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Board Size as Moderator: Understanding Environmental Practices in Indonesia

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ABSTRACT

Global warming, driven primarily by carbon emissions, poses a critical challenge worldwide, including in Indonesia. In response, the Indonesian government issued Law No. 71 of 2021 to mitigate risks and promote carbon emission reduction. This study examines the influence of media exposure, managerial ownership, and industry type on carbon emission disclosure (CED), employing a quantitative design with purposive sampling of 66 companies from 2020-2022, resulting in 198 data points. CED is assessed through direct greenhouse gas (GHG) emissions, indirect emissions from electricity, and other GHG emissions. Findings reveal an adjusted R-square of 53.9%, with media exposure and industry type significantly impacting CED positively. The study underscores the importance of organizations adopting carbon-friendly initiatives to reduce emissions in business operations. It highlights the need for stronger governmental regulations to enhance corporate awareness and compliance with carbon disclosure practices.

Keywords: *Board Size; Carbon Emission Disclosure; Industry Type; Managerial Ownership; Media Exposure*

1. Introduction

Global warming in Indonesia has a significant and profound impact on climate change. Based on data given by CNBC Indonesia, it has been observed that the rate of global temperature increases between 1980 and 2021 was twice as rapid as in the preceding period. Global warming is the consequence or result of climate change. As per the 2022 report of the Intergovernmental Panel on Climate Change (IPCC), the mean temperature of the earth's surface has risen by around 0.85 degrees Celsius since 1880 (Intergovernmental Panel on Climate Change (IPCC), 2023). The IPCC states that human activities are responsible for 95% of the earth's surface temperature rise. Below is a visual representation of the chronological pattern of temperature fluctuations spanning from 1850 to 2021:

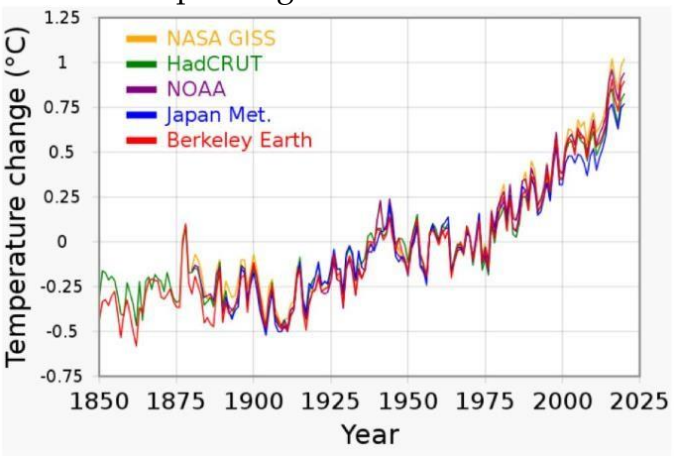

Figure 1. Temperature Change Trend from 1850 to 2021
Source: (Chen et al., 2021)

Climate change occurs because human activities' greenhouse gases (GHG) continue to increase in the earth's atmosphere. According to the head of the Indonesian Agency for Meteorology, Climatology, and Geophysics, Dwikorita Karnawati, on August 26, 2021, the current rise in air temperature in Indonesia is deemed to have induced climatic chaos, resulting in extreme weather characterized by heightened severity, prolonged duration, and increased frequency. According to her, in the absence of adequate mitigating, by 2100, the rise in air temperature in Indonesia is projected to exceed 3°C (Thirafi, 2021). Global warming in Indonesia, accompanied by erratic climate change, brings awareness of the importance of protecting the environment. The company's stakeholders began to demand movements and solutions to this problem (Pitrakkos & Maroun, 2019). The government is encouraged to immediately establish regulations on greenhouse gas emissions and ask corporate entities to take proactive action on carbon emission strategies (Liu et al., 2021).

Corporate disclosure of carbon emissions in Indonesia is not yet widely practiced, as it remains voluntary. However, proactively addressing environmental issues and adopting strategic approaches are crucial for companies to maintain their reputation among stakeholders. Indonesia's Law No. 71 of 2021 and Presidential Regulation No. 98 of 2021 establish the target of reducing greenhouse gas emissions by 29% through domestic efforts and 41% with international support by 2030. Additionally, Indonesia aims to achieve Net Zero Emissions by 2060, or sooner with international assistance (Wirawan & Setijaningsih, 2022).

CED is crucial for showcasing a company's dedication to sustainable and transparent business practices. Carbon emission disclosure reveals information about GHG emissions due to operational activity (Nursulistyo et al., 2022). Typically, these disclosures encompass the complete quantity of emissions, the origins of the emissions, and the measures the organization

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is implementing to diminish those emissions. By publicly revealing carbon emissions, firms showcase their dedication to environmental transparency and responsibility (Destiyuanita et al., 2022). Establishing trust with stakeholders, including investors, customers, and the general public, is crucial. Multiple factors, including media exposure, industry type, and managerial ownership, can influence the disclosure of carbon emissions. In addition, the number of board of commissioners might serve as a moderator variable that impacts the extent of disclosure.

The media exposure can compel corporations to increase their transparency in reporting carbon emissions due to the pressure to publish and the attention they receive from the media (Noh & Park, 2023). In capital markets, the media plays an increasingly vital role as an external organization responsible for monitoring and oversight. As an information intermediary, the media significantly influences information dissemination and directly affects corporations' willingness to disclose information (Ananzeh et al., 2023). Multiple prior studies have established a substantial correlation between media exposure and carbon emissions (Asmeri et al., 2023; Herdiawan & Dewi, 2023). However, past studies have indicated no substantial correlation between media consumption and carbon emissions (Ananzeh et al., 2023; Wirawan & Setijaningsih, 2022).

The nature of the industry can catalyze a corporation to report its carbon emissions publicly. Sectors such as energy, manufacturing, and mining commonly generate significant carbon emissions and are subject to close examination by authorities and the general public (Gerged, 2021). As a result, companies in this industry are frequently motivated to reveal their carbon emissions. Nevertheless, service companies generally exhibit lower carbon emissions and may not encounter the same imperative to reveal their carbon emissions (Velte et al., 2020). Nonetheless, it is still advisable for all sectors to uphold transparency as a best practice. Previous research discovered a substantial correlation between the kind of industry and the disclosure of carbon emissions (Apriliana, 2019; Rusdi & Helmayunita, 2023). However, other research has discovered no substantial correlation between the type of industry and the disclosure of carbon emissions (Meiryani et al., 2023).

Managerial ownership can potentially impact the company's policy on the disclosure of information (Gerged, 2021). Managers who possess shares in a company typically exhibit a higher level of dedication towards implementing transparency and disclosure rules (Elsayih et al., 2018). These policies can potentially enhance the firm's worth and, consequently, the value of its shares. In regards to the impact of managerial ownership on carbon emissions disclosure, there were still conflicting findings. Multiple studies have discovered a strong correlation between managerial ownership and the disclosure of carbon emissions (Budiharta & Kacaribu, 2020; Hamdiyani, 2023). However, other individuals argue that there is no substantial correlation between management ownership and carbon emissions (Ladista et al., 2023; Simamora et al., 2022).

What sets this research apart from past studies is that the CED measurement in this investigation utilized the 18 measuring items employed by Choi et al. by incorporating three greenhouse gas measurement scopes (Choi et al., 2013), so there are 23 items for CED measurement, and there are moderating variables in this study: board size. Due to existing inconsistencies in prior research, it is anticipated that incorporating the board size as a moderating variable can enhance the association between media exposure, managerial ownership, industry type, and carbon emissions disclosure (Apriliana, 2019; Meiryani et al., 2023; Rusdi & Helmayunita, 2023; Setiany et al., 2022). This study incorporates the return on assets (ROA) variables and company size as control variables. This is anticipated to mitigate the exclusion of factors to prevent research results that are influenced by bias.

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2. Literature Review

2.1. Carbon Emission Disclosure

The carbon emission reduction measures utilized in this study are based on the framework developed by Choi et al. and include specific disclosure items. A total of 18 core elements are identified, with six additional items included as per the National Greenhouse and Energy Reporting Act (NGER Act). These supplementary components are critical, as they represent significant advancements in the measurement and reporting of carbon emissions (Choi et al., 2013).

The construction of the Carbon Emission Disclosure (CED) index assigns a score to each disclosure item, where each item is valued at 1 point. The maximum possible score is 23, while the minimum is 0. Companies that disclose all items achieve the highest score of 23. The specific disclosure items are listed in Table 1 (Choi et al., 2013).

Table 1. CED Disclosure Items

Category	Item Code	Description
Climate Change: Risks and Opportunities	CC1	Assessment and characterization of risks (regulatory, physical, or general) related to climate change, along with mitigation plans.
	CC2	Evaluation of current and potential financial impacts, business implications, and opportunities arising from climate change.
GHG Emissions	GHG1	Methodologies used for calculating greenhouse gas emissions.
	GHG2	External verification of greenhouse gas emissions, specifying the verifier and verification purpose.
	GHG3	Total greenhouse gas emissions (in metric tons of CO2 equivalent).
	GHG4	Disclosure of Scope 1 and Scope 2 emissions, or direct and indirect greenhouse gas emissions.
	GHG5	Breakdown of greenhouse gas emissions by sources, such as coal and electricity.
	GHG6	Greenhouse gas emissions are reported at the facility or segment level.
	GHG7	Year-on-year analysis of greenhouse gas emissions trends.
Energy Consumption	EC1	Total energy consumption (measured in terajoules or petajoules).
	EC2	Energy consumption is derived from renewable sources.
	EC3	Breakdown of energy consumption by type, facility, or segment.
GHG Reduction and Cost	RC1	Details of initiatives undertaken to reduce

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Category	Item Code	Description
		greenhouse gas emissions.
	RC2	Specific reduction targets and timelines for greenhouse gas emissions.
	RC3	Emission reductions achieved and their associated costs.
	RC4	Future emissions costs integrated into capital expenditure planning.
Carbon Emission Accountability	AEC1	Identification of board members or executives responsible for climate-related actions.
	AEC2	Processes conducted by the board or executive team to monitor progress on climate-related goals.
Direct GHG Emissions (Scope 1)	DGE1	Emissions from combustion in owned or controlled boilers, furnaces, vehicles, etc.
	DGE2	Emissions from chemical processes using owned or controlled equipment.
Electricity Indirect GHG Emissions (Scope 2)	EIG1	Emissions are from the generation of electricity purchased by the company.
	EIG2	Emissions occur at facilities where electricity is produced.
Other Indirect GHG Emissions (Scope 3)	OIG1	Emissions from the extraction and production of purchased materials.
	OIG2	Emissions from the transportation of purchased fuels and the use of sold goods and services.

2.2. Media Exposure

Media exposure encompasses the extent and method by which a firm or individual garners notice from many forms of media, including print media, television, radio, and digital platforms like social media and online news sites (Asmeri et al., 2023; Herdiawan & Dewi, 2023). Media exposure refers to the frequency and manner in which the company is reported or discussed. Additionally, it entails evaluating the tone or attitude of the media coverage, which can be categorized as good, negative, or neutral. Media exposure is a dummy variable, assigning a value of 1 to firms that disseminate substantial information regarding carbon emissions through their corporate websites, annual reports, and sustainability reports. The company will score 1 out of 3 if it discloses information about carbon emissions on its corporate website, annual report, and sustainability report. However, if the company only discloses this information in one of the aforementioned media, it will receive a score of 1 out of 3 (Saputri & Fidiana, 2023).

2.3. Type of Industry

Industry type categorizes different economic sectors based on their distinctive traits, production methods, and resulting output. Industry type plays a crucial role in carbon emissions disclosure research as different industrial sectors exhibit varying levels of carbon emissions and regulatory pressures (Gerged, 2021). These factors significantly impact the

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development and implementation carbon emissions disclosure policies and practices. The type of industry is a dummy variable, with a value of one assigned to companies operating in emissions industries such as energy, transportation, raw materials, and utilities, as defined by the Global Industry Classification Standard (GICS). Conversely, a zero value is assigned to companies outside these industries, and their production and operational operations have low carbon intensity.

2.4. Managerial Ownership

Managerial ownership is the term used to describe the ownership of shares in a firm by its managers or executives (Budiharta & Kacaribu, 2020; Lumapow, 2019; Nugroho, 2022). This includes the manager's direct ownership of shares, shares acquired through compensation systems like stock options, and shares owned by the manager's immediate family. Managerial ownership can synchronize the interests of managers with the interests of other shareholders (Simamora et al., 2022). Shareholding managers are inclined to make measures that enhance long-term firm value, including improving transparency in disclosing carbon emissions. Managers who possess shares may exhibit greater concern over the company's reputation among shareholders and the wider public. Consequently, they could be more inclined to actively disclose their carbon footprints to showcase their dedication to sustainable and responsible business operations (Gerged, 2021). This study used managerial ownership as a quantitative measure, determined by dividing the number of shares held by management by the total number of shares issued by the company.

2.5. Board Size

Board size pertains to the numerical count of individuals who serve as members of the board of commissioners or directors within a firm. The board of commissioners or directors is responsible for overseeing and advising management while ensuring that the firm functions optimally for the benefit of shareholders and other stakeholders (Budiharta & Kacaribu, 2020). Expanding the board's dimensions may enhance supervision relating to management, guaranteeing the company's adherence to environmental standards and its dedication to lowering carbon emissions (Nasih et al., 2019). In addition, larger boards typically possess a greater range of knowledge, which might enhance the board's capacity to comprehend and tackle environmental concerns, such as carbon emissions (Velte et al., 2020). Board size (moderating variable) within this research is assessed by calculating the number of board directors, quantified by determining the total count of board members inside the organization.

2.6. Return on Assets

Return on Assets (ROA) is a financial metric that measures the effectiveness of a company in generating profits from its owned assets (Wirawan & Setijaningsih, 2022). ROA is determined by dividing the company's net margin after tax by its mean total assets over a specific time frame. ROA is a comprehensive assessment of how well management utilizes assets to create profits (Christiana, 2020). Companies that have a high ROA demonstrate robust financial success. Strong financial success enables greater allocation of resources towards sustainability initiatives and environmental stewardship, such as the disclosure of carbon emissions (Giannarakis et al., 2017). Transparent and committed companies perform well and adhere to sound governance procedures (Saputri & Fidiana, 2023). This includes the revelation of environmental data, such as carbon emissions, which have the potential to impact a company's standing and the contentment of its stakeholders.

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2.7. Firm Size

Corporation size pertains to the magnitude or extent of a corporation, which can be assessed using diverse criteria such as aggregate assets, revenue, workforce size, or market capitalization (Giannarakis et al., 2017). When studying carbon emissions disclosure, researchers frequently consider firm size a significant factor since it impacts the organization's capacity to handle and reveal information regarding carbon emissions. Major corporations typically possess greater financial and human resources to effectively handle and report information about carbon emissions (Burgwal & Vieira, 2014). They are more likely to embrace ecologically sustainable technologies and adhere to environmental standards (Destiyuanita et al., 2022). The study measured firm size by taking the logarithm of the total assets of each company.

2.8. Firm Size

Empirical research indicates that media exposure, type of industry, and managerial ownership can substantially affect firms' carbon emission disclosure levels. Media exposure intensifies public scrutiny, potentially compelling companies to improve openness in their environmental disclosures. Likewise, the industry type affects disclosure levels, as firms in high-emission sectors frequently encounter more rigorous demands. Managerial ownership may influence company disclosure decisions due to managerial incentives and priorities. Additionally, it is suggested that board size influences these connections, either enhancing or diminishing the effect of the independent variables on carbon emission disclosure. The conceptual framework is illustrated in **Figure 2**:

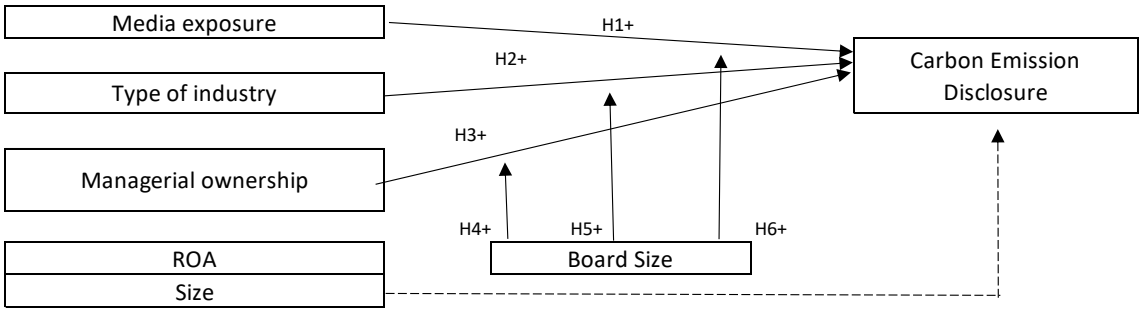

Figure 2. Conceptual Framework: Media Exposure, Industry Type, Managerial Ownership, Board Size, and Carbon Emission Disclosure

The hypotheses of this study are as follows:

H1: Media exposure has a beneficial impact on the disclosure of carbon emissions.
H2: The type of industry has a favorable impact on the disclosure of carbon emissions.
H3: Managerial ownership positively influences the disclosure of carbon emissions.
H4: Existence board size enhances the beneficial impact of media exposure regarding the publication of carbon emissions.
H5: Existence board size enhances the favorable impact of industry type on Carbon Emission Disclosure.
H6: Increasing the number of board members enhances the favorable impact of managerial ownership on carbon emission disclosure.

Legitimacy theory underlies companies disclosing social and environmental responsibility reports, such as one disclosing carbon emissions (Almaeda et al., 2023). Dowling and Pfeffer

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state that organizations try to create compatibility between the social values that exist in their activities and the norms of the social system in which the organization is part of the social system of society (Almaeda et al., 2023). The legitimacy that the company wants to get from the community is that the company's operating activities are following applicable norms and regulations (Hamdiyani, 2023). Legitimacy theory is a conceptual framework employed to comprehend how businesses strive to guarantee that their operations align with the boundaries and norms acknowledged by society and their stakeholders (Hamdiyani, 2023). According to this theory, corporations strive to establish legitimacy by undertaking different acts and disclosing information to obtain support, resources, and societal permission to operate. Companies utilize carbon emissions disclosures to showcase their dedication to environmental sustainability and social responsibility (Dutta & Dutta, 2024). Companies disclose this information to meet stakeholder expectations and enhance their validity.

Media exposure measures the attention and focus a firm receives from the media (Wirawan & Setijaningsih, 2022). This encompasses news, articles, reports, and other media coverage about the company. Media exposure can impact the extent to which corporations disclose information about their carbon emissions in the context of carbon emissions disclosure. Media exposure can enhance management's understanding of the significance of providing environmental information (Setiany et al., 2022). Management cognizant of media exposure's influence on the company's reputation may be more aggressive in overseeing and revealing facts about carbon emissions (Pratiwi & Sari, 2016). The media is crucial in disseminating information to the public in this scenario. Monitoring information about company activities is crucial for maintaining its image and reputation, as the media often scrutinizes it. Conveying favorable information about the company can result in a beneficial influence on the company, and conversely. The aforementioned remark aligns with other prior research findings that indicate media exposure possesses a beneficial effect on the revelation of carbon emissions (Asmeri et al., 2023; Herdiawan & Dewi, 2023; Pratiwi & Sari, 2016; Saputri & Fidiana, 2023; Setiany et al., 2022).

H1: Media exposure possesses a beneficial impact on the disclosure of carbon emissions.

The correlation between industry type and carbon emission disclosure is highly significant because of the varying environmental implications of different economic sectors (Asmeri et al., 2023). Heavy manufacturing or mining industries typically exhibit more carbon emissions than service or technological industries (Meiryani et al., 2023). The connection between the two is evident in the requirement and requests for carbon emission disclosure. Industries that employ industrial processes reliant on fossil fuels or non-renewable energy sources typically exhibit elevated levels of carbon emissions. On the other hand, industries that are more ecologically friendly, such as information technology or financial services, tend to have lower levels of carbon emissions (Apriliana, 2019). Companies are more likely to reveal their business activity if it enhances their reputation.

Wang et al. found that prominent companies with environmentally harmful operations are more likely to provide detailed information about corporate responsibility compared to less prominent companies (Wang et al., 2024). Companies operating in environmentally sensitive industries are more likely to provide more Corporate Social Responsibility (CSR) information, particularly concerning their environmental responsibilities. This is corroborated by prior studies that discovered a notable and favorable impact of industry type on the disclosure of carbon emissions (Apriliana, 2019; Pratiwi & Sari, 2016; Rusdi & Helmayunita, 2023).

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H2: The type of industry has a favorable impact on the disclosure of carbon emissions.

Managers who possess substantial ownership in a firm, such as through stock options or other incentive programs, are vested in the company's performance and reputation. This can motivate individuals to actively participate in environmental legislation and practices, including the revelation of carbon emissions (Gerged, 2021). In conjunction with share ownership, managers are personally incentivized to increase the value of shares and minimize the risk the company faces. This may encompass endeavors to diminish carbon emissions and adopt more sustainable corporate methodologies within an environmental framework. Substantial executive ownership can enhance a company's dedication to social responsibility (Elsayih et al., 2018). Managers who possess shares may have a greater tendency to support progressive environmental legislation and to reveal information about carbon emissions openly. In addition, regarding reputation considerations, managers who possess shares may exhibit greater sensitivity toward the influence of the company's reputation (Velte et al., 2020). Open and honest reporting of carbon emissions and environmentally conscious initiatives can enhance or uphold a company's standing among stakeholders.

Ownership of company shares incentivizes management to engage in decision-making processes actively, prioritizing the company's long-term viability. This includes the disclosure of social information, which can enhance the overall quality and worth of the company. Companies with a significant amount of ownership by managers, particularly in social information, exhibit a higher propensity to engage in voluntary revelation by publicly revealing their carbon emissions. Consistent with prior studies, it was discovered that managerial ownership had a notable and favorable impact on the disclosure of carbon emissions (Budiharta & Kacaribu, 2020; Hamdiyani, 2023).

H3: Managerial ownership positively influences the disclosure of carbon emissions.

Two reasons can incentivize firms to disclose information to the media: (1) Media coverage can enhance public scrutiny on corporations, compelling them to adopt greater transparency regarding their ecological footprints (2) Companies have a tendency to desire to uphold a favorable perception among the general public and investors, so they are more inclined to reveal comprehensive environmental data (Budiharta & Kacaribu, 2020). The composition of the board of directors can significantly influence a company's response to media scrutiny. The board of directors supervises and establishes strategic policies for the organization (Gerged, 2021). More directors in the firm can enhance their capacity to oversee operations, positively influencing the organization's reputation and image. Having a sizable board of directors increases the likelihood of the corporation promptly and openly sharing information with the media regarding carbon emissions. Prior studies have also discovered that the number of board members substantially and favorably impacts the disclosure of carbon emissions (Simamora et al., 2022).

H4: A board size enhances the beneficial impact of media exposure on the disclosure of carbon emissions.

Companies operating in sectors with significant carbon emissions, such as energy, chemicals, and manufacturing, generally experience more stringent regulatory requirements and increased public demand for transparency in reporting their carbon emissions (Asmeri et

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al., 2023). In industries characterized by significant emissions, a larger board of directors can enhance the supervision and responsibility of management in effectively managing and transparently reporting carbon emissions. Boards of larger size have a greater capacity to form specialized environmental committees and guarantee that corporations adhere to more rigorous disclosure requirements (Hamdiyani, 2023). Utilizing a broader board can facilitate organizations in making intricate decisions about carbon emissions control and sustainability plans. They can ensure corporations undertake suitable measures to assess, control, and reveal their carbon emissions (Velte et al., 2020). Companies operating in high-emission industries are more inclined to enhance their disclosure of carbon emissions when they own larger boards of directors. Increasing the board size can enhance supervision, enable the implementation of robust environmental policies, and guarantee adherence to more stringent standards (Waweru, 2020).

H5: The presence of a board size enhances the favorable impact of industry type on Carbon Emission Disclosure.

Managers with ownership stakes in organizations are typically more focused on achieving long-term success and sustainability (Hamdiyani, 2023). This includes being committed to disclosing carbon emissions, as they have financial motivations that align with the company's long-term well-being. Managers who own shares are more inclined to proactively disclose carbon emissions to enhance the company's reputation and mitigate environmental concerns that could impact the value of their shares (Velte et al., 2020). Having a board of commissioners can enhance the oversight of management actions, ensuring that the interests of managers are in line with the interests of broader stakeholders, particularly in terms of environmental transparency. Companies with substantial executive ownership and a big board of commissioners tend to provide more extensive and proactive disclosure of their carbon emissions (Elsayih et al., 2018).

H6: Increasing the number of board size enhances the favorable impact of managerial ownership Regarding Carbon Emission Disclosure

3. Research Methodology

3.1. Research Design

This study adopts a quantitative research approach, utilizing secondary data. The research focuses on companies listed on the Indonesia Stock Exchange (IDX).

3.2. Sampling

A purposive sampling method was employed with the following criteria:

1) Companies in the basic materials and industrial sectors were continuously listed on the IDX from 2020 to 2022.
2) Companies that issued audited financial reports prepared by independent auditors.
3) Companies that provided complete and relevant data for this research.

3.3. Measurement

The operational definitions and measurement indicators for each variable are detailed in **Table 2** below:

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Table 2. Operational Definitions and Indicators

Variable	Operational Definition	Indicators
Carbon Emission Disclosure (CED) (Choi et al., 2013)	Information disclosed by companies regarding greenhouse gas (GHG) emissions is typically presented in annual or sustainability reports.	1) Greenhouse Gas Emissions 2) Energy Consumption, GHG Reduction, and Expenditure 3) Accountability for Carbon Emissions 4) Direct GHG Emissions 5) Indirect GHG Emissions from Electricity 6) Additional Indirect GHG Emissions
Media Exposure (Asmeri et al., 2023)	The extent of media coverage and attention a company receives across print, online, or broadcast formats.	Media exposure is measured using a dummy variable: a value of 1 is assigned if the company discloses carbon emissions in all three platforms (website, annual report, and sustainability report). Partial disclosures receive fractional scores (e.g., 1/3).
Type of Industry (Asmeri et al., 2023)	Classification of the industry sector based on primary attributes and operations.	A dummy variable is assigned: 1 for firms in emissions-intensive industries and 0 for other sectors.
Managerial Ownership (Budiharta & Kacaribu, 2020)	Percentage of company shares held by managers or executives actively involved in management.	Total shares owned by management divided by total outstanding shares.
Board Size (Budiharta & Kacaribu, 2020)	Total number of board members responsible for overseeing and guiding the company's strategic direction.	Calculated as the total count of directors within the firm.
Return on Assets (ROA) (Saputri & Fidiana, 2023)	A profitability metric that evaluates the company's ability to generate net income from its total assets.	ROA = Net Income / Average Total Assets
Company Size (Saputri & Fidiana, 2023)	A measure of the company's magnitude, typically based on total assets, revenue, or employee count.	Quantified using the logarithm of total assets.

3.4. Data Collection

Data collection was conducted systematically to ensure reproducibility and usability for future research. The data was sourced from publicly available information on the IDX, covering the period from 2020 to 2022. This timeframe was selected to identify relevant trends and advancements in carbon emission disclosure.

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3.5. Data Analysis

Data analysis was performed using EViews 12, a sophisticated econometric software designed for advanced statistical testing. The primary analytical technique was multiple regression analysis, which was applied to examine the relationships between the dependent variable (carbon emission disclosure) and independent variables (media exposure, industry type, and managerial ownership). The moderating effect of board size was also evaluated.

Multiple regression analysis was chosen for its ability to assess the impact of multiple predictors on a single dependent variable simultaneously. This method provides a comprehensive understanding of the influence of each independent variable, both individually and collectively, on carbon emission disclosure. Additionally, it facilitates the examination of interaction effects, such as the moderating role of board size, which may strengthen or weaken these relationships.

4. Results

The research sample consisted of 67 companies, yielding a total of 198 data points. **Table 3** summarizes the sample acquisition process:

Table 3. Summary of Sample Size

Description	Amount
Companies in the fundamental materials and industrial sectors consistently listed on the IDX (2020–2022)	123
Companies with audited financial reports prepared by independent auditors	118
Companies with complete and relevant data for this research	66

Source: Prepared by authors

Table 4 provides the descriptive statistics for the variables used in this study:

Table 4. Descriptive Statistics

Variable	Mean	Median	Max	Min	Std. Dev.
CED	7.09	5.00	23.00	0.00	6.88
MEDEX	0.25	0.33	1.00	0.00	0.28
TYPE	0.40	0.00	1.00	0.00	0.49
MGROWN	0.19	0.07	0.80	0.00	0.22
BS	3.98	3.00	15.00	2.00	2.02
ROA	0.01	0.02	0.44	-1.04	0.12
SIZE	26.38	27.31	32.57	15.85	3.46

Source: Data processed using EViews 12

Note:
CED: Carbon Emission Disclosure;
MEDEX: Media Exposure;
MGROWN: Managerial Ownership;
TYPE: Type of Industry;
BS: Board Size;

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ROA: Return on Assets;
SIZE: Firm Size

The standard deviation values for CED, BS, and ROA are smaller than their respective mean values, indicating a homogeneous distribution. This suggests that the population shares similar characteristics for these variables. Conversely, other variables, such as MEDEX and TYPE, have standard deviations exceeding their mean values, suggesting a more diverse distribution and a population with varied attributes.

Consistent with the recommendations of the previous study (Ekananda, 2016; Ghasemi & Zahediasl, 2012; Gujarati & Porter, 2014), the study omitted normality and autocorrelation tests as these are not required for panel data analysis.

The mean CED value is 7, with a maximum value of 23, indicating that only 30% of the sample disclosed detailed information on carbon emissions. These findings highlight that less than half of the companies in the fundamental materials and industrial sectors in Indonesia provide sufficient disclosure. Government regulatory intervention may be required to enhance this level of transparency.

A heteroscedasticity test revealed a probability value of 0.07 ($p > 0.05$), indicating homoscedasticity. Additionally, a multicollinearity test showed that all tolerance values were above 0.10, and all variance inflation factor (VIF) values were below 10, confirming the absence of multicollinearity in the dataset.

Table 5 presents the results of the correlation test, which examines the relationships between the dependent variable (CED) and the independent variables included in the study.

Table 5. Correlation Test

Variable	CED	MEDEX	MGROWN	TYPE	BS	MEDEXBS	MGROWNBS	TYPEBS	ROA	SIZE
CED	1									
MEDEX	0.662**	1								
MGROWN	0.138*	0.074	1							
TYPE	0.566**	0.404**	0.227**	1						
BS	0.240**	0.287**	-0.188**	0.095	1					
MEDEXBS	0.539**	0.817**	-0.071	0.233**	0.667**	1				
MGROWNBS	0.194**	0.099	0.886**	0.262**	0.124	0.068	1			
TYPEBS	0.540**	0.363**	0.111	0.888**	0.327**	0.324**	0.269**	1		
ROA	0.211**	0.083	0.101	0.228**	0.185**	0.129	0.127	0.219**	1	
SIZE	0.083**	0.138*	-0.177**	0.005**	0.086	0.143*	-0.184**	0.051	0.086	1

$p < 0.01$ (**): Highly significant at the 1% level
$p < 0.05$ (*): Significant at the 5% level

Source: Data processed using EViews 12

Note:
CED: Carbon Emission Disclosure;
MEDEX: Media Exposure;
MGROWN: Managerial Ownership;
TYPE: Type of Industry;
BS: Board Size;
ROA: Return on Assets;
SIZE: Firm Size

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The correlation test identifies a strong positive relationship between MEDEX and CED, consistent with the t-test results, which indicate a significant positive effect ($p < 0.05$). Similarly, MGROWN, TYPE, and BS exhibit notable positive correlations with CED. However, an interesting finding emerges: while MGROWN demonstrates a positive correlation with CED, the t-test reveals a negative relationship. This discrepancy highlights the distinction between correlation and regression analyses.

A correlation test measures the direct association between two variables without accounting for the influence of additional variables. In contrast, a regression analysis (as evidenced by the t-test) evaluates the impact of independent variables on the dependent variable while controlling for other factors within the model.

Table 6 presents the hypothesis testing results, including coefficients, significance levels, and multicollinearity diagnostics for each variable.

Table 6. T-Test Results

Variable	Prediction	Coefficient	p-value	Tolerance	VIF
Constant		2.011	0.497		
MEDEX	+	11.647	0.000**	0.170	5.879
TYPE	+	3.051	0.090*	0.130	7.703
MGROWN	+	-1.799	0.695	0.100	9.989
BS	+	-0.139	0.694	0.217	4.605
MEDEX*BS	+	0.254	0.659	0.114	8.798
TYPE*BS	+	0.374	0.349	0.127	7.890
MGROWN*BS	+	0.783	0.514	0.101	9.874
ROA		4.737	0.093	0.891	1.122
SIZE		0.009	0.926	0.914	1.094

$p < 0.05$ (**): Significant at the 5% level
$p < 0.10$ (*): Significant at the 10% level

Source: Data processed using EViews 12

Table 7 summarizes the overall fit of the regression model, including the coefficient of determination, F-statistic, and sample size.

Table 7. Model Summary

Model Summary	Value
R^2	0.560
Adjusted R^2	0.539
F-Statistic	26.693
p-value (F-stat)	0.000
Observations	198

Source: Data processed using EViews 12

The adjusted R^2 value of 0.539 indicates that the independent variables account for 53.9% of the variation in the dependent variable (CED), with the remaining 46.1% attributable to other

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factors not included in the model. Among the independent variables, MEDEX and TYPE demonstrate a substantial positive influence on CED, as indicated by their significant p-values ($p < 0.05$ and $p < 0.10$, respectively).

In contrast, MGROWN does not exhibit a significant effect on CED ($p = 0.695$). According to agency theory, managers with substantial ownership stakes may prioritize profitability and performance over carbon emission disclosures, perceiving such disclosures as an additional cost with no immediate financial benefit. Consequently, managerial ownership may lead to reduced transparency in environmental reporting.

The results also indicate that BS, the moderating variable, does not significantly influence CED. Board size measures the number of members, but it does not account for their quality, expertise, or commitment to environmental concerns. Increasing the number of board members without improving their knowledge or dedication to carbon emission disclosure is unlikely to enhance disclosure practices.

Furthermore, the findings suggest that companies in the sample may not universally prioritize carbon emission disclosures as a strategic objective for their boards. Board members may focus on financial, operational, or other strategic matters, limiting their involvement in environmental transparency initiatives.

5. Discussions

The level of media exposure and the type of industry have a significant and positive impact on carbon emission disclosure (CED). This finding aligns with the previous studies (Apriliana, 2019; Meiryani et al., 2023). Media plays a crucial role in shaping public opinion and raising awareness about environmental issues. Companies receiving substantial media coverage may feel compelled to disclose their carbon emissions in response to heightened public awareness and concern about climate change and its environmental impacts. Firms with high media visibility are particularly motivated to maintain their public image and reputation. Disclosing carbon emission data contributes to fostering a positive reputation as a socially responsible and environmentally conscious corporation. Similarly, industries with a direct environmental impact due to their manufacturing and operational processes are more likely to disclose their carbon emissions proactively.

Contrary to expectations, managerial ownership, which was hypothesized to have a positive effect, shows a negative impact on CED. Legitimacy theory suggests that firms disclose information to gain legitimacy from society and stakeholders. However, managers with substantial ownership stakes may perceive carbon emission disclosure as offering limited benefits to the company's legitimacy, especially if they believe the company has already established sufficient credibility through other initiatives. Furthermore, higher managerial ownership may heighten managers' awareness of the costs associated with carbon emission disclosure, including those related to implementing eco-friendly practices and reporting systems. As shareholders, managers may prioritize cost reduction to maximize profits and enhance the value of their shares. This inverse relationship between managerial ownership and CED can be explained through various theoretical and empirical perspectives. Managers with ownership stakes might prioritize short-term profitability over long-term sustainability goals, reducing their motivation to disclose detailed carbon emission information. Additional research is necessary to explore and validate these mechanisms further under different conditions.

A similar pattern is observed for the moderating effect of board size. The BS variable does not strengthen the relationship between MEDEX, TYPE, and MGROWN on CED. In this study, board size is measured solely by the number of members without considering their

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qualifications or competencies. A lack of knowledge, experience, or commitment to environmental issues and carbon emission disclosure among board members cannot be addressed merely by increasing board size. Further research is required to investigate the effectiveness of boards of directors in this context. Qualitative interviews could provide deeper insights into how boards influence carbon emission disclosure practices.

The findings also reveal that the BS variable, whether treated as an independent or moderating variable, does not have a significant impact on CED. This suggests that board size functions as a moderating homogenizer, indicating that its role as a moderator neither amplifies nor diminishes the relationships between the independent variables and CED.

5.1. Media Exposure Positively Influences Carbon Emission Disclosure

The research findings indicate that media exposure (MEDEX) has a significant positive effect on carbon emission disclosure, with a coefficient of 11.647 and a p-value of 0.000, demonstrating significance at the 5% level. This suggests that increased media exposure correlates with heightened corporate motivation to disclose carbon emissions, likely driven by public pressure and demands for transparency.

5.2. Industry Type Positively Impacts Carbon Emission Disclosure

The industry type (TYPE) shows a coefficient of 3.051 and a significance level of 0.090, indicating a positive influence on carbon emission disclosure, significant at the 10% threshold. Firms in specific industries, particularly those with higher emissions, are more inclined to disclose carbon emissions due to regulatory pressures and stakeholder expectations.

5.3. Managerial Ownership Shows No Meaningful Impact on Carbon Emission Disclosure

Managerial ownership (MGROWN) exhibits a negative coefficient of -1.799 with a p-value of 0.695, indicating no significant effect on carbon emission disclosure. This suggests that managerial ownership does not serve as a direct incentive for disclosure. The lack of significance may stem from divergent priorities between managers and shareholders regarding the perceived benefits of such disclosures.

5.4. Board Size Does Not Enhance the Relationship Between Media Exposure and Carbon Emission Disclosure

The interaction between media exposure and board size (MEDEX*BS) has a coefficient of 0.254 with a significance level of 0.659, indicating that board size does not significantly strengthen the relationship between media exposure and carbon emission disclosure. This suggests that the moderating influence of board size on this relationship is weaker than hypothesized.

5.5. Board Size Does Not Enhance the Relationship Between Industry Type and Carbon Emission Disclosure

The interaction between industry type and board size (TYPE*BS) yields a coefficient of 0.374 and a significance level of 0.349, indicating no significant moderating effect. In this study, board size does not substantially strengthen the relationship between industry type and carbon emission disclosure.

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5.6. Board Size Does Not Strengthen the Effect of Managerial Ownership on Carbon Emission Disclosure

The interaction between board size and managerial ownership (MGROWN*BS) results in insignificant findings, with the coefficient indicating no meaningful enhancement. This suggests that increasing board size does not amplify the impact of managerial ownership on carbon emission disclosure within the context of this study.

The findings highlight that corporations should improve transparency in sustainability reporting due to the significant influence of media exposure on carbon emission disclosure. This strategy can bolster a company's reputation and enhance stakeholder trust. Companies in high-emission industries are encouraged to adopt more robust disclosure practices and invest in sustainable technologies. From a regulatory perspective, enhancing disclosure legislation and leveraging media partnerships can promote greater transparency and compliance. Regulatory bodies can use media-driven public scrutiny to encourage sustainable corporate practices.

This study contributes to environmental disclosure theory, specifically concerning carbon emission disclosure in Indonesian firms. The findings demonstrate that external factors such as media exposure and industry type significantly influence disclosure practices, reinforcing the notion that external pressures are critical drivers of corporate transparency. This aligns with disclosure theory, which posits that companies respond to external pressures to enhance legitimacy and influence stakeholder perceptions.

The study also addresses a theoretical gap by exploring the moderating role of board size, even though the findings indicate a minimal effect. This underscores that the board's role in environmental disclosure is more complex than previously assumed, opening opportunities for further research into the conditions and factors that enhance board effectiveness in promoting transparency. Additionally, this study highlights the importance of contextualizing external factors and corporate attributes in disclosure practices, particularly in developing countries. It also underscores the limitations of board size as a moderating factor, suggesting that structural aspects of governance require further examination.

This research is subject to several limitations. First, its scope is confined to companies in Indonesia's basic materials, industrial, consumer cyclical, and consumer non-cyclical sectors, which may limit the generalizability of findings to industries with different characteristics. Second, the study relies on publicly available financial and sustainability reports, which may contain incomplete or inconsistent data across organizations. These limitations highlight the need for further studies to expand the scope and enhance data reliability.

6. Conclusion

This research highlights the need for the government to establish uniform standards mandating corporations to disclose their carbon emissions. The findings reveal that only 30% of the sample actively engaged in carbon emission disclosure, underscoring a lack of widespread awareness and practice. However, the study's generalizability is limited by the small sample size. Of the 123 companies examined, only 66 provided relevant carbon emission disclosure data. Consequently, the findings cannot be broadly applied to all companies listed on the Indonesia Stock Exchange (IDX).

To overcome the limitations of this study, future research should expand its scope to include additional industrial sectors, particularly those with distinct carbon emission disclosure characteristics. Incorporating a broader range of sectors will enhance the understanding of disclosure practices across different industries. Furthermore, combining secondary data from

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financial and sustainability reports with primary data from interviews with corporate executives or direct surveys can provide deeper insights into the factors influencing carbon emission disclosure. This approach will facilitate a more comprehensive understanding of corporate practices and challenges in promoting transparency.

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