greenhouse gas emissions, is a burning issue that has caused various environmental devastations in many parts of the world, MNEs will want to address their carbon emissions issues and diminish environmental pollution to maintain the implied social contract with the society. They will emplace corporate governance structures to improve their carbon emissions performance to demonstrate their relevance and gain stakeholders' acceptance as a legitimisation strategy (Ghosh and Wolf, 2021).

The high spate of environmental pollution and carbon emissions in recent times suggests that the social contract is in jeopardy, as it appears business organisations are not satisfactorily fulfilling their ethical responsibilities of minimising the negative impact of their business operations and production externalities on the society. To address this, therefore, corporate governance mechanisms such as holding frequent and effective board meetings, strengthening board independence through the injection of independent and experienced directors to the board, ensuring board gender diversity through more female representation, separation of the office of the board Chairperson from executive directorship (i.e., de-emphasis of CEO duality), linking executive compensation to environmental performance through ESG-based compensation, and enhancing the functionality of the ESG Committee through regular meetings, training and active engagements are some of the strategies corporate entities are implementing to generally improve board performance and achieve decarbonisation targets. These initiatives are targeted at satisfying the interest of various stakeholders and preserving corporate legitimacy.

2.2. Hypotheses development

2.2.1. Board meeting

In line with the stakeholder theory, best practice in corporate governance recommends that board of directors meet regularly to effectively perform their fiduciary responsibilities (Nuskiya et al., 2021). Having regular board meetings provide opportunity for board members to discuss matters affecting the organisation (Bukair and Rahman, 2015). When issues are brought to bear in a timely manner, this provides

an avenue to resolve them. When challenges are delayed and left unattended to, this may affect the overall efficiency of an organisation. This underscores the importance of frequent meetings in tackling organisational problems and improving board performance, including addressing carbon emissions management issues (Elsayih et al., 2021). Moreover, having frequent board meetings provide an avenue to monitor the opportunistic behaviour of executive board members/managers on a regular basis as part of the oversight function of independent directors (Disli et al., 2022). Studies have shown that directors' frequent meetings have a positive impact on environmental and social performance (Disli et al., 2022; Elsayih et al., 2021; Kumar et al., 2022; Nuskiya et al., 2021). Nevertheless, Wang and Hussainey (2013) contend that larger boards are associated with communication and coordination problems, and this may hamper the effectiveness of board meetings in addressing carbon emissions issues. Nevertheless, other studies report no significant relationship between board meeting frequency and environmental performance (e.g., Harun et al., 2020; Tingbani et al., 2020). However, the current study contends that regular board meetings contribute to carbon emissions performance of compnaies, informing the hypothesis that:

H1. Board meeting is negatively associated with carbon emissions rate of MNEs

2.2.2. Board independence

Independent/non-executive directors (NEDs) are generally appointed to strengthen board independence, performance and overall board effectiveness. As a result, independent directors/NEDs are unlikely to collude with managers, thus checkmating managerial opportunism, because they are aware that their relevance as non-executive board members consists in their ability to remain independent and discharge their duties as entrusted by stakeholders (Fama and Jensen, 1983). Zahra and Stanton (1988) suggest that non-executive directors are more likely to respond to concerns about honour and obligations and would generally be more interested in satisfying the sustainability responsibilities of the firm because this might improve their social prestige, as well as the firm's image and reputation.

With these thoughts in mind, having a high number of independent directors on board should anticipatorily promote carbon minimisation endeavours of organisations in an effort to satisfy stakeholders and gain legitimacy. Scholars argue that independent directors advocate for the dissemination of environmental information as a tactic geared towards taking on a balanced accountability process and signalling to stakeholders that an organisation is environmentally responsible (Mudiyanselage, 2018). Considering that independent/non-executive directors are board members who are not associated with the firm, or any of its directors, and have no financial interest in a company (apart from their shareholding in the firm, if any), it may be envisaged that they will bring independence to the board and improve the quality of decision on carbon emissions. This may promote the public image of the company and improve board performance with respect to addressing carbon emissions challenges. Empirical studies abound supporting the contention that board independence enhances corporate environmental performance (e.g., Maroun, 2019; Liao et al., 2015; Mudiyanselage, 2018). Therefore,

H2. Board independence is negatively associated with carbon emissions rate of MNEs

2.2.3. Board gender diversity

Branco and Rodrigues (2008) contend that the theme of board gender diversity correctly links into the structure of stakeholder theory. Since women thinking differs from men's (Liao et al., 2015), approaches to environmental issues by both genders may vary and influence the type and depth of a company's commitment to carbon emissions management. Women are known to be naturally concerned about environmental issues, are more generous, more humanitarian, and are more stakeholder-oriented (Kassinis et al., 2016). Female directors are, therefore, more likely to respond to stakeholders' clamour for carbon emissions reduction and support projects that improve the environmental performance of organisations in comparison to their male counterparts (Lu and Herremans, 2019; Nuber and Velte, 2021). In addition, women have different leadership styles (Nadeem et al., 2020), and having them on board ensures a balanced decision and better engagement with stakeholders (Konadu et al., 2021). These arguments inform the consideration that gender diverse boards may record better carbon emissions performance than less gender-diverse boards. Empirically, majority of studies report a positive association between a gender-diverse board and environmental performance (e.g., Nadeem et al., 2020; Tingbani et al., 2020; Elsayih et al., 2021; Konadu et al., 2021). Therefore,

H3. Board gender diversity is negatively associated with carbon emissions rate of MNEs

2.2.4. CEO duality

Chief executive officer (CEO) duality arises when the function of the Chairperson of the board and the CEO of the company is combined in one person. Whilst the CEO has the responsibility for running the company, the Chairperson is tasked with running the board and coordinating the activities of board members (i.e., the non-executive/independent directors and executive directors). Best practice in corporate governance recommends that organisations should recruit non-executive directors as Chairperson of the company to protect stakeholders and avoid moral hazard which may occur because of conflict of interest when simultaneously performing Chairperson-CEO roles (Lu and Wang, 2021). CEO duality reduces the independence of the board and impairs board effectiveness (Zhang et al., 2021), whereas Chairperson/CEO role separation institutes a checking mechanism on exploitative behaviour and opportunistic tendencies by managers. CEO duality may negatively affect environmental performance because there may be lack of checks and balance on environmental pollution. Given that independent directors are more likely to respond to concerns about obligations and would be generally interested in satisfying the environmental responsibilities of the firm (Zahra and Stanton, 1988; Mudiyanselage, 2018), having a non-executive board member as the Chairperson can checkmate the tendency of the CEO as head of the executive directors to dodge ethical responsibility to minimise carbon emissions. Chairperson/CEO role separation should contribute to carbon emissions performance. Conversely, combining both functions (i.e., CEO duality) may adversely affect environmental performance of organisations.

Empirical studies support the proposition that having the function of the CEO and Chairperson of the board combined in a person negatively affects environmental performance (e.g., Harun et al., 2020; Lu and Wang, 2021; Nuskiya et al., 2021). Whilst some studies observe that CEO duality has no significant impact on environmental performance (Rudyanto and Veronica Siregar, 2018; Adel et al., 2019), the current study supports the contention that CEO duality will adversely affect carbon emissions performance, informing the next hypothesis that:

H4. CEO duality is positively associated with carbon emissions rate of MNEs

2.2.5. ESG-based compensation

The practice of linking executive compensation or payment to meeting and surpassing environmental targets is a nascent governance practice that scholars have suggested could improve carbon emissions performance (Malik and Shim, 2022). ESG-based compensation could serve as a motivator for board members to be more conscious of environmental pollution, and this may propel them to implement decarbonisation strategies. In line with the legitimacy theory, when companies implement ESG-based compensation and make such policies public knowledge, they seek to legitimise their existence by demonstrating in-depth commitment to resolving environmental pollution

(Moats et al., 2022). By linking executive payment to environmental sustainability performance, companies signal to stakeholders that carbon emissions management is a priority, and this strengthens the legitimacy of an organisation in the eyes of stakeholders, and portrays the organisation as a responsible corporate citizen in the society. Further, ESG-based compensation also signals to stakeholders that carbon emissions management is part of the executives' roles (Spierings, 2022).

According to Spierings (2022), the vast majority of US firms listed in the S&P 500 companies are now tying executive compensation to some form of ESG performance, with 19 percent of such companies linking executive payment to achievement of carbon emissions goals in 2021. Previously, in year 2020, about 10 percent of the companies compensated executives based on meeting carbon emissions reduction targets. However, for ESG-based compensation to achieve the desired impact of achieving decarbonisation targets, the ESG/environmental goals should be sufficiently challenging, specific and transparent (Moats et al., 2022). The metrics for measuring performance achievement should also be reliable and sufficiently linked to the areas of improvement desired to avoid rewarding wrong behaviour. Studies have shown a positive association between ESG-based executive compensation and environmental performance (e.g., Okafor and Ujah, 2020; Lu and Wang, 2021). Hence,

H5. *ESG-based compensation is negatively associated with carbon emissions rate of MNEs.*

2.3.6. ESG committee

In an effort to satisfy stakeholders interests and legitimise their existence in line with the legitimacy theory, corporate entities are now setting up environmental sustainability/ESG committees tasked with formulating, monitoring and implementing environmental sustainability initiatives (Lu and Wang, 2021). The ESG committee also has a responsibility to minimise ESG risks, whilst maximising ESG opportunities and associated actions that promote the sustainability image of an organisation.

The emplacement of ESG committee as a formal corporate governance apparatus stems from the consideration that legitimacy is deliberate, and if decarbonisation targets must be met, formal structures for monitoring environmental strategy implementation should be in place (Ghosh and Wolf, 2021). However, for the environmental/ESG committee to be effective, it has to be well constituted in terms of injecting experienced NEDs/independent directors in the committee (Adel et al., 2019), recruiting committee members that are knowledgeable about environmental sustainability issues, and allowing the ESG committee some level of autonomy in discharging their duties. Thus, a well constituted ESG committee should anticipatorily enhance carbon emissions management and overall environmental performance. Empirically, while majority of studies report a positive impact of ESG Committee on environmental performance (Kend, 2015; Adel et al., 2019; Elsayih et al., 2021; Lu and Wang, 2021), few studies submit that the influence is negative (Al-Shaer et al., 2021), and some other studies conclude that there is no significant relationship (Masud et al., 2018). Lu and Wang (2021) observe from the analysis of firms operating in 25 international countries over the period of 2010 and 2017 that ESG committee enhances ESG practice. Elsayih et al.'s (2021) study of Australian firms participating in the carbon disclosure project concludes that ESG committee has a positive impact on ESG practice. However, Masud et al.'s (2018) examination of 88 firms from Afghanistan, Bangladesh, India and Pakistan find no significant association between the presence of ESG committee and quality of environmental and social sustainability practice. Al-Shaer et al.'s (2021) study also report a negative relationship between ESG committee and sustainability practice. The current study supports the proposition that the presence of the ESG Committee bolsters carbon emissions performance, leading to the hypothesis that.

H6. The presence of ESG Committee is negatively associated with carbon emissions rate of MNEs

3. Methodology

3.1. Research design and data source

The population of the study is global MNEs. Using the Forbes global company list as at January 2022 as the sampling frame, the top 500 companies were selected as sample. The choice of the Forbes Global 500 is informed by the consideration that it is a comprehensive list of the world's largest, most powerful public companies, as measured by revenues, profits, assets and market value. The Forbes selection has been widely employed in prior research (e.g., Martínez-Ferrero and García-Sánchez, 2017). From this list, companies belonging to the financial service industry were excluded as the nature of their business and regulatory frameworks for environmental pollution differ from that of the non-financial companies (Tingbani et al., 2020).

Secondary data on carbon emissions was collected from the Refinitiv/DataStream database. Refinitiv offers one of the most comprehensive ESG databases in the industry, available on global companies and continuously growing across more than 450 different ESG metrics, with history going back to 2002 Refinitiv (2022). Refinitiv/DataStream measure of ESG provides transparent ESG data and scores for 11,000+ companies globally with data since FY2002, longer than other providers. A plethora of studies have used data sourced from Refinitiv/DataStream database (Ioannou and Serafeim, 2012; Pekovic and Vogt, 2020).

After deleting 160 entries of financial firms from the list, there were 340 firms left. 4 firms with no data on carbon emissions performance were removed. The final sample comprises of 336 firms operating in 42 industries from 32 countries. The study covered a 15-year period (2006–2020), spanning the MDGs (2006–2015) and SDGs (2016-2020) period. A longitudinal research design was adopted for the purpose of performing a more comprehensive analysis of the influence of corporate governance mechanisms on carbon emissions performance as recommended in literature (Zaman et al., 2020). The panel research design yielded 4550 firm-year observations.

3.2. Measurement of variables

3.2.1. Dependent variable

Carbon emissions performance was measured using total carbon emissions rate from scope 1 and scope 2 (i.e., Total of scope 1 CO_2 and scope 2 CO_2 emission in tonnes) as the main measurement. The Refinitiv database follows a greenhouse gas (GHG) protocol for all emission classifications by type. The choice of Total scope 1 and scope 2 carbon emissions is informed by the consideration that it is a comprehensive measure of both direct and indirect emissions attributable to an organisation. Prior studies have used carbon emissions rate as proxy for carbon emissions performance (Baboukardos, 2017; Konadu et al., 2021). To ensure robustness of variable measurement, the individual components of scope 1 emissions and carbon 2 emissions were used as alternative measure of carbon emissions performance (Konadu et al., 2021). Carbon emissions rate has a negative polarity, with lower carbon emissions rate connoting better carbon emissions performance (Moussa et al., 2020).

3.2.2. Independent variables

Six corporate governance factors that have been well documented to affect carbon emissions performance were investigated, namely: board meeting, board independence, board gender diversity, CEO duality, ESG-based compensation and ESG Committee (Liao et al., 2015; Tingbani et al., 2020; Nuber and Velte, 2021; Elsayih et al., 2021). Measurement of variables is summarised in Table 1.

3.2.3. Control variables

In line with prior studies, five firm-level variables that affect environmental practice of organisations were included as control variables, notably firm size, market presence, leverage, liquidity, and profitability

(Tingbani et al., 2020; Doni et al., 2021; Nadeem et al., 2020). Studies show that country-level governance factors and national culture affect sustainability commitment (e.g., Albers and Günther, 2011; Lenssen et al., 2014)). The study included country-level factors (i.e., economic development and world governance indicators) and national cultural orientation (i.e., Hofstede cultural dimensions of Individualism/collectivism, Long-term Orientation and Indulgence) as control variables affecting environmental sustainability practice in line with prior studies (Lu and Wang, 2021). Measurement of variables and data source is summarised in Table 1.

3.3. Method of data analysis

Panel quantile regression (PQR) was employed to assess possible non-linear relationship between corporate governance mechanisms and carbon emissions performance (Gallego-Álvarez and Ortas, 2017; Nuskiya et al., 2021). PQR has certain advantages over linear models, those being that (Coad and Rao, 2008; Fernhaber & Patel, 2012): (i) they are not sensitive to outliers; (ii) they allow for appropriately fitting data with skewed distributions, and; (iii) they allow capturing non-monotonous and non-uniform impacts of the independent variables on the dependent variable. For the aim of this research, the most interesting feature of PQR is that it has the potential to uncover differences in the level of carbon emissions rate across different quantiles (q 0.1, q0.2 … q0.95), thus allowing testing the working hypotheses across all quantiles. Meanwhile, it will be inappropriate to use linear models such as OLS which uses the mean of the dependent variable, because carbon emissions performance of firms is likely to be scattered, and not normally distributed. As such, mean will not be an appropriate measure of central tendency (Coad and Rao, 2008). Robustness check was carried out using 2 stage least square (2SLS)/instrumental variable (IV) regression with the Anderson canonical correlation LM statistic for under-identification test, and the Stock-Yogo weak identification test.

4. Results and analysis

4.1. Descriptive analysis and multicollinearity test

Descriptive analysis of variables, disaggregated into industry carbon-intensity and MDGs/SDGs era is presented in Table 2 and Table 3.

Result shows that there is significant difference in carbon emissions rate, corporate governance mechanisms and firm attributes between carbon-intensive and non-carbon-intensive industries (Table 2). There is also marked difference in carbon emissions rate, corporate governance structure and firm attributes in the MDGs and SDGs periods (Table 3). These differences provide a rich context for examining the impact of corporate governance on carbon emissions performance in various industries and across different periods.

Correlation matrix in Table 4 shows that none of the correlation coefficients between the independent variables is up to 0.80. Therefore, multicollinearity among the independent variables is not a concern (Tabachnick et al., 2007).

4.2. Baseline result: impact of corporate governance mechanisms on carbon emissions performance

The baseline result on the impact of corporate governance mechanism on carbon emissions performance, combined for both carbon-intensive and non-carbon-intensive industries is presented in Table 5, and the result is graphed in Fig. 1.

Result in Table 5 shows that whilst board gender diversity, CEO duality, and ESG committee are significantly and negatively associated with carbon emissions rate, board independence and ESG-based compensation have significant positive impact. The impact of board meeting is not significant. Board gender diversity is negatively associated with carbon emissions rate, implying that gender diverse boards are

Table 1
Variables measurement, supporting literature and data sources.

	Variables	Measurement/Supporting literature	Data sources
1	Carbon emissions performance	Carbon emissions rate measured as natural log of total carbon emissions in metric tonnes (Baboukardos, 2017; Konadu et al., 2021) scope 1 emissions and scope 2 emissions rate measured as natural log of carbon emissions in metric tonnes (Baboukardos, 2017; Konadu et al., 2021)	Refinitiv/DataStream database
2	Board Meeting	Number of board meeting held in a year (Nuskiya et al., 2021; Disli et al., 2022)	Refinitiv/DataStream database & Annual Reports
3	Board Independence	Proportion of Non-executive Directors (NEDs) to total board size expressed in % (Elsayih et al., 2021; Disli et al., 2022)	
4	Board Gender Diversity	Number of Female directors to total board size in a year expressed in % (Nadeem et al., 2020; Tingbani et al., 2020)	
5	CEO duality	If Chairperson also serves as the CEO = 1, otherwise = 0 (Nuskiya et al., 2021)	
6	ESG-based Compensation	If executive pay is linked to ESG performance = 1, else = 0 (Lu and Wang, 2021)	
7	ESG Committee	If there is an ESG committee = 1, otherwise = 0 (Adel et al., 2019; Elsayih et al., 2021)	
8	Firm Size	Natural log of Revenue (Peel, 2018)	Refinitiv/DataStream database & Annual Reports
9	Firm Market Presence	Natural log of Market capitalisation (Elsayih et al., 2021)	
10	Firm Leverage	Ratio of Total Debt to Total Assets (Al-Shaer et al., 2021)	
11	Firm Liquidity	Ratio of current assets to current liabilities (Tingbani et al., 2020)	
12	Firm Profitability	Return on Total Assets ratio, ROTA (Adel et al., 2019; Elsayih et al., 2021)	
13	Industry carbon intensity	If firm operates in carbon-intensive industry = 1, otherwise = 0 (Baboukardos, 2017; Adel et al., 2019)	Researcher's conceptualisation
14	MDGs/SDGs Era	MDGs period = 2006–2015; SDGs period = 2016–2020	
15	Economic Development	Natural log of Gross Domestic Product (GDP) (Nuber and Velte, 2021)	World Bank
16	World Governance Indicators (Average of 6 items)	Average of WGI Measures based on World bank data on (i)Voice & Accountability; (ii) Political Stability and Lack of Violence; (iii) Government Effectiveness; (iv)Regulatory Quality; (v) Rule of Law; and (vi) Control of Corruption (Cuadrado-Ballesteros and Bisogno, 2020)	
17	National culture Orientation (Hofstede Model)	Hofstede index on (Disli et al., 2022): ((i)Individualism; (ii) long-term orientation; (iii) Indulgence	Hofstede insight: https://www.hofstede-insights.com

Table 2
Descriptive Analysis of Variables based on Industry Carbon Intensity.

Variable	Industry Type	N	Mean	Std. Deviation	F ratio
Total Carbon Emissions (Metric tonnes)	Non-carbon intensive	1251	2,462,764.33	5,544,559.75	115.04***
	Carbon intensive	3299	11,121,199.48	28,345,261.54	
	Total	4550	8,740,605.55	24,614,942.68	
Board Meeting	Non-carbon intensive	1251	7.85	4.06	22.52***
	Carbon intensive	3299	8.80	6.64	
	Total	4550	8.54	6.056	
Board Independence	Non-carbon intensive	1251	79.59%	19.34%	27.58***
	Carbon intensive	3299	75.61%	23.96%	
	Total	4550	76.70%	22.87%	
Board Gender Diversity	Non-carbon intensive	1251	19.10%	12.64%	47.32***
	Carbon intensive	3299	16.19%	12.80%	
	Total	4550	16.99%	12.82%	
CEO Duality	Non-carbon intensive	1251	0.53	0.49	0.37
	Carbon intensive	3299	0.52	0.50	
	Total	4550	0.53	0.49	
ESG-based Compensation	Non-carbon intensive	1251	0.27	0.44	9.46***
	Carbon intensive	3299	0.32	0.46	
	Total	4550	0.31	0.46	
ESG Committee	Non-carbon intensive	1251	0.70	0.45	26.68***
	Carbon intensive	3299	0.78	0.41	
	Total	4550	0.76	0.43	
Revenue (Million' USD)	Non-carbon intensive	1251	47,130.57	63,009.48	0.73
	Carbon intensive	3299	48,861.10	60234.05	
	Total	4550	48,385.30	61,007.64	
Market Capitalisation (Million' USD)	Non-carbon intensive	1251	85,016.92	155,014.27	21.08***
	Carbon intensive	3299	65,741.60	113,380.20	
	Total	4550	71,045.29	126,488.09	
Leverage	Non-carbon intensive	1251	24.87%	16.25%	16.50***
	Carbon intensive	3299	26.94%	14.93%	
	Total	4550	26.37%	15.33%	
Liquidity (Current Ratio)	Non-carbon intensive	1251	1.44	1.17	18.43***
	Carbon intensive	3299	1.63	1.30	
	Total	4550	1.58	1.27	
Return on Total Assets	Non-carbon intensive	1251	10.76%	8.35%	47.05***
	Carbon intensive	3299	8.99%	7.53%	
	Total	4550	9.47%	7.81%	

***$p < 0.01$.

able to achieve better carbon emissions performance. The impact is also strongest at the highest levels of board gender diversity, notably quantiles 0.60 to 0.95, implying that the more the level of gender diversity, the greater the impact on improving carbon emissions performance. The fall in the impact of board gender diversity on carbon emissions rate between quantile 0.20 ($b = -0.292$, $p < 0.10$) to 0.40 ($b = -0.140$, $p > 0.10$), and the subsequent rise in the impact from quantiles 0.60 ($b = -0.627$, $p < 0.01$) to 0.95 ($b = -0.933$, $p < 0.01$) shows a curvilinear relationship between board gender diversity and carbon emissions performance. In sum, gender diversity has the strongest negative impact on carbon emissions rate going by its highest negative coefficients across the quantiles. This supports the acceptance of H3.

CEO duality is also negatively associated with carbon emissions, with the impact increasing across the quantiles, and having the strongest impact in the upper quantiles 0.80 and 0.95. Thus, H4 is rejected. The impact of ESG committee was initially positive in quantile 0.20, but subsequently became negative without evincing statistical significance in quantiles 0.40 to 0.60, before assuming statistical significance and recording the greatest impact in quantile 0.80 ($b = -0.114$, $p < 0.10$). Thereafter, its coefficient declines in quantile 0.95 ($b = -0.024$, $p > 0.10$), thus depicting a curvilinear relationship between ESG committee and carbon emissions rate. This provides partial support for the acceptance of H6.

Board independence has a significant positive impact on carbon emissions rate in quantiles 0.40 to 0.95. However, the increase in value in quantiles 0.40 ($b = 0.195$, $p < 0.05$) to 0.80 ($b = 0.594$, $p < 0.01$), and its subsequent decline in quantile 0.95 ($b = 0.355$, $p < 0.01$) also establishes a curvilinear relationship between board independence and carbon emissions rate. The result leads to the rejection of H2. ESG-based compensation has a significant positive impact in quantiles 0.20 to 0.95. However, the increase in value in quantiles 0.20 ($b = 0.084$, $p < 0.01$) to 0.60 ($b = 0.369$, $p < 0.01$), and its subsequent decline from quantile 0.80 ($b = 0.361$, $p < 0.01$) to 0.95 ($b = 0.120$, $p < 0.05$) also confirms a curvilinear relationship between ESG-based compensation and carbon emissions rate. The result leads to the rejection of H5. Board meeting has no significant impact on carbon emissions rate across the quantiles, leading to the rejection of H1.

The curvilinear relationship between the corporate governance variables and carbon emissions rate is graphically presented in Fig. 1. OLS result is represented by the straight lines in the graphs, while the standard errors are depicted by the straight dotted lines laying above and below the straight OLS lines (Fig. 1). The PQR graphs are represented by the undulating lines, and the standard errors by the U-shaped paths surrounding the PQR graphs, clearly showing that the relationship between the corporate governance mechanisms and carbon emissions rate is non-linear. Whereas the OLS presents a misleading result that the relationship between corporate governance variables and carbon emissions rate is linear (which might have possibly accounted for the mixed results in prior studies using linear models), PQR reveals that the relationship is curvilinear as demonstrated by the current study.

With respect to the impact of firm attributes on carbon emissions performance (Table 5), firm size is positively associated with carbon emissions rate, implying that large sized firms have higher carbon emissions level, whilst the negative impact of market presence connotes that market visible firms have a higher propensity to reduce their carbon emissions and environmental pollution as a legitimisation strategy to gain stakeholders acceptance. The significant positive impact of leverage on carbon emissions (in quantiles 0.20 to 0.60) implies that highly geared companies have higher level of environmental pollution. This may possibly be explained by the argument that high debt level

Table 3
Descriptive Analysis of Variables based on MDGs/SDGs Era.

Variable	Era	N	Mean	Std. Deviation	F ratio
Total Carbon Emissions (Metric tonnes)	MDGs era	2912	8,259,438.51	23,540,989.35	3.09*
	SDGs era	1638	9,596,013.62	26,402,420.66	
	Total	4550	8,740,605.55	24,614,942.68	
Board Meeting	MDGs era	2912	8.57	6.49	0.25
	SDGs era	1638	8.48	5.19	
	Total	4550	8.54	6.05	
Board Independence	MDGs era	2912	76.10%	24.79%	5.73**
	SDGs era	1638	77.79%	18.89%	
	Total	4550	76.70%	22.85%	
Board Gender Diversity	MDGs era	2912	14.12%	11.17%	444.21***
	SDGs era	1638	22.09%	13.94%	
	Total	4550	16.99%	12.82%	
CEO Duality	MDGs era	2912	0.54	0.49	7.60***
	SDGs era	1638	0.50	0.50	
	Total	4550	0.53	0.49	
ESG-based Compensation	MDGs era	2912	0.32	0.46	5.10**
	SDGs era	1638	0.28	0.45	
	Total	4550	0.31	0.46	
ESG Committee	MDGs era	2912	0.71	0.45	79.43***
	SDGs era	1638	0.83	0.37	
	Total	4550	0.76	0.43	
Revenue (Million' USD)	MDGs era	2912	45,423.13	59,073.07	19.14***
	SDGs era	1638	53,651.39	63,983.94	
	Total	4550	48,385.30	61,007.64	
Market Capitalisation (Million' USD)	MDGs era	2912	55,697.09	67,504.46	121.61***
	SDGs era	1638	98,292.34	187,527.01	
	Total	4550	71,045.29	126,488.09	
Leverage	MDGs era	2912	25.24%	15.72%	44.61***
	SDGs era	1638	28.38%	14.40%	
	Total	4550	26.37%	15.33%	
Liquidity (Current Ratio)	MDGs era	2912	1.63	1.41	15.71***
	SDGs era	1638	1.48	0.98	
	Total	4550	1.58	1.27	
Return on Total Assets	MDGs era	2912	9.86%	7.84%	20.02***
	SDGs era	1638	8.78%	7.70%	
	Total	4550	9.47%	7.81%	

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

reduces financial resource availability to highly-geared companies as to invest in greenhouse gas reduction technologies and initiatives, thus contributing to high emissions rate by such highly-geared companies. This proposition is confirmed by the significant negative association between liquidity and carbon emissions rate, implying that highly liquid firms are able to mobilise financial resources to invest in environmental sustainability projects that reduce emissions level. Relatedly, the significant negative impact of profitability on carbon emissions across the quantiles reveals that highly-profitable firms with more economic resources are able to implement emissions reduction strategies, ultimately contributing to reduction in carbon emissions level. The positive impact of industry carbon intensity establishes that firms operating in carbon-intensive industries have higher emissions rate in comparison to non-carbon-intensive firms. This corroborates the result in Table 2 in which the emissions level of carbon-intensive firms (M = 11, 121, 199.48 CO_2 metric tonnes) far outstrips that of non-carbon-intensive firms (M = 2,462,764.33 CO_2 metric tonnes).

The negative impact of the MDGs/SDGs era dichotomy (Table 5) implies that United Nations agenda for sustainable development affected carbon emissions performance of MNEs, with the SDGs era generally witnessing better carbon emissions management in comparison to the MDGs era, in spite of the higher emissions level in the SDGs era (M = 9,596,013.62 CO_2 metric tonnes) when benchmarked against the MDGs period (M = 8,259,438.51 CO_2 metric tonnes). There is a positive trend in the relationship between economic development and carbon emissions rate, as the impact of economic development changes from strong negative coefficient in quantile 0.20 to a positive one from quantiles 0.60 to 0.95. The positive trend implies that economically prosperous countries/wealthy nations contribute the most to carbon emissions/environmental pollution (Banerjee et al., 2021). The negative impact of world governance index implies that the quality of country governance has a significant impact in diminishing carbon emissions/environmental pollution. Regarding the influence of national culture, MNEs operating in less individualist/more collectivist societies, countries having a long-term orientation, and societies with low level of indulgence (i.e., high level of restraint/control of desires and impulses) are able to minimise emissions rate and achieve better carbon emissions performance.

4.3. Impact of corporate governance mechanisms on carbon emissions performance based on industry carbon intensity

Result in Table 5 shows that industry carbon intensity has a significant impact on carbon emissions performance. Further analysis was performed to closely examine the impact of the governance factors on carbon emissions based on industry carbon pollution rate/environmental sensitivity to carbon emissions. Using the classification applied in prior studies (e.g., Baboukardos, 2017; Konadu et al., 2021), MNEs were split into carbon intensive and non-carbon intensive industries. The result of the analysis is presented in Table 6 (graphed in Fig. 2) and Table 7 (graphed in Fig. 3) respectively.

Result in Table 6 for the carbon-intensive industries shows that whilst board gender diversity and CEO duality have significant negative impact on carbon emissions rate, the impact of board meeting, board independence and ESG-based compensation is significant and positive. Although the coefficient of ESG committee is negative in quantiles 0.40 to 0.80, the impact is not statistically significant. The result in Table 6 reinforces the acceptance of H3 and the rejection of H1, H2, H4 and H5. The curvilinear relationship between corporate governance mechanisms and carbon emissions rate, revealed by the fluctuating coefficients of the

Table 4
Correlation matrix for multicollinearity test.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Board Meeting (1)	1															
Board Independence (2)	−.081***	1														
Board Gender Diversity (3)	.004	.430***	1													
CEO Duality (4)	−.055***	.033**	.054**	1												
ESG-based Compensation (5)	.047***	.286***	.278***	.034**	1											
ESG Committee (6)	.097***	.046***	.170***	−.021	.204***	1										
Firm Size (7)	.095***	.053***	.076***	−.031**	.106***	.285***	1									
Market Presence (8)	.033**	.198***	.240***	.045***	.138***	.256***	.529***	1								
Leverage (9)	.059***	.069***	.072***	.041***	.053***	.003	.002	−.059***	1							
Liquidity (10)	−.069***	−.103***	−.100***	.009	−.077**	−.106**	−.253***	−.046***	−.211***	1						
Profitability (11)	−.052***	.086***	.059***	.028	−.030**	.000	−.119***	.268***	−.223***	.251***	1					
Eco Devt. (12)	−.017	.272***	.373***	.121***	.198***	.160***	.059***	.213***	.098***	−.014	−.058***	1				
World Gov. Ind. (13)	−.123***	.038***	.236***	.017	.110***	.108***	−.021	−.007	.046***	−.096***	−.111***	.492***	1			
Individualism (14)	.004	.471***	.503***	.163***	.308***	.110***	−.007	.226***	.148***	.016	.099***	.643***	.404***	1		
Long-term Orientation (15)	.075***	−.498***	−.396***	−.220**	−.226**	.028	.130***	−.188***	−.125***	−.059***	−.194***	−.513***	−.121***	−.795***	1	
Indulgence (16)	−.056**	.406**	.416**	.132**	.250**	.122**	−.034*	.208**	.137**	.031*	.111**	.605**	.424**	.878***	−.776***	1

***p < 0.01, **p < 0.05.

governance variables across the quantiles, is graphed in Fig. 2.

Result in Table 7 shows that board meeting, board gender diversity and CEO duality have significant negative impact on carbon emissions rate in the non-carbon-intensive industries, whilst the impact of ESG-based compensation is positive in most of the quantiles. Although board independence has negative but insignificant impact in the lower quantiles (0.20 and 0.40), it has the greatest significant positive impact in quantile 0.80, leading to the overall conclusion that it is positively associated with carbon emissions rate. Similarly, the coefficient of ESG committee is positive and significant in quantile 0.80, although it evinces a negative but insignificant coefficient in quantile 0.95. It is concluded, overall, that ESG committee is positively associated with carbon emissions. Result in Table 7 shows a curvilinear relationship between the corporate governance variables and carbon emissions rate, and this is graphically depicted in Fig. 3.

4.4. *Impact of corporate governance mechanisms on carbon emissions performance in the MDGs and SDGs era*

Result shows that the MDGs/SDGs era dichotomy significantly affects carbon emissions performance (Table 5). Further analysis was performed to closely examine the impact of the governance factors on carbon emissions by disaggregating the result into the MDGs and SDGs era. The result of the analysis is presented in Table 8 (MDGs era) and Table 9 (SDGs era) with the corresponding graphs in Figs. 4 and 5 respectively.

Result in Table 8 shows that in the MDGs era, the impact of board gender diversity, CEO duality, and ESG committee is significant and negative, whilst board independence and ESG-based compensation is positively associated with carbon emissions rate. The impact of board meeting is not significant. In the SDGs era (Table 9), board gender diversity and CEO duality have significant negative impact on carbon emissions, whilst board independence, ESG-based compensation and ESG committee are positively associated with carbon emissions. Although the coefficients of board meeting are negative across the quantiles, they are not statistically significant. The curvilinear relationship between corporate governance variables and carbon emissions rate is evidenced by the rising and falling coefficients of the variables in quantiles 0.20 to 0.95, as further illustrated in Figs. 4 and 5 for the MDGs and SDGs era respectively.

4.5. *Robustness check*

4.5.1. *Alternative measure of carbon emissions performance*

To check the robustness of result for sensitivity to alternative measure of carbon emissions performance, scope 1 emissions and scope 2 emissions were used as dependent variables (Baboukardos, 2017; Konadu et al., 2021). The result of the analysis is presented in Table 10 and Table 11 respectively for scope 1 emissions and scope 2 emissions.

Result in Table 10 shows that board gender diversity, CEO duality, and ESG Committee are significantly and negatively associated with scope 1 emissions, whilst board independence and ESG-based compensation have significant positive impact. The impact of board meeting is positive, significant but weak. Board gender diversity emerged as the strongest negative driver of carbon emissions rate. The result in Table 10 follows a similar pattern to the baseline result in Table 5. The result supports the acceptance of H3 and H6 and the rejection of H1, H2, H4 and H5. Furthermore, the effect size of the coefficients of determination of the baseline result in Table 5 (R^2 in the range of 18.5%–24.2%) is comparable to that of Table 10 (with R^2 in the range of 18.4%–26.7%). This confirms that the baseline result (Table 5) is robust to alternative measure of the dependent variable.

Result in Table 11 shows that board gender diversity, CEO duality, and ESG committee are significantly and negatively associated with scope 2 carbon emissions, whilst ESG-based compensation has significant positive impact. The impact of board meeting and board

Table 5
Governance Factors and Carbon emissions performance (Combined for carbon-intensive and non-carbon-intensive industries).

$N = 4550$	DV: Total Emissions				
Variable	0.20	0.40	0.60	0.80	0.95
Board Meeting	.005 (.004)	.005 (.003)	.000 (.004)	.001 (.004)	.002 (.003)
Board Independence	.094 (.076)	.195** (.096)	.339*** (.099)	.594*** (.142)	.355*** (.121)
Board Gender Diversity	−.292* (.174)	−.140 (.235)	−.627*** (.179)	−.836*** (.245)	−.933*** (.249)
CEO Duality	−.001 (.020)	−.060** (.027)	−.081* (.042)	−.123** (.036)	−.144*** (.040)
ESG-based Compensation	.084*** (.019)	.150*** (.037)	.369*** (.054)	.361*** (.055)	.120** (.049)
ESG Committee	.056 (.041)	−.045 (.082)	−.075 (.079)	−.114* (.067)	−.024 (.081)
Firm characteristics (control)					
Firm Size	1.187*** (.064)	1.135*** (.046)	1.051*** (.066)	.584*** (.068)	.609*** (.086)
Market Presence	−.057 (.048)	−.197*** (.054)	−.120* (.077)	.051 (.079)	−.218** (.096)
Leverage	.003*** (.001)	.003*** (.001)	.002*** (.001)	−.002 (.001)	.002 (.003)
Liquidity	−.070*** (.015)	−.077*** (.016)	−.002 (.026)	−.075*** (.024)	−.089*** (.020)
Profitability	−.006*** (.001)	−.008*** (.002)	−.017*** (.004)	−.018*** (.002)	−.013*** (.003)
Industry carbon intensity	.164*** (.026)	.259*** (.035)	.408*** (.045)	.489*** (.050)	.662*** (.050)
Era (MDGs Vs SDGs)	−.198*** (.022)	−.159*** (.032)	−.047 (.043)	−.035 (.036)	−.002 (.064)
Country Governance (control)					
Economic Development	−.299* (.170)	−.170 (.219)	.024 (.165)	.117 (.158)	.240 (.252)
World Gov. Index	−.009* (.005)	−.008* (.004)	−.007** (.002)	−.007*** (.002)	.002 (.003)
National culture (control)					
Individualism	−.002 (.001)	−.010*** (.002)	−.006*** (.001)	−.002 (.002)	−.003* (.002)
Long-term Orientation	−.001 (.002)	−.009*** (.002)	−.010*** (.001)	−.006*** (.001)	−.010*** (.002)
Indulgence	.005 (.003)	.003 (.003)	−.005** (.002)	−.003** (.001)	−.008*** (.003)
R^2	0.242	0.196	0.185	0.201	0.208

Standard error in parentheses.
***p < 0.01, **p < 0.05, *p < 0.10.

independence is negative but weak and not statistically significant. Similarly, board gender diversity remains the strongest negative driver of carbon emissions rate. The result in Table 11 supports the acceptance of H3 and H6 and the rejection of H1, H2, H4 and H5. The effect size of the coefficients of determination of the baseline result in Table 5 (R^2 in the range of 18.5%–24.2%) compares to that of Table 11 (with R^2 in the range of 18.6%–25.6%).

Overall, comparison of the baseline result (Table 5) with robustness check result in Tables 10 and 11 confirms that the result is robust to alternative measure of carbon emissions performance.

4.5.2. Treatment of endogeneity using 2 stage least square (2SLS)/ instrumental variable regression

Scholars have argued that endogeneity do occur between board gender diversity and environmental management performance (Adams, 2016; Gould et al., 2018; Konadu et al., 2021). To address endogeneity concerns, the study applied instrumental variable (2 stage least square, 2SLS) regression (Elsayih et al., 2021; Ullah et al., 2021). Under-identification test was carried out using the Anderson canonical correlation LM statistic, whilst weak identification test was conducted using Stock-Yogo weak ID test (Stock and Yogo, 2005). In applying the two-stage least square (2SLS)/instrumental variable regression, six variables were applied as the instrument for board gender diversity as suggested by literature (Tingbani et al., 2020; Konadu et al., 2021), namely:

(i) executive director (ED) gender diversity [measured as the ratio of female executive directors to total executive board size];
(ii) board nationality diversity [measured as the ratio of number of nationalities represented by the members in the board to board size]
(iii) board size [measured as total number of board members]
(iv) strictly independent directors on the board [measured as total number of independent board members to board size]
(v) cross directorship [measured as average number of other corporate affiliations for board member]
(vi) ED nationality diversity [measured as the ratio of number of nationalities represented by executive board members to total executive board size]

The regression analysis was run using the main measurement of carbon emissions performance (Total emissions), and the alternative measures (scope 1 emissions and scope 2 emissions) as dependent variable. The result of the analysis is presented in Table 12.

The under-identification test examines whether instrumental variables (i.e., executive director (ED) gender diversity, board nationality diversity, board size, strictly independent directors on the board, cross directorship, and ED nationality diversity) are less powerful than the endogenous variable (board gender diversity). Based on the Anderson canon. corr. LM statistics for Total emissions (349.67, $p < 0.01$), Scope 1 emissions (345.58, $p < 0.01$), and Scope 2 (328.82, $p < 0.01$), the test establishes that the model is not under-identified since the chi-square p value < 0.01 for all measures of carbon emissions performance.

The weak identification test examines if the instrumental variables have the ability to fully define the endogenous variables. It also shows how strong the instrumental variables are in defining the endogenous variables, and the extent to which the instrumental variables are appropriate replacement for the endogenous variables in the regression equation. For Total emissions as a measure of carbon emissions performance, the Cragg Donald Wald F statistics (65.382) is greater than each of the Stock-Yogo weak ID test critical values (19.28, 11.12, 6.76, 5.15, 29.18, 16.23, 11.72, 9.38). With respect to scope 1 emissions, the Cragg Donald Wald F statistics (64.554) is greater than each of the Stock-Yogo weak ID test critical values (19.28, 11.12, 6.76, 5.15, 29.18, 16.23, 11.72, 9.38). Also, for scope 2 emissions, the Cragg Donald Wald F statistics (61.250) is greater than each of the Stock-Yogo weak ID test critical values (19.28, 11.12, 6.76, 5.15, 29.18, 16.23, 11.72, 9.38). On the whole, since the Cragg Donald Wald F statistics is greater than the Stock-Yogo weak ID test critical values in all cases, the result confirms that there is no weak identification problem, as the instrumental variables are valid predictors for the endogenous variables in the regression equation. The result of the IV (2SLS) regression is thus robust.

Result in Table 12 shows that board gender diversity and CEO duality have significant negative impact on the three measures of carbon emissions (i.e., total emissions, scope 1 emissions and scope 2 emissions), whilst board independence and ESG-based compensation are positively associated with carbon emissions rate. The impact of board meeting is weak, whilst the presence of the ESG committee has no significant impact on any of the measures/dimensions of carbon emissions

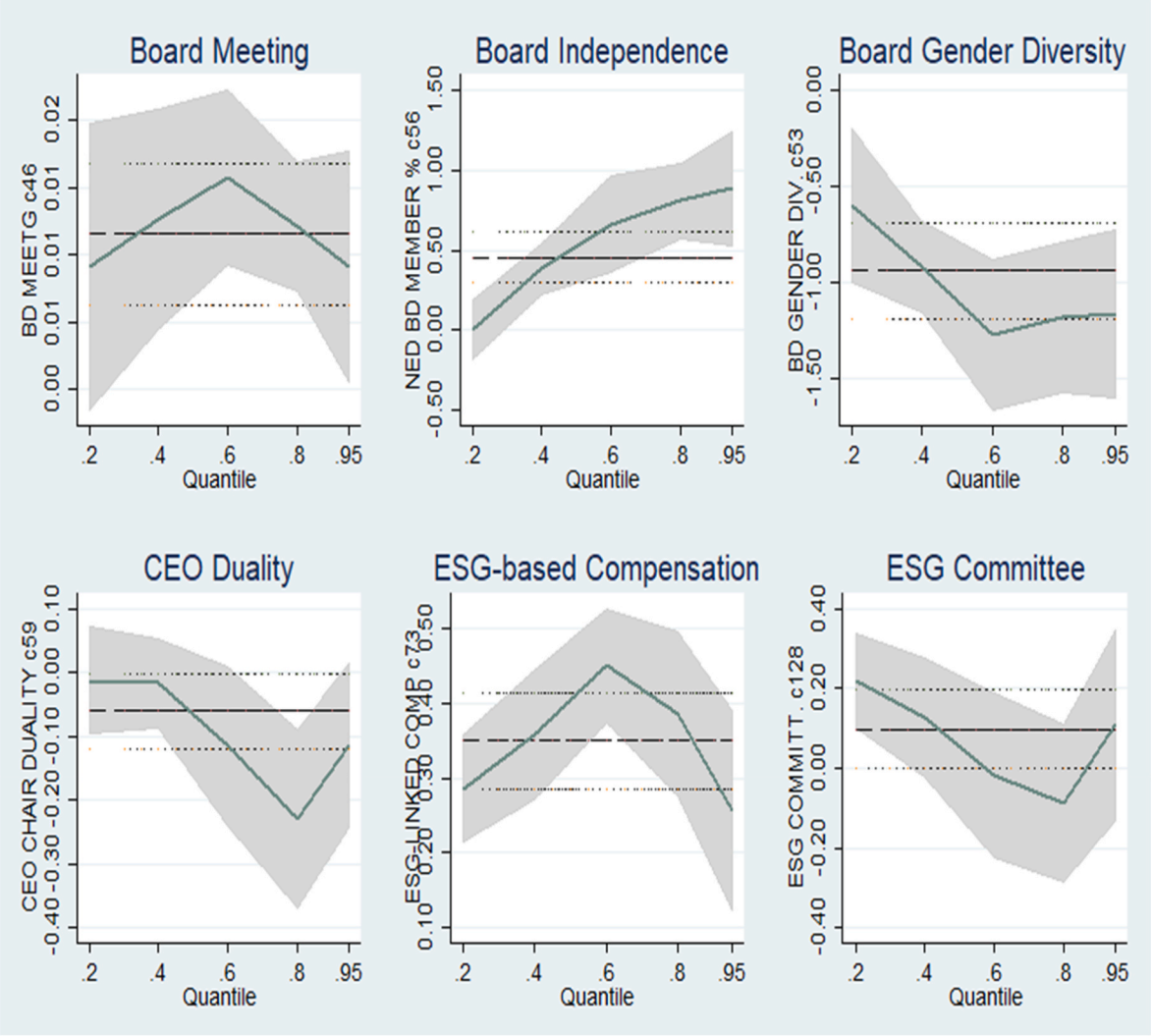

Fig. 1. Relationship between corporate governance mechanisms and carbon emissions rate (combined for both carbon-intensive and non-carbon-intensive industries.

Table 6
Governance Factors and Carbon emissions performance in Carbon-Intensive Industries.

N = 3299	DV: Total Emissions				
Variable	0.20	0.40	0.60	0.80	0.95
Board Meeting	.009*** (.001)	.005*** (.001)	.001 (.001)	−.001 (.003)	−.001 (.001)
Board Independence	.136 (.089)	.298** (.078)	.487*** (.093)	.731*** (.215)	.250** (.098)
Board Gender Diversity	−.362 (.237)	−.242 (.165)	−.493*** (.174)	−.309 (.190)	−.267 (.163)
CEO Duality	.029 (.048)	−.077 (.059)	−.153*** (.041)	−.172*** (.038)	−.055 (.042)
ESG-based Compensation	.098* (.052)	.179*** (.051)	.582*** (.058)	.373*** (.052)	.121** (.054)
ESG Committee	.038 (.058)	−.049 (.077)	−.165 (.101)	−.132 (.104)	.044 (.079)
Firm characteristics (control)					
Firm Size	.943*** (.081)	.834*** (.083)	.723*** (.078)	.587*** (.084)	.330*** (.080)
Market Presence	.002 (.052)	−.116* (.061)	−.057 (.080)	−.057 (.097)	−.171* (.087)
Leverage	.002** (.001)	.000 (.001)	−.001 (.001)	−.007*** (.002)	−.009** (.002)
Liquidity	−.108*** (.019)	−.113*** (.024)	−.064 (.052)	−.158*** (.037)	−.233*** (.034)
Profitability	−.010*** (.003)	−.010*** (.002)	−.014*** (.002)	−.013*** (.002)	−.011*** (.002)
Era (MDGs Vs SDGs)	−.221*** (.047)	−.139*** (.033)	−.084* (.045)	−.066 (.057)	−.021 (.058)
Country Governance (control)					
Economic Development	.225 (.344)	−.142 (.236)	.052 (.163)	.066 (.245)	.069 (.255)
World Gov. Index	−.021*** (.003)	−.014*** (.002)	−.015*** (.002)	−.012*** (.002)	−.008** (.003)
National culture (control)					
Individualism	−.001 (.002)	−.006*** (.002)	−.005*** (.001)	−.001 (.001)	.001 (.001)
Long-term Orientation	.001 (.002)	−.007*** (.001)	−.006*** (.001)	−.003 (.002)	−.002 (.003)
Indulgence	.009** (.003)	−.002 (.002)	−.006** (.002)	−.001 (.002)	−.008*** (.003)
R^2	0.182	0.172	0.187	0.191	0.169

Standard error in parentheses.
***p < 0.01, **p < 0.05, *p < 0.10.

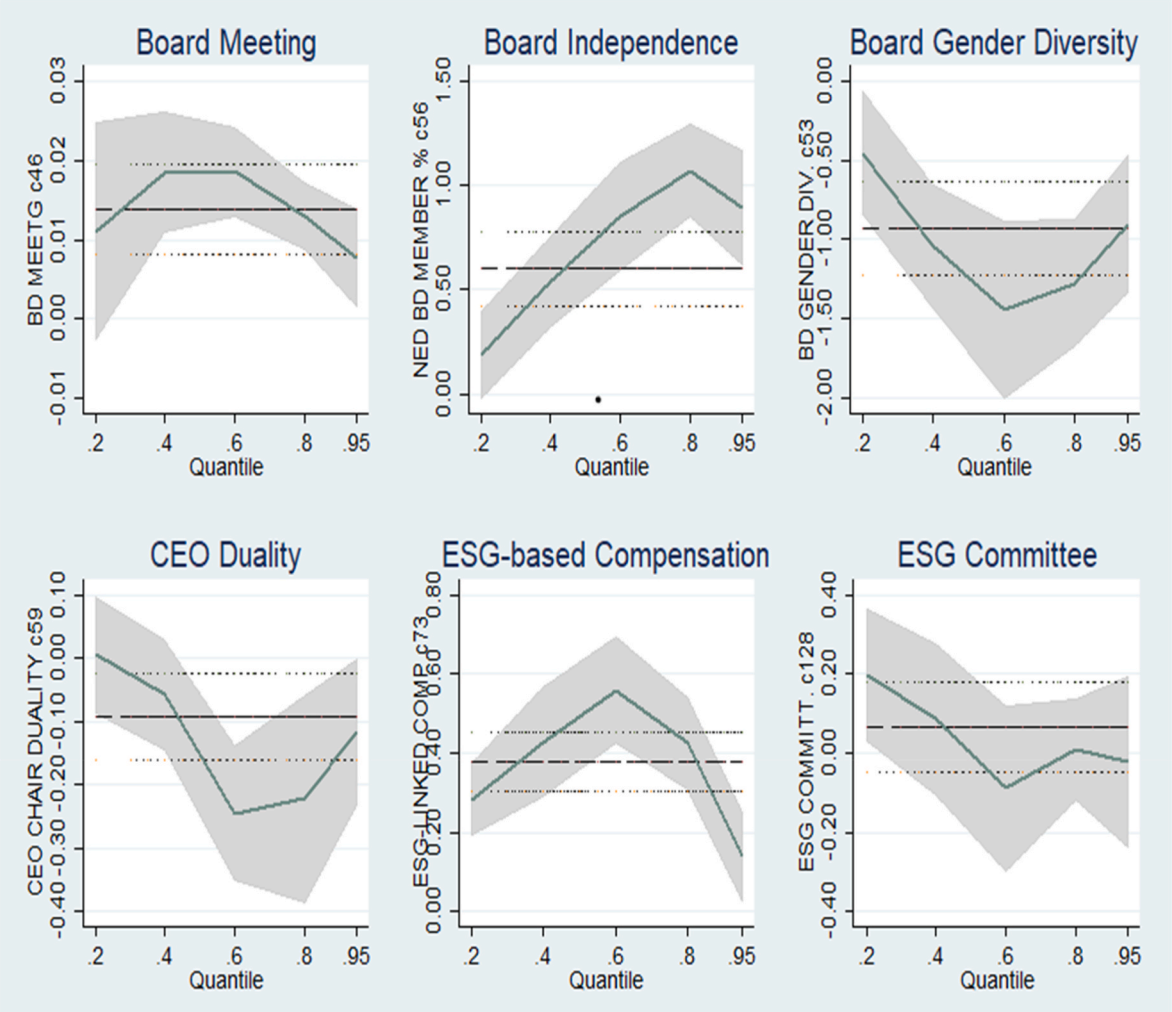

Fig. 2. Relationship between corporate governance mechanisms and carbon emissions rate in carbon-intensive industries.

Table 7
Governance Factors and Carbon emissions performance in Non-Carbon-Intensive Industries.

$N = 1251$	DV: Total Emissions				
Variable	0.20	0.40	0.60	0.80	0.95
Board Meeting	−.006 (.007)	−.006 (.006)	−.009* (.005)	−.030*** (.007)	−.022* (.012)
Board Independence	−.230 (.174)	−.015 (.086)	.121 (.173)	.478** (.206)	.057 (.174)
Board Gender Diversity	−.260 (.267)	−.131 (.239)	−.504*** (.171)	−1.751*** (.300)	−1.373*** (.415)
CEO Duality	.022 (.050)	−.036 (.042)	−.004 (.043)	.108** (.050)	−.118* (.069)
ESG-based Compensation	.078** (.036)	.061** (.030)	.012 (.039)	.117 (.075)	.140** (.061)
ESG Committee	.033 (.080)	.033 (.097)	.011 (.072)	.185* (.101)	−.028 (.061)
Firm characteristics (control)					
Firm Size	1.450*** (.086)	1.309*** (.051)	1.226*** (.109)	.594*** (.138)	.784*** (.110)
Market Presence	−.155** (.063	−.105 (.086)	−.073 (.066)	−.014 (.151)	−.302*** (.109)
Leverage	.009*** (.002)	.009*** (.001)	.008*** (.001)	.005 (.003)	.007*** (.002)
Liquidity	.035 (.029)	.040** (.015)	.032* (.018)	−.032 (.028)	−.049 (.037)
Profitability	−.010** (.004)	−.012*** (.004)	−.015*** (.002)	−.022*** (.003)	−.008 (.008)
Era (MDGs Vs SDGs)	−.158** (.064)	−.042 (.058)	.036 (.042)	.214*** (.051)	.277*** (.073)
Country Governance (control)					
Economic Development	−.563** (.225)	−1.016*** (.203)	−1.193*** (.197)	−1.157*** (.249)	−.538 (.389)
World Gov. Index	.004 (.005)	.019*** (.005)	.028*** (.004)	.036*** (.006)	.028*** (.006)
National culture (control)					
Individualism	−.008* (.004)	−.016*** (.003)	−.014*** (.002)	−.007 (.005)	−.006 (.004)
Long-term Orientation	−.009*** (.002)	−.010*** (.002)	−.013*** (.002)	−.014*** (.003)	−.018*** (.004)
Indulgence	.001 (.004)	.007* (.003)	−.008** (.003)	−.001 (.004)	−.001 (.008)
R^2	0.434	0.405	0.324	0.263	0.293

Standard error in parentheses.
***p < 0.01, **p < 0.05, *p < 0.10.

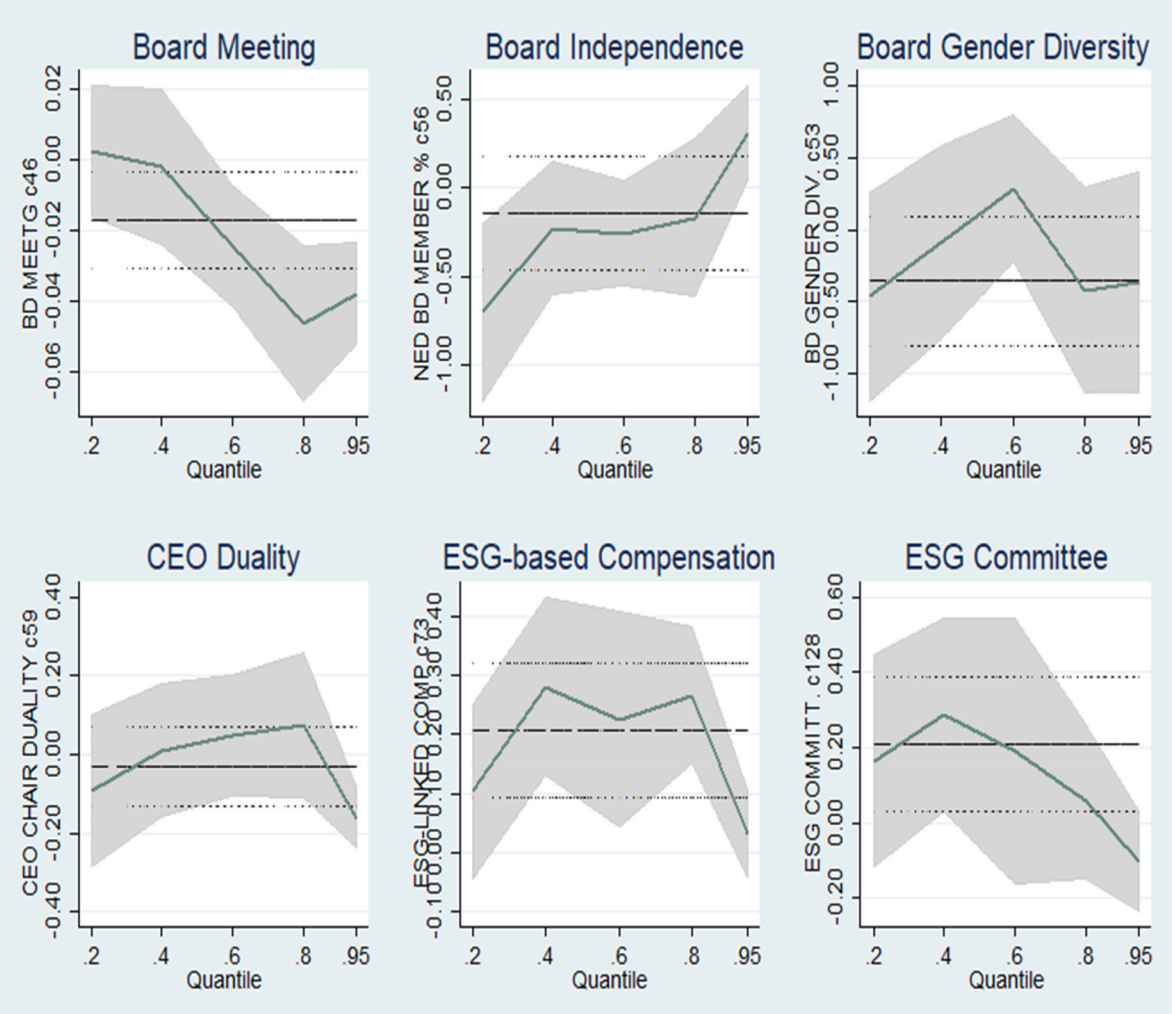

Fig. 3. Relationship between corporate governance mechanisms and carbon emissions rate in non-carbon-intensive industries.

Table 8
Governance Factors and Carbon emissions performance in the MDGs Era.

$N = 2912$	DV: Total Emissions				
Variable	0.20	0.40	0.60	0.80	0.95
Board Meeting	.007 (.005)	.005 (.005)	.007 (.005)	.004 (.008)	.005 (.007)
Board Independence	.072 (.079)	.174* (.097)	.377*** (.092)	.705*** (.182)	.304** (.127)
Board Gender Diversity	−.214 (.227)	−.143 (.280)	−.763*** (.218)	−.947** (.410)	−.886** (.355)
CEO Duality	−.040 (.032)	−.019 (.038)	.026 (.045)	−.019 (.045)	−.113* (.061)
ESG-based Compensation	.078*** (.028)	.143*** (.048)	.411*** (.062)	.385*** (.088)	.188** (.072)
ESG Committee	−.048 (.062)	−.142** (.057)	−.161*** (.060)	−.180** (.072)	−.070 (.087)
Firm characteristics (control)					
Firm Size	1.176*** (.081)	1.089*** (.062)	1.022*** (.115)	.629*** (.132)	.800*** (.107)
Market Presence	−.001 (.064)	−.061 (.074)	−.050 (.095)	.038 (.142)	−.190* (.109)
Leverage	.004*** (.001)	.005*** (.001)	.004** (.001)	−.000 (.002)	.008** (.003)
Liquidity	−.085*** (.018)	−.108*** (.038)	−.012 (.030)	−.063** (.031)	−.060** (.027)
Profitability	−.006** (.003)	−.008** (.003)	−.015*** (.003)	−.020** (.004)	−.024*** (.005)
Industry carbon intensity	.179*** (.025)	.279*** (.047)	.370*** (.041)	.511*** (.064)	.625*** (.082)
Country Governance (control)					
Economic Development	−.455* (.261)	−.443* (.248)	−.029 (.223)	.232 (.188)	−.127 (.155)
World Gov. Index	−.009* (.005)	−.001 (.005)	−.006 (.004)	−.009 (.007)	.005 (.004)
National culture (control)					
Individualism	−.004* (.002)	−.012*** (.002)	−.006*** (.001)	−.002 (.003)	−.002 (.002)
Long-term Orientation	−.002 (.002)	−.010*** (.001)	−.009*** (.001)	−.003 (.003)	−.009*** (.002)
Indulgence	.008*** (.003)	.002 (.002)	−.003* (.002)	−.000 (.002)	−.004 (.004)
R^2	0.290	0.231	0.211	0.230	0.234

Standard error in parentheses.
***p < 0.01, **p < 0.05, *p < 0.10.

Table 9
Governance Factors and Carbon emissions performance in the SDGs Era.

$N = 1638$	DV: Total Emissions				
Variable	0.20	0.40	0.60	0.80	0.95
Board Meeting	−.002 (.006)	.003 (.005)	−.004 (.004)	−.004 (.006)	−.003 (.004)
Board Independence	.141 (.186)	.192 (.138)	.415*** (.125)	.316 (.329)	.760* (.430)
Board Gender Diversity	−.424 (.287)	−.140 (.172)	−.539** (.263)	−.385 (.432)	−.507 (.437)
CEO Duality	.032 (.057)	−.151*** (.045)	−.301*** (.076)	−.209*** (.073)	−.197** (.084)
ESG-based Compensation	.111*** (.038)	.120* (.063)	.238** (.097)	.241*** (.080)	.098 (.087)
ESG Committee	.250 (.179)	.331** (.149)	.062 (.157)	.011* (.071)	.058 (.126)
Firm characteristics (control)					
Firm Size	1.192*** (.073)	1.093*** (.094)	1.078*** (.156)	.573*** (.128)	.564*** (.138)
Market Presence	−.148* (.084)	−.249*** (.075)	−.267** (.107)	.009 (.123)	−.328** (.155)
Leverage	.001 (.001)	.001 (.002)	−.001 (.002)	−.006** (.003)	−.003 (.003)
Liquidity	−.067* (.034)	−.068* (.035)	.015 (.057)	−.111** (.045)	−.069 (.044)
Profitability	−.009*** (.003)	−.009* (.005)	−.013* (.006)	−.014* (.007)	−.015** (.006)
Industry carbon intensity	.138*** (.048)	.239*** (.063)	.439*** (.087)	.542*** (.126)	.561*** (.101)
Country Governance (control)					
Economic Development	.142 (.151)	.238 (.034)	.030 (.026)	−.385 (.358)	.072 (.353)
World Gov. Index	−.015** (.006)	−.017** (.006)	−.008** (.002)	−.008*** (.002)	.002 (.005)
National culture (control)					
Individualism	−.002 (.003)	−.009*** (.003)	−.006* (.003)	−.000 (.002)	−.008* (.005)
Long-term Orientation	.000 (.003)	−.006** (.003)	−.011*** (.002)	−.008*** (.001)	−.013** (.005)
Indulgence	.000 (.007)	.002 (.006)	−.005 (.003)	−.006*** (.002)	−.007 (.005)
R^2	0.196	0.165	0.168	0.175	0.199

Standard error in parentheses.
***p < 0.01, **p < 0.05, *p < 0.10.

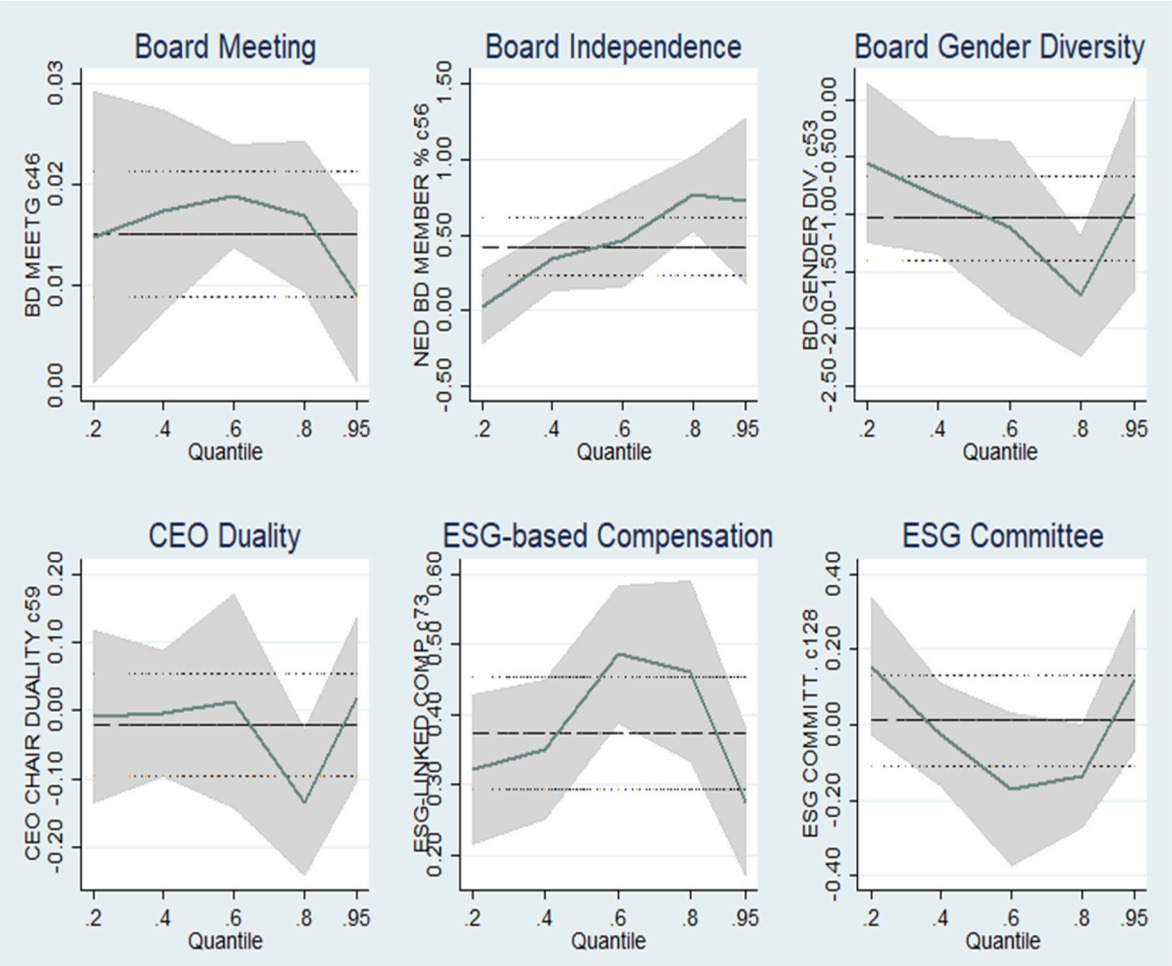

Fig. 4. Relationship between corporate governance mechanisms and carbon emissions rate in the MDGs era.

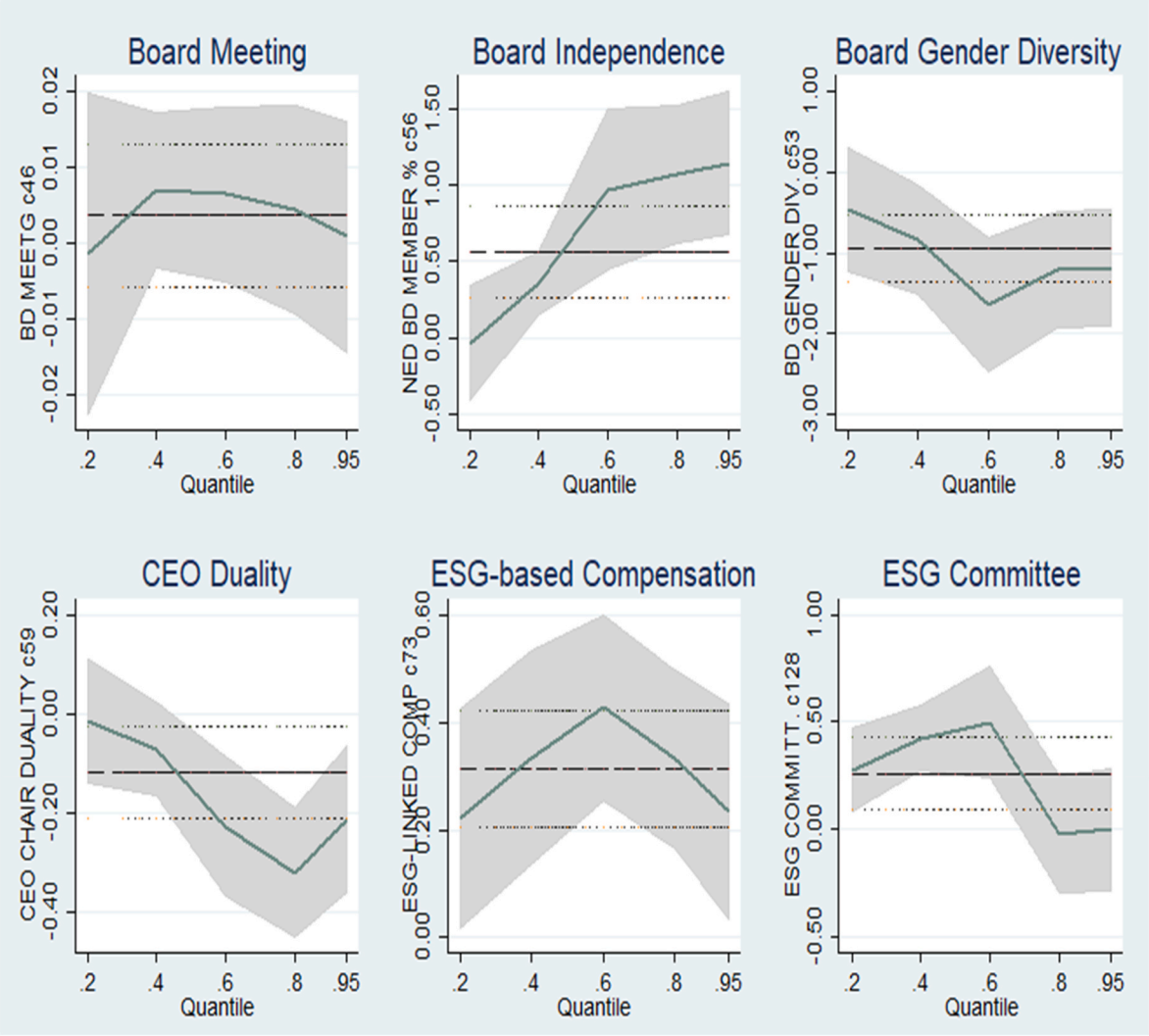

Fig. 5. Relationship between corporate governance mechanisms and carbon emissions rate in the SDGs era.

performance. The result supports the acceptance of H3 and the rejection of H1, H2, H4 and H5. Overall, comparison of the baseline result (Table 5) with robustness check result in Table 12 confirms that the result is robust to endogeneity test.

5. Discussion

5.1. Impact of governance factors on carbon emissions performance

Result shows that board gender diversity, CEO duality, and ESG committee are significantly and negatively associated with carbon emissions rate, with board gender diversity exerting the strongest negative impact (Table 5). The negative influence of board gender diversity on carbon emissions rate aligns with prior studies that gender diversity enhances carbon emissions performance (Tingbani et al., 2020; Elsayih et al., 2021; Konadu et al., 2021). Presence of the ESG committee also contributes to carbon emissions performance by reducing carbon emissions rate as reported in literature (Adel et al., 2019; Elsayed and Ammar, 2020). The negative impact of CEO duality on carbon emissions rate could be interpreted to mean that persons combining both functions of the board Chairperson and the company CEO are able to use their influence to improve carbon emissions performance. In other words, the importance that companies' Chairpersons/CEOs attaches to environmental pollution/carbon emissions influences both the support they give in addressing climate change, as well as how they wield their power/-authority in either supporting initiatives that reduce environmental pollution or exploiting weak environmental regulations to dodge ethical responsibilities in preserving the ecosystem. This makes it important to investigate how CEO characteristics such as education, age, nationality, and experience influence carbon emissions performance.

Further, board independence and ESG-based compensation have significant positive impact on carbon emissions rate (Table 5). The positive impact of board independence, as well as the curvilinear relationship implies that oversized boards (i.e., boards with high concentration of independent/non-executive directors (NEDs) relative to the overall board size) may not be effective, possibly because of ineffective communication, lack of coordination of board activities and/or social loafing tendencies among board members (Wang and Hussainey, 2013). Oversized board may also not be effective possibly because executive directors (who are employees of the companies, responsible for the daily operations of the organisation) may hide beneficial information from NEDs or hoard information that will enable non-executive board members to effectively discharge their duties, especially if executive board members feel monitored.

Positive impact of ESG-based compensation on carbon emissions rate implies that linking executive compensation to environmental performance may be counter-productive. ESG-based compensation may not achieve the desired outcome of improving carbon emissions

Table 10
Governance Factors and Carbon emissions performance, using Scope 1 emissions as alternative measure (Combined for carbon-intensive and non-carbon-intensive industries).

N = 4550	DV: Scope 1 Emissions				
Variable	0.20	0.40	0.60	0.80	0.95
Board Meeting	.012*** (.002)	.008*** (.003)	.006 (.004)	.001 (.004)	.004 (.002)
Board Independence	.249** (.110)	.673*** (.089)	.782*** (.119)	1.170*** (.144)	.543*** (.142)
Board Gender Diversity	−.204 (.182)	−.353* (.173)	−.657*** (.221)	−.789*** (.214)	−.904*** (.297)
CEO Duality	−.006 (.028)	−.045 (.040)	−.147*** (.040)	−.143*** (.043)	−.178*** (.050)
ESG-based Compensation	.098** (.044)	.237*** (.049)	.408*** (.066)	.390*** (.056)	.147*** (.042)
ESG Committee	−.002 (.057)	−.029 (.050)	−.027 (.092)	−.171** (.081)	.028 (.093)
Firm characteristics (control)					
Firm Size	1.119*** (.082)	1.357*** (.059)	1.246*** (.100)	.694*** (.104)	.779*** (.093)
Market Presence	−.161** (.068)	−.438*** (.036)	−.465*** (.096)	−.111 (.098)	−.387*** (.110)
Leverage	.005*** (.001)	.004*** (.001)	.003 (.002)	−.001 (.002)	.002 (.003)
Liquidity	−.177*** (.033)	−.134*** (.025)	−.077** (.039)	−.160*** (.022)	−.196*** (.029)
Profitability	−.004 (.002)	−.010*** (.002)	−.015*** (.005)	−.018*** (.002)	−.015*** (.003)
Industry carbon intensity	.784*** (.042)	.827*** (.046)	1.035*** (.064)	1.078*** (.106)	.627*** (.059)
Era (MDGs Vs SDGs)	−.274*** (.039)	−.161*** (.043)	−.037 (.067)	−.058 (.044)	.040 (.052)
Country Governance (control)					
Economic Development	−.166 (.152)	−.298 (.288)	−.225 (.188)	.097 (.072)	.251 (.188)
World Gov. Index	−.019*** (.004)	−.018*** (.004)	−.012*** (.003)	−.012*** (.002)	.005 (.004)
National culture (control)					
Individualism	.005** (.002)	−.003* (.001)	−.003** (.001)	−.000 (.002)	−.007** (.003)
Long-term Orientation	.002* (.001)	−.003 (.002)	−.008*** (.001)	−.005*** (.001)	−.015*** (.003)
Indulgence	.006* (.003)	.009** (.003)	−.000 (.003)	−.002 (.001)	−.012*** (.002)
R^2	0.267	0.211	0.206	0.204	0.184

Standard error in parentheses.
***p < 0.01, **p < 0.05, *p < 0.10.

Table 11
Governance Factors and Carbon emissions performance, using Scope 2 emissions as alternative measure (Combined for carbon-intensive and non-carbon-intensive industries).

N = 4550	DV: Scope 2 Emissions				
Variable	0.20	0.40	0.60	0.80	0.95
Board Meeting	−.002 (.004)	.002 (.003)	−.001 (.002)	−.003 (.002)	−.004 (.003)
Board Independence	−.083 (.068)	−.063 (.045)	.003 (.066)	−.153 (.105)	−.135 (.151)
Board Gender Diversity	−.625*** (.115)	−.178 (.116)	−.156 (.135)	−.201 (.133)	−.951*** (.217)
CEO Duality	.092** (.036)	.015 (.028)	−.006 (.023)	−.145*** (.034)	−.209*** (.046)
ESG-based Compensation	.079*** (.019)	.045** (.022)	.088*** (.031)	.122*** (.033)	.099** (.045)
ESG Committee	.150*** (.051)	−.012 (.049)	−.069** (.030)	−.024 (.054)	−.356*** (.110)
Firm characteristics (control)					
Firm Size	1.159*** (.037)	1.124*** (.038)	1.079*** (.038)	.797*** (.041)	.341*** (.076)
Market Presence	−.052 (.033)	−.122*** (.023)	−.169*** (.024)	−.076** (.036)	.261*** (.047)
Leverage	.001*** (.000)	.000 (.001)	.000 (.001)	.001 (.001)	.001 (.001)
Liquidity	−.018 (.013)	−.026 (.019)	.019* (.010)	.015 (.014)	−.080*** (.015)
Profitability	−.005*** (.002)	−.002* (.001)	−.002 (.002)	−.002 (.002)	−.009*** (.003)
Industry carbon intensity	−.005 (.024)	.025 (.020)	.055*** (.021)	.243*** (.029)	.395*** (.063)
Era (MDGs Vs SDGs)	−.140*** (.028)	−.104*** (.026)	−.085*** (.022)	−.038 (.029)	.007 (.049)
Country Governance (control)					
Economic Development	−.089 (.121)	−.107 (.114)	.238** (.114)	.416*** (.155)	.005 (.105)
World Gov. Index	−.003 (.003)	.001 (.002)	−.005*** (.002)	−.002 (.002)	−.001 (.002)
National culture (control)					
Individualism	−.000 (.001)	−.005*** (.001)	−.007*** (.001)	−.008*** (.001)	−.003* (.001)
Long-term Orientation	−.000 (.001)	−.005*** (.001)	−.002*** (.001)	−.005*** (.002)	−.005*** (.001)
Indulgence	.004* (.002)	.001 (.002)	.005*** (.001)	.002 (.002)	.001 (.002)
R^2	0.256	0.254	0.220	0.186	0.164

Standard error in parentheses.
***p < 0.01, **p < 0.05, *p < 0.10.

performance if executive directors feel that carbon emissions targets are too high or not achievable, thus demotivating performance (Spierings, 2022), or if the performance metrics are not sufficiently linked to the areas of improvement desired, thereby leading to rewarding executives for wrong behaviour (Moats et al., 2022). The positive impact may also be due to the nascent nature of ESG-based compensations (Okafor and Ujah, 2020; Lu and Wang, 2021).

Whilst the positive impact of firm size aligns with literature that large sized firms have higher carbon emissions rate and a greater burden to address environmental pollution (Zhang et al., 2021), the negative impact of market presence aligns with the stakeholder-legitimacy theory that globally visible firms have a higher propensity to curtail their carbon emissions levels and environmental pollution rate as a strategy for gaining stakeholders acceptance and preserving corporate legitimacy (Luo et al., 2012; Rudyanto and Veronica Siregar, 2018). The significant positive impact of leverage on carbon emissions rate on one hand, and the negative impact of liquidity on the other hand corroborate the argument of scholars that the availability of liquid assets and financial resources affect the ability of organisations to implement environmental sustainability projects (Kamarudin et al., 2021; Zhang et al., 2021). The significant negative impact of profitability on carbon emissions also aligns with extant literature that highly-profitable firms have more

Table 12
Instrumental Variable Regression Result on impact of Governance Factors on Carbon emissions performance (Combined for carbon-intensive and non-carbon-intensive industries).

$N = 4550$	Total Emissions	Scope 1 Emissions	Scope 2 Emissions
Board Meeting	.003 (.002)	.006** (.003)	−.002 (.002)
Board Independence	.421*** (.093)	.771*** (.125)	.070 (.074)
Board Gender Diversity (instrumented)	−1.635*** (.385)	−1.853*** (.510)	−1.483*** (.309)
CEO Duality	−.088*** (.026)	−.116*** (.035)	−.025 (.021)
ESG-based Compensation	.290*** (.029)	.362*** (.038)	.150*** (.023)
ESG Committee	.029 (.044)	.032 (.059)	.023 (.035)
Firm characteristics (control)			
Firm Size	.901*** (.041)	.950*** (.054)	.913*** (.033)
Market Presence	−.135*** (.044)	−.305*** (.058)	−.065* (.034)
Leverage	.002*** (.001)	.004*** (.001)	.001 (.001)
Liquidity	−.074*** (.015)	−.154*** (.020)	−.015 (.012)
Profitability	−.013*** (.002)	−.014*** (.002)	−.003** (.001)
Industry carbon intensity	.369*** (.024)	.812*** (.040)	.130*** (.023)
Era (MDGs Vs SDGs)	−.003 (.046)	−.009 (.061)	.002 (.036)
Country Governance (control)			
Economic Development	−.055 (.102)	−.124 (.134)	.131 (.082)
World Gov. Index	−.007*** (.001)	−.016*** (.002)	−.003 (.001)
National culture (control)			
Individualism	−.001 (.001)	.003* (.002)	−.001 (.001)
Long-term Orientation	−.006*** (.001)	−.002* (.001)	−.002*** (.001)
Indulgence	−.000 (.001)	.004** (.002)	.003** (.001)
R^2	0.309	0.335	0.318

Standard error in parentheses.
***p < 0.01, **p < 0.05, *p < 0.10.

economic resources to implement greenhouse gas emissions reduction strategies (Al-Shaer et al., 2021).

5.2. Impact of corporate governance on carbon emissions performance based on industry carbon intensity

Result shows that whilst board gender diversity and CEO duality have significant negative impact on carbon emissions rate, the impact of board meeting, board independence and ESG-based compensation is significant and positive in the Carbon-Intensive industries (Table 6). Although the coefficients of ESG committee are negative in some quantiles 0.40 to 0.80 in the carbon-intensive industries, the impact is not statistically significant (Table 6). This implies that the ESG committee has the potential to improve carbon emissions performance, provided the committee is reinvigorated by strengthening the independence of the committee, as well as improving the skills of committee members on environmental sustainability issues. Relatedly, the negative but insignificant impact of board meetings in quantiles 0.80 and 0.95 (Table 6) implies that holding regular board meetings can be an effective strategy for improving carbon emissions performance, given that such meetings are used as avenues to thrash out environmental issues (Bukair and Rahman, 2015). Also, the positive impact of board meetings in quantiles 0.20 and 0.40 (Table 6) suggests that it is not the mere convening of meetings (in an effort to fulfil statutory obligations of holding pre-determined number of meetings per annum) that matters, but it is active engagement on environmental issues during such meetings that yields the desired outcome of achieving zero-carbon emissions. In essence, carbon emissions management should be accorded importance in board meetings to promote environmental performance.

Result shows that board meeting, board gender diversity and CEO duality have significant negative impact on carbon emissions in the non-carbon-intensive industries, whilst the impact of ESG-based compensation is positive (Table 7). Although board independence has negative but insignificant impact in the lower quantiles (0.20 and 0.40), it has the greatest significant positive impact in quantile 0.80. The negative but insignificant impact of board independence in the lower quantiles (0.20 and 0.40) in the non-carbon-intensive industries (Table 7) suggests that although board independence can improve carbon emissions performance, the board has to be well constituted in terms of (a) injecting a reasonable number of experienced independent directors/NEDs on board to improve carbon emissions performance, and (b) avoiding oversized board which creates social loafing tendencies. The significant negative impact of board meeting in the non-carbon-intensive industries in Table 7 substantiates the argument that holding regular board meetings can be an effective strategy for improving carbon emissions performance, provided environmental issues are thoroughly addressed in such meetings. The negative but insignificant impact of ESG Committee in quantile 0.95 (Table 7) equally upholds the argument that the ESG committee has the potential to contribute to carbon performance as long as the efficacy of the committee is strengthened.

5.3. Impact of corporate governance factors on carbon emissions performance In the MDGs and SDGs era

Result shows a negative association between the MDGs/SDGs era dichotomy and carbon emissions (Table 5), implying that United Nations agenda for sustainable development significantly affected carbon emissions performance of MNEs, with the SDGs era generally witnessing better carbon emissions management in comparison to the MDGs era. This is commendable, in spite of the high carbon emissions rate in the SDGs era as compared to the MDGs era (Table 3).

Whilst board gender diversity, CEO duality and ESG committee have significant negative impact on carbon emissions rate in the MDGs era, the influence of board independence and ESG-based compensation is significantly positive (Table 8). However, in the SDGs era, board gender diversity and CEO duality still exert significant negative impact, whilst board independence, ESG-based compensation and ESG committee wield significant positive influence on carbon emissions rate. The impact of board meeting on carbon emissions rate shifted from a positive insignificant influence in the MDGs era (Table 8) to a negative insignificant influence in the SDGs era (Table 9). Although the impact of board meeting is not statistically significant in the SDGs era, it is commendable that the influence shifted from positive in the MDGs era to negative in the SDGs era, suggesting that company directors may have started engaging actively on environmental issues in the SDGs era, which may have contributed to the slight improvement in carbon emissions performance in terms of diminished carbon emissions rate. The negative but insignificant impact of board meetings on carbon emissions in the SDGs era (Table 9) also suggests that active engagement on environmental issues can contribute to carbon emissions performance of MNEs.

6. Conclusion

This study investigates the impact of corporate governance on carbon emissions performance, with a focus on scope 1 and scope 2 emissions. Six corporate governance factors that have been well documented to affect carbon emissions performance were investigated namely board meeting, board independence, board gender diversity, CEO duality, ESG-based compensation and ESG committee

Result shows that board gender diversity, CEO duality, and ESG committee are negatively associated with carbon emissions rate, whilst board independence and ESG-based compensation have significant positive impact. Whereas board gender diversity and CEO duality have significant negative impact on carbon emissions rate in carbon-intensive industries, the impact of board meeting, board independence and ESG-based Compensation is significant and positive. In the non-carbon-

intensive industries, board meeting, board gender diversity and CEO duality have significant negative impact on carbon emissions rate, whilst the impact of ESG-based compensation is positive. Further, there is a negative association between the MDGs/SDGs era dichotomy and carbon emissions rate, implying that United Nations agenda for sustainable development significantly affected carbon emissions performance of MNEs, with the SDGs era generally witnessing better carbon emissions management in comparison to the MDGs era in spite of the higher emissions level in the SDGs era. The impact of board meeting on carbon emissions rate shifted from a positive insignificant influence in the MDGs era to a negative insignificant influence in the SDGs era. Although the impact of board meeting is not statistically significant in the SDGs era, it is commendable that the influence shifted from positive in the MDGs era to negative in the SDGs era, suggesting that company directors may have started engaging actively on environmental issues in the SDGs era, which may have contributed to the slight improvement in carbon emissions performance.

The positive impact of ESG-based compensation on carbon emissions rate suggests that if executive directors feel carbon emissions targets are too high or not achievable, this may demotivate them from attaining decarbonisation goals. Therefore, metrics of environmental performance targets should be achievable, reliable and sufficiently linked to areas of improvement desired to avoid rewarding wrong behaviour. The positive impact of ESG-based compensation may also be due to the nascent nature of linking executive compensation to environmental targets. Thus, ESG-based compensation is an area organisations may seriously look into to ensure appropriate tying of compensation to achievable targets so that such schemes are not counter-productive in worsening carbon emissions performance rather than improving it. The study therefore calls for an investigation of the nature of executive compensations linked to carbon emissions performance. Drawing from the negative but weak and insignificant impact of ESG committee on carbon emissions rate in carbon-intensive industries, the study recommends strengthening the effectiveness of the ESG committee. Similarly, the weak negative impact of board meetings on carbon emissions rate in carbon-intensive industries underpins the recommendation that board meetings should be used as a platform to satisfactorily address environmental sustainability issues. Carbon emissions matters should be accorded the required level of importance in the agenda for board meetings.

The study contributes to knowledge in several ways. First, it adds to the limited literature on the determinants of carbon emissions reduction in an international context. The study analysed international sample of 336 top MNEs operating in 42 non-financial industries from 32 countries over a 15-year period, thus enhancing generalisability of results. Second, the current study is also important in resolving some of the mixed results reported by prior studies. Whilst the discrepancies in the result of prior studies may not be unconnected to methodological differences, sample size, and location/countries where studies were carried out/ samples were selected, among other considerations, the current study seeks to resolve the discrepancies by conducting an inter-country study, using larger sample size of top MNEs. It is believed that such an approach could close some of the observed gaps in literature. The study uniquely addresses mixed result reported in prior studies in two ways: one, it shows that the impact of corporate governance factors on carbon emissions vary based on industry carbon intensity and MDGs/SDGs era. Whereas, prior studies generally reported the impact on governance factors on carbon emissions performance, the current study shows that the impact varies by industry carbon emissions intensity/environmental sensitivity, as well as over the MDGs/SDGs periods. Two, it uses panel quantile regression analysis to demonstrate that the relationship between corporate governance and carbon emissions rate is curvilinear, whereas most prior studies have overlooked the possibility of a non-linear relationship by analysing data using linear models. Few related studies have applied quantile regression. The current study adds to the limited literature using a novel method.

Third, whilst most studies have concentrated on a single country, and economic or geographic region, the few studies that have investigated the corporate governance/carbon emissions reduction nexus in an inter-country context did not disaggregating carbon emissions performance into MDGs and SDG periods. The study adds to knowledge on the governance factors affecting carbon emissions performance in the MDGs and SDGs periods, thus providing evidence on progress MNEs are making towards addressing climate change challenges through carbon emissions management.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

References

Adams, R.B., 2016. Women on boards: the superheroes of tomorrow? Leadership Quart. 27 (3), 371–386. https://doi.org/10.1016/j.leaqua.2015.11.001.

Adel, C., Hussain, M.M., Mohamed, E.K.A., Basuony, M.A.K., 2019. Is corporate governance relevant to the quality of corporate social responsibility disclosure in large European companies? Int. J. Account. Inf. Manag. 27 (2), 301–332. https://doi.org/10.1108/IJAIM-10-2017-0118.

Agyemang, A.O., Yusheng, K., Ayamba, E.C., 2020. Impact of board characteristics on environmental disclosures for listed mining companies in China. Environ. Sci. Pollut. Control Ser. 27, 21188–21201. https://doi.org/10.1007/s11356-020-08599-2.

Albers, C., Günther, T., 2011. Disclose or not disclose : determinants of social reporting for STOXX Europe 600 firms. J. Management Control 21 (1), 323–347. https://doi.org/10.1007/s00187-010-0113-4.

Al-Shaer, H., Albitar, K., Hussainey, K., 2021. Creating sustainability reports that matter: an investigation of factors behind the narratives. J. Appl. Account. Res. https://doi.org/10.1108/JAAR-05-2021-0136.

Baboukardos, D., 2017. Market valuation of greenhouse gas emissions under a mandatory reporting regime: evidence from the UK. Account. Forum 41 (3), 221–233. https://doi.org/10.1016/j.accfor.2017.02.003.

Banerjee, S., Khan, M.A., Husnain, M., 2021. Searching appropriate system boundary for accounting India's emission inventory for the responsibility to reduce carbon emissions. J. Environ. Manag. 295 https://doi.org/10.1016/j.jenvman.2021.112907.

Brammer, S., Pavelin, S., 2008. Factors influencing the quality of corporate environmental disclosure. Bus. Strat. Environ. 17 (2), 120–136. https://doi.org/10.1002/bse.506.

Branco, M., Rodrigues, L., 2008. Communication of corporate social responsibility by Portuguese banks: a legitimacy theory perspective. Corp. Commun. Int. J. 11 (3), 232–248.

Bukair, A.A., Rahman, A.A., 2015. The effect of the board of directors' characteristics on corporate social responsibility disclosure by Islamic banks. J. Manag. Res. 7 (2), 506–519.

Chithambo, L., Tauringana, V., 2017. Corporate governance and greenhouse gas disclosure: a mixed-methods approach. Corp. Govern. 17 (4), 678–699. https://doi.org/10.1108/CG-10-2016-0202.

Coad, A., Rao, R., 2008. Innovation and firm growth in high-tech sectors: a quantile regression approach. Res. Pol. 37 (4), 633–648. https://doi.org/10.1016/j.respol.2008.01.003.

Cuadrado-Ballesteros, B., Bisogno, M., 2020. Public sector accounting reforms and the quality of governance. Publ. Money Manag. 41 (2), 107–117. https://doi.org/10.1080/09540962.2020.1724665.

Disli, M., Yilmaz, M.K., Mohamed, F.F.M., 2022. Board characteristics and sustainability performance: empirical evidence from emerging markets. Sustain. Accounting, Manag. Policy J. https://doi.org/10.1108/SAMPJ-09-2020-0313.

Dong, Y., Zhao, Y., Zhang, J., Liu, P., 2022. Development of a framework of carbon accounting and management on the township level in China. J. Environ. Manag. 318 https://doi.org/10.1016/j.jenvman.2022.115609.

Doni, F., Corvino, A., Martini, S.B., 2021. Corporate governance model, stakeholder engagement and social issues evidence from European oil and gas industry. Soc. Respons. J. https://doi/10.1108/SRJ-08-2020-0336.

Elsayed, N., Ammar, S., 2020. Sustainability governance and legitimisation processes: Gulf of Mexico oil spill. Sustain. Account. Manag. Pol. J. 11 (1), 253–278. https://doi.org/10.1108/SAMPJ-09-2018-0242.
Elsayih, J., Datt, R., Tang, Q., 2021. Corporate governance and carbon emissions performance: empirical evidence from Australia. Australas. J. Environ. Manag. 28 (4), 433–459. https://doi/10.1080/14486563.2021.1989066.
Erin, O.A., Bamigboye, O.A., Oyewo, B., 2022. Sustainable development goals (SDG) reporting: an analysis of disclosure. Journal of Accounting in Emerging Economies. https://doi.org/10.1108/JAEE-02-2020-0037.
Fama, E.F., Jensen, M.C., 1983. Agency problems and residual claims. J. Law Econ. 26 (2), 327–349.
Fernhaber, S.A., Patel, P.C., 2012. How do young firms manage product portfolio complexity? The role of absorptive capacity and ambidexterity. Strategic management J. 33 (13), 1516–1539. https://doi.org/10.1002/smj.1994.
Gallego-Álvarez, I., Ortas, E., 2017. Corporate environmental sustainability reporting in the context of national cultures: a quantile regression approach. Int. Bus. Rev. 26, 337–353. https://doi.org/10.1016/j.ibusrev.2016.09.003.
García-Sánchez, I., Suárez-Fernández, O., Martínez-Ferrero, J., 2019. Female directors and impression management in sustainability reporting. Int. Bus. Rev. 28, 359–374. https://doi.org/10.1016/j.ibusrev.
Ghosh, R., Wolf, S., 2021. Hybrid governance and performances of environmental accounting. J. Environ. Manag. 284 https://doi.org/10.1016/j.jenvman.2021.111995.
Gould, J.A., Kulik, C.T., Sardeshmukh, S.R., 2018. Trickle-down effect: the impact of female board members on executive gender diversity. Human Resour. Manag. 57 (4), 931–945. https://doi.org/10.1002/hrm.21907.
Haans, R.F.J., Pieters, C., He, Z.-L., 2016. Thinking about U: theorizing and testing U- and inverted U-shaped relationships in strategy research. Strat. Manag. J. 37, 1177–1195. https://doi.org/10.1002/smj.2399.
Haque, F., Ntim, C.G., 2018. Environmental policy, sustainable development, governance mechanisms and environmental performance. Bus. Strat. Environ. 27, 415–435.
Harun, M., Hussainey, K., Kharuddin, K., Farooque, O., 2020. CSR disclosure, corporate governance and firm value: a study on GCC Islamic Banks. Int. J. Account. Inf. Manag. 28 (4), 607–638. https://doi.org/10.1108/IJAIM-08-2019-0103.
Ioannou, I., Serafeim, G., 2012. What drives corporate social performance? International evidence from social, environmental and governance scores. J. Int. Bus. Stud. 43 (9), 834–864.
Kamarudin, K.A., Ariff, A.M., Wan Ismail, W.A., 2021. Product market competition, board gender diversity and corporate sustainability performance: international evidence. J. Financ. Report. Account. https://doi.org/10.1108/JFRA-01-2021-0020.
Kassinis, G., Panayiotou, A., Dimou, A., Katsifaraki, G., 2016. Gender and environmental sustainability: a longitudinal analysis. Corp. Soc. Responsib. Environ. Manag. 23, 399–412. https://doi.org/10.1002/csr.1386.
Kend, M., 2015. Governance, firm-level characteristics and their impact on the client's voluntary sustainability disclosures and assurance decisions. Sustain. Accounting, Manag. Policy J. 6 (1), 54–78. https://doi.org/10.1108/SAMPJ-12-2013-0061.
Konadu, R., Ahinful, G.A., Boakye, D.J., Elbardan, H., 2021. Board Gender Diversity, Environmental Innovation and Corporate Carbon Emissions. *Technological Forecasting and Social Change*. https://doi.org/10.1016/j.techfore.2021.121279.
Kumar, K., Kumari, R., Nandy, M., Sarim, M., Kumar, R., 2022. Do Ownership Structures and Governance Attributes Matter for Corporate Sustainability Reporting? an Examination in the Indian Context. Management of Environmental Quality. https://doi.org/10.1108/MEQ-08-2021-0196.
Lee, B.O., Li, M.L., 2012. Diversification and risk-adjusted performance: a quantile regression approach. J. Bank. Finance 36 (7), 2157–2173.
Lenssen, J.-J., Dentchev, A., N, Roger, L., 2014. Sustainability, risk management and governance: towards an integrative approach. Corp. Govern. 14 (5), 670–684. https://doi.org/10.1108/CG-07-2014-0077.
Liao, L., Luo, L., Tang, Q., 2015. Gender diversity, board independence, environmental committee and greenhouse gas disclosure. Br. Account. Rev. 47 (4), 409–424.
Liu, C., 2018. Are women greener? Corporate gender diversity and environmental violations. J. Corp. Finance 52 (October), 118–142. https://doi.org/10.1016/j.jcorpfin.2018.08.004.
Lu, J., Herremans, I.M., 2019. Board gender diversity and environmental performance: an industries perspective. Bus. Strat. Environ. 28 (7), 1449–1464. https://doi.org/10.1002/bse.2326.
Lu, J., Wang, J., 2021. Corporate governance, law, culture, environmental performance and CSR disclosure: a global perspective. J. Int. Financ. Mark. Inst. Money 70. https://doi.org/10.1016/j.intfin.2020.101264.
Luo, L., Lan, Y.-C., Tang, Q., 2012. Corporate incentives to disclose carbon information: evidence from the CDP global 500 report. J. Int. Financ. Manag. Account. 23 (2), 93–120. https://doi.org/10.1111/j.1467-646X.2012.01055.x.
Malik, M., Shim, E.D., 2022. Empirical examination of the direct and moderating role of corporate social responsibility in top executive compensation. Pac. Account. Rev. 34 (5), 708–727. https://doi.org/10.1108/PAR-09-2021-0162.
Maroun, W., 2019. Does external assurance contribute to higher quality integrated reports? J. Account. Publ. Pol. 38 (4), 106–120.
Martínez-Ferrero, J., García-Sánchez, I., 2017. Coercive, normative and mimetic isomorphism as determinants of the voluntary assurance of sustainability reports. Int. Bus. Rev. 26, 102–118. https://doi.org/10.1016/j.ibusrev.2016.05.009.
Masud, M.A.K., Nurunnabi, M., Bae, S.M., 2018. The effects of corporate governance on environmental sustainability reporting: empirical evidence from south Asian countries. Asian J. Sustain. Soc. Responsibility 3 (1), 21–26. https://doi.org/10.1186/s41180-018-0019-x.
Moats, M.C., Malone, L., Hamilton, C., 2022. The evolving role of ESG metrics in executive compensation plans. Harvard law school forum on corporate governance. https://corpgov.law.harvard.edu/2022/03/19/the-evolving-role-of-esg-metrics-in-executive-compensation-plans/.
Moussa, T., Allam, A., Elbanna, S., Bani-Mustafa, A., 2020. Can board environmental orientation improve US firms' carbon performance? The mediating role of carbon strategy. Bus. Strat. Environ. 29 (1), 72–86.
Mudiyanselage, N.C.S.R., 2018. Board involvement in corporate sustainability reporting: evidence from Sri Lanka. Corp. Govern.: Int. J. Business Soc. 18 (6), 1042–1056.
Nadeem, M., Bahadar, S., Gull, A., Iqbal, U., 2020. Are women eco-friendly? Board gender diversity and environmental innovation. Bus. Strat. Environ. 29 (8), 3146–3161. https://doi.org/10.1002/bse.2563.
Nuber, C., Velte, P., 2021. Board gender diversity and carbon emissions: European evidence on curvilinear relationships and critical mass. Bus. Strat. Environ. 30 (4), 1958–1992.
Nuskiya, M.N.F., Ekanayake, A., Beddewela, E., Gerged, A.M., 2021. Determinants of corporate environmental disclosures in Sri Lanka: the role of corporate governance. J. Account. Emerg. Econ. 11 (3), 367–394.
Okafor, C.E., Ujah, N.U., 2020. Executive compensation and corporate social responsibility: does a golden parachute matter? Int. J. Manag. Finance 16 (5), 575–598. https://doi.org/10.1108/IJMF-12-2018-0379.
Oyewo, B., Tawiah, V., Hussain, S.T., 2022. Drivers of environmental and social sustainability accounting practices in Nigeria: a corporate governance perspective. Corporate Governance. https://doi.org/10.1108/CG-09-2021-0336.
Peel, M.J., 2018. Addressing unobserved selection bias in accounting studies: the bias minimisation method. Eur. Account. Rev. 27 (1), 173–183. https://doi.org/10.1080/09638180.2016.1220322.
Pekovic, S., Vogt, S., 2020. The fit between corporate social responsibility and corporate governance: the impact on a firm's financial performance. Rev. Managerial Sci. 15 (4), 1–31. https://doi.org/10.1007/s11846-020-00389-x.
Refinitiv (2022). Environmental, Social and Governance Scores From Refinitiv. https://www.refinitiv.com/content/dam/marketing/en_us/documents/methodology/refinitiv-esg-scores-methodology.pdf.
Rudyanto, A., Veronica Siregar, S., 2018. The effect of stakeholder pressure and corporate governance on the sustainability report quality. Int. J. Ethics Systems 34 (2), 233–249. https://doi.org/10.1108/IJOES-05-2017-0071.
Ruggie, J.G., 2018. Multinationals as global institution: power, authority and relative autonomy. Regulation and governance 12 (3), 317–333. https://doi.org/10.1111/rego.12154.
Spierings, M., 2022. Linking executive compensation to ESG performance. Harvard law school forum on corporate governance. https://corpgov.law.harvard.edu/2022/11/27/linking-executive-compensation-to-esg-performance/.
Stock, J., Yogo, M., 2005. Testing for weak instruments in linear IV regression. In: Andrews DWK Identification and Inference for Econometric Models. Cambridge University Press, New York, pp. 80–108.
Suchman, M., 1995. Managing legitimacy: strategic and institutional approaches. Acad. Manag. Rev. 20 (3), 571–610.
Tabachnick, B.G., Fidell, L.S., Ullman, J.B., 2007. Using Multivariate Statistics, vol. 5. Pearson, Boston, MA, pp. 481–498.
Tauringana, V., Moses, O., 2021. Greenhouse gas emissions reporting and management in global top emitting countries and companies. Special issue call for papers for Advances in environmental Accounting and management. https://books.emeraldinsight.com/resources/docs/AEAM%20Vol_%2011%20CFP%202022_Final.pdf.
Tingbani, I., Chithambo, L., Tauringana, V., Papanikolaou, N., 2020. Board gender diversity, environmental committee and greenhouse gas voluntary disclosures. Bus. Strat. Environ. 29 (6), 2194–2210. https://doi.org/10.1002/bse.2495.
Ullah, S., Zaefarian, G., Ullah, F., 2021. How to use instrumental variables in addressing endogeneity? A step-by-step procedure for non-specialists. Indus. Market. Manag. https://doi.org/10.1016/j.indmarman.2020.03.006.
Union of Concerned Scientists, 2022. Each country's share of CO2 emissions. https://www.ucsusa.org/resources/each-countrys-share-co2-emissions.
United Nations, 2023. United Nations Sustainable Development Goals 2030. Retrieved from. https://www.un.org/development/desa/disabilities/envision2030.html.
Wang, M., Hussainey, K., 2013. Voluntary forward-looking statements driven by corporate governance and their value relevance. J. Account. Publ. Pol. 32 (3), 26–49.
Zahra, S.A., Stanton, W.W., 1988. The implication of board of directors' composition for corporate strategy and performance. Int. J. Manag. 5 (2), 229–237.
Zaman, R., Jain, T., Samara, G., Jamali, D., 2020. Corporate Governance Meets Corporate Social Responsibility: Mapping the Interface. Business & Society. https://journals.sagepub.com/doi/10.1177/0007650320973415.
Zhang, D., Zhang, Z., Ji, Q., Lucey, B., Liu, J., 2021. Board characteristics, external governance and the use of renewable energy: international evidence. J. Int. Financ. Mark. Inst. Money 72. https://doi.org/10.1016/j.intfin.2021.101317.

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