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Carbon Emissions as a Moderator of Board Characteristics and Cost of Debt

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ABSTRACT

This study investigates how carbon emissions moderate the relationship between board characteristics and cost of debt in Indonesia's two-tier corporate governance system. A total of 612 firm-year observations were collected from 204 non-financial companies that were incorporated in the Indonesia Stock Exchange (IDX) from the year 2020 to 2022. Using Moderated Regression Analysis (MRA), the study demonstrates that the cost of debt is unrelated to the number of women on the board and the independence of commissioners. However, this finding indicates that carbon emissions moderate the influence of gender diversity on cost of debt. Employing Robustness Standard Errors, the study's findings are solid. The outcome of this research implies that board members and management may use this information to manage loan expenses by hiring more women. It is suggested that women on the board are more aware of environmental performance, which could lower the cost of debt for companies with low carbon emissions.

Keywords: Board of Comissioners; Board Gender Diversity; Carbon Emission; Cost of Debt.

INTRODUCTION

The cost of capital is a crucial aspect of corporate finance because it aids in making investment decisions, forecasting investment profits, and enhancing a firm's performance (Bruner et al., 1998). Generally, companies seek a low cost of capital to maximize profitability (Sherly & Fitria, 2019) and increase firm value (Salehi et al., 2020; Vo & Ellis, 2017). The cost of capital includes both cost of equity and cost of debt. Cost of debt is considered a cheaper source of funding than cost of equity due to the restrictions on management policies when there is a violation of the agreement, which benefits both shareholders and debtholders (Bharath & Hertzel, 2019). Additionally, the cost of debt offers advantages because corporate income tax can reduce interest costs on debt, there is no dilution of share ownership, and it provides better long-term access to flexibility (Egbadju & Jacob, 2022). Therefore, managing the firm's funding sources through debt is essential to keep the cost of debt under control. Previous studies have identified several factors that minimize the cost of capital, such as dissemination of company information (Albarrak et al., 2019, 2020), social and environmental performance (Chava, 2014; Cheng et al., 2014), and corporate governance (Y. Li et al., 2014; Reza Ashkhabi et al., 2015).

Good corporate governance (GCG) is the practice of ensuring that management operates the company in a responsible, transparent and accountable manner. Companies that consistently apply GCG principles tend to have a management system that is integrity, efficient, and free from conflicts of interest. This is in line with agency theory, which states that agency risk and costs are automatically reduced by reducing the agency conflict between management (agent) and owners (principal) through the implementation of GCG. Literature related to GCG shows that companies with strong governance practices benefit from lower financing costs (Javaid et al., 2023; H. Li, 2019).

Board characteristics are one of the factors that influence corporate governance practices that

lead to the high and low cost of capital. In particular, researchers examined how board structures such as board size, board independence, and board gender diversity can reduce the firm's cost of debt (García & Herrero, 2021), which in turn improves the firm's financial performance (Mihail et al., 2022; Ricotta et al., 2021). However, several studies relating board independence and board gender diversity to the cost of debt show mixed results. The results concluded that the cost of debt can be affected by the presence of independent directors (Aksoy & Yilmaz, 2023; McCumber & Jandik, 2017) or women on the board of directors (Pandey et al., 2020; Usman et al., 2019). In contrast, other studies conclude that there is no relationship between the presence of independent directors (Bacha, 2019; Stefany & Joni, 2020) or women on the board of directors and a decrease in the cost of debt (Benjamin & Biswas, 2019; Gyapong et al., 2021).

Seeing the inconsistencies in previous research indicates that through this study, other factors are needed to clarify further the influence of the relationship between the presence of independent directors and women on debt costs. Thus, this study integrates carbon emissions as a moderator into the previously explored relationship between independent directors, female board members, and debt costs (Aksoy & Yilmaz, 2023; Bacha, 2019; Kamil & Appiah, 2022). Companies with good environmental performance (i.e., low carbon emissions) have a low risk perception for investors and creditors because they can avoid strict regulations, fines and reputational losses. Studies reveal that high financing cost risk leads banks to limit lending and investors to reduce their trust in companies with high carbon emission levels (Giacchetta & Giacometti, 2024; Heo, 2023). Previous studies also demonstrate that carbon emissions positively affect cost of debt (Y. Li et al., 2014; Pizzutilo et al., 2020). Furthermore, the presence of independent and female board members is expected to actively promote the management of carbon emissions through transparent carbon reduction policies.

Additionally, most earlier studies focus exclusively on the one-tier system in Anglo-Saxon countries (Elsayih et al., 2021; Ghouma et al., 2018; Vijayakumaran & Vijayakumaran, 2019). In contrast, this study was conducted in Indonesia, which uses a two-tier system of governance. A one-tier system integrates the roles of management and control in one administrative body, whereas a two-tier system separates these functions into a management board (MB) and a supervisory board (SB). The management board is responsible for the company's operational activities, while the supervisory board oversees and monitors the performance of the management board, provides advice, and ensures accountability. In a one-tier system, objective supervision and assessment of management cannot be done optimally by insider board members (Jouber, 2021). In a two-tier system, the presence of SBs can influence company performance through strategic oversight of management (Joni et al., 2020), offer new perspectives on environmental developments (Millet-Reyes & Zhao, 2010), and validate the accountability and transparency of both boards (Hermawan, 2011).

This study aims to identify the complex interaction among board features on cost of debt, moderated by carbon emissions. Integrating environmental performance factor, such as carbon emissions level, into the relationship between board characteristics and cost of debt represents the novelty of this study. Therefore, this study provides new insights for academics, corporate managers, regulators, and investors to understand the complex dynamics between sustainability, governance, and finance in several ways. To begin with, it enriches the literature on the association between board characteristics (gender diversity and commissioner independence) and financing decisions (cost of debt) in a two-tier governance structure context. In addition, the integration of carbon emissions as a moderating factor provides new theoretical insights into the interplay between environmental sustainability and financial decision-making. Furthermore, this study gives corporate managers essential information about how important it is to control carbon emissions, which might affect the cost of loans. Businesses should think about how their increased carbon emissions may affect the risk perceptions of their creditors. Furthermore, this research provides valuable information and insights for regulators and policymakers in optimizing carbon emission disclosures and beginning to realize sustainability practices as one of the components of good corporate governance. Finally, investors and creditors can add new criteria related to the company's environmental performance practices as one of the assessments in evaluating loan and investment risks. This is very important as awareness of responsible investment from an environmental, social,

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and governance (ESG) perspective continues to grow.

LITERATURE REVIEW

The agency theory states that there is a conflict between the owner (principal) and the manager (agent) caused by information asymmetry and moral hazard (Jensen & Meckling, 2000). For example, a manager may make a decision that could harm the fund providers by allocating excessive investment funds into a high-risk project (Lugo, 2019). This behavior is not in line with the interests of the owners, who expect the manager to make low-risk decisions that can maximize the company's profits. Another form of the agency problem that is found in the literature is the management of earnings. In fact, the research shows that management often practices earnings management to hide the true condition of the company from stakeholders (Elhaj & Mansor, 2019). This earnings management will ultimately have an impact on increasing the cost of debt because creditors have a high-risk perception for companies that manipulate financial statements, especially if the company has a significant amount of debt (Tran, 2024).

Resource dependency theory explains how organizations acquire, manage, and use external resources to sustain their businesses (Gaur et al., 2015). These resources include not only tangible assets such as cash, land, and buildings, but also intangible assets such as information, networks, experience, and knowledge. Studies show that companies that focus on developing the capabilities and knowledge of their human resources are better able to deal with conditions of business uncertainty (Saha & Maji, 2022). In the context of governance, a diverse board is an important asset, as new networks, ideas, and perspectives are useful for strategy development and the organization's ability to manage financial risks, which in turn, lowering the cost of debt.

Stakeholder Theory explains that companies have responsibilities not only to shareholders, but also to all parties affected by the company's activities (stakeholders). According to stakeholder theory, the company's goal is to create long-term value for all stakeholders, minimize risks for them, and achieve long-term success (Freeman, 1984). These parties include investors, creditors, employees, government, and society. In the context of sustainability and finance, companies that pay attention to environmental issues, such as carbon emission reduction, are perceived positively by stakeholders, including creditors, because the company is considered to be committed to sustainable business practices (Chithambo & Tauringana, 2017). Additionally, environmental practices will be considered in the overall risk assessment and determine the lending decisions made by financial institutions as stakeholders. Higher interest rates will be applied to companies with significant carbon footprints (Delis et al., 2024; Maaloul, 2018), effectively increasing the cost of debt.

Hypothesis Development

In two-tier system divides the board structure into, the board of directors (management board) and the board of commissioners (supervisory board) where board independence refers to the board of commissioners in the company's board. The presence of an independent board is expected to provide more objective and effective oversight to control managerial behavior in line with the interests of investors and creditors (Kent Baker et al., 2020; D. Zhang et al., 2021). The independent board plays a vital role in reducing information asymmetry and improving investors and creditors confidence, thereby reducing both risk and the cost of debt (Yeung & Lento, 2018). This argument is reinforced by the results of research showing that board independence is significantly negatively related to cost of debt (Bradley & Chen, 2015; McCumber & Jandik, 2017). In other words, the more board independence in the board structure, the more it reduces the company's cost of debt because the competence of the board independence is considered sufficient to manage the company's performance better. In contrast, other research suggests that board independence is not related to cost of debt (Bacha, 2019; Stefany & Joni, 2020).

H1: Independent board of commissioners has a significant negative effect on cost of debt.

One approach to increasing board diversity is to increase the presence of women on boards. Saha & Maji (2022) state that women's participation in the structure of the board has an important function to enriching the company's resources through human and social capital. First, in terms of

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human capital, women directors are more conservative about high-risk investments (Bernile et al., 2018) and less overconfident (Levi et al., 2014), which increases creativity and decision-making quality (Vieira, 2018). Second, social capital improves communication and relationships with corporate stakeholders, promoting a greater focus on environmental and social responsibility (Hussain et al., 2018). Therefore, women may have an important role with their capital and characteristics that can provide economic and non-economic benefits for the company. Based on this discussion, this research postulates that: Women's contributions may reduce the information gap between borrowing and lending companies, thereby lowering interest rates and effectively decreasing cost of debt (Pandey et al., 2020; Usman et al., 2019). However, some research found that gender diversity is unrelated to cost of debt (Bacha, 2019; Stefany & Joni, 2020).

H2: Gender diversity on the board has a significant negative effect on cost of debt.

The corporate governance is essential for successfully implementing environmental practices because the independent boards tend to be more aware of expensive carbon emission control projects and can advise on long-term environmental investments that reduce the risk of climate mitigation (Liao et al., 2015). Additionally, women's contributions bring a broader perspective such as being more environmentally conscious, compassionate, empathetic, and stakeholder-oriented than men (Kassinis et al., 2016), making them more receptive to stakeholders' demands to reduce carbon emissions (Nuber & Velte, 2021). The stakeholder theory explains that in overall risk assessment and loan decisions, consideration of the company's environmental practices and regular monitoring of carbon emission intensity are required, as failure to manage these properly can increase the cost of debt. High carbon emission intensity requires companies to comply with regulations (Nguyen & Phan, 2020), thereby increasing the costs of limiting their carbon emissions. If this condition continues, it will increase the risk of financial difficulties due to high loan interest rates(Chava, 2014).

In addition, funding companies with carbon-intensive projects can harm the environment, creating a conflict of interest between borrowers and lenders (Jung et al., 2018; Maaloul, 2018). With these conditions, it is enough to prove that it is important for companies to reduce the intensity of carbon emissions because the impact is not only on the environment, but also related to access to funding for companies because of the emergence of demands from stakeholders and creditors. Previous evidence shows that cost of debt are influenced by carbon emissions intensity (Jung et al., 2018; Kumar & Firoz, 2018; Zhou et al., 2018).

H3: The interaction between independent board of commisssioners and cost of debt is strengthened by carbon emissions.

H4: The interaction between gender diversity on the board and cost of debt is strengthened by carbon emissions.

Research Model

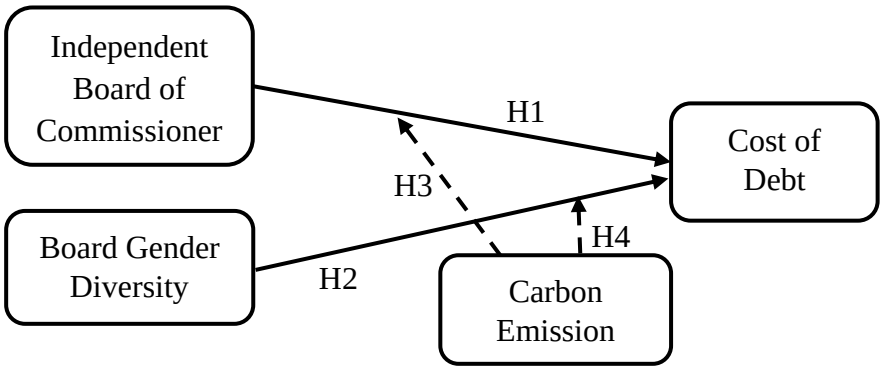

Figure 1 Research Model
Source: The image was created by the authors

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METHOD

The research sample includes 204 non-financial companies listed on the Indonesian Stock Exchange, as represented in Table 1. We do not use the financial sector because it has its own regulations, making its debt financing and capital structure significantly different from those of non-financial companies (Nguyen & Phan, 2020). The final sample of the study consists of 612 firm-year observations over 3 years from 2020-2022. We searched for research data through annual and sustainability reports available on company websites because they provide information about independent commissioners, gender diversity on the board, and carbon emissions. In addition, other data related to debt costs and control variables can be obtained through Refinitiv Eikon - Thomson Reuters.

Table 1. Sample Criteria

Sample Criteria	Total
Total population of non-financial companies listed on IDX	816
Companies that listed on IDX up to 2019	(247)
Companies that do not have carbon emissions information for 2020-2022	358
Companies that have incomplete data obtained for the year 2020-2022	(7)
Total research sample	204
Total data observation between 2020 to 2022	612

Source : Summarized by the researcher

In this analysis, carbon emissions (CE) act as the moderating variable, while board independence (BINDP) and gender diversity on the board (BG) are independent variables. The cost of debt (COD) is the dependent variable. The variables accounted for the control variables consist of carbon emissions (CE), firm size (FS), board size (BS), leverage (LEV) and return on assets (ROA). The measurement of our variables is as follows:

Table 2. Variables Measurement

Variables	Measurement	Source
Cost of Debt (CED)	Pre-tax interest expense divided by the total amount of short- and long-term debt	(Hashim & Amrah, 2016; Usman et al., 2019)
Board Independence (BINDP)	The number of independent directors divided by board size	(Fu et al., 2012; Stefany & Joni, 2020)
Board Gender (BG)	The percentage of women on the board to total board size.	(Nadeem et al., 2020; Tingbani et al., 2020)
Carbon Emission (CE)	Natural log of total scope 1 and scope 2 emissions in metric tons.	(Baboukardos, 2017; Konadu et al., 2022)
Firm Size (FS)	The natural logarithm of total assets	(Aksoy & Yilmaz, 2023; Elsayih et al., 2021)
Board Size (BS)	Natural log of the number of board members	(Aksoy & Yilmaz, 2023; Haque, 2017)
Leverage (LEV)	Ratio of total debt to total assets	(Al-Shaer et al., 2022; Oyewo, 2023)
Return On Assets (ROA)	Return on total assets ratio	(Adel et al., 2019; Elsayih et al., 2021)

Source : Summarized by the researcher

The research design aims to test two independent variables, board independence and board gender, while the dependent variable is the cost of debt, with carbon emissions as a moderating variable. The test is performed using the moderated regression analysis (MRA) method with IBM SPSS Statistics 23. The regression model for hypothesis testing is formulated as follows:

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$$COD = \alpha + \beta 1\, BINDP + \beta 2\, BG + \beta 6\, FS + \beta 7\, BS + \beta 8\, LEV + \beta 9\, ROA + \varepsilon \text{.....(1)}$$

$$COD = \alpha + \beta 1\, BINDP + \beta 2\, BG + \beta 3\, CE + \beta 4\, BINDP * CE + \beta 5\, BG * CE + \beta 6\, FS + \beta 7\, BS + \beta 8\, LEV + \beta 9\, ROA + \varepsilon \text{.....(2)}$$

Information:
COD = Cost of Debt
α = Constant
BINDP = Board Independence
BG = Board Gender
CE = Carbon Emission
FS = Firm Size
BS = Board Size
LEV = Leverage
ROA = Return on Assets

RESULT

Classic Assumption Test. This research shows that the classic assumptions test has been met, including multicollinearity (VIF value < 10 and tolerance value > 0.1), heteroscedasticity tested by the Glejser method (sig. > 0.05), and autocorrelation (1.890 < 1.987 < 2.110), except for normality. The adjusted R square before and after moderation is 4.4% and 6.1%, respectively.

Table 3. Descriptive Statistics

Variables	N	Min	Max	Mean	Std. Deviation
COD	612	-0.002	0.088	0.03904	0.19407
BINDP	612	0.000	0.403	0.19169	0.086742
BG	612	0.000	0.500	0.12793	0.128670
CE	612	3.939	18.311	11.0168	2.753740
FS	612	25.510	33.655	29.4280	1.577754
BS	612	1.386	2.833	2.18297	0.332195
LEV	612	0.000	83.060	24.78974	19.43697
ROA	612	-11.859	20.531	4.50306	7.053210

Notes: COD = cost of debt; BINDP = board independence; BG = board gender; CE = carbon emission; FS = firm size; BS = board size; LEV = leverage; ROA = return on assets; IS = intensive sector.

Table 4 shows the descriptive statistics within 612 data observations, indicating that the cost of debt (COD) expected by investors is generally around 3.9%, with a range of -0.2% to 8.8%. The maximum value of independent commissioners (BINDP) is 40.3%, with an average level of around 19.16%. The variable representing board gender (BG) has a maximum value of 50% and an average of 12.8%. For the moderating variable, carbon emission (CE) has an average value of 11.02%, ranging from 3.9% to 18.3%.

Table 4. Moderated Analysis Regression

Variables	Model I Non-moderation	Model II Moderation
Constant	0.522	0.098
BINDP	0.011	-0.024
Sig. BINDP	(0.223)	(0.484)
BG	0.009	-0.071
Sig. BG	(0.129)	(0.010)
CE		-0.001

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Sig. CE		(0.028)
BINDP*CE		0.003
Sig. BINDP*CE		(0.262)
BG*CE		0.008
Sig. BG*CE		(0.003)*
FS	0.001	0.001
Sig. FS	(0.175)	(0.255)
BS	-0.001	0.000
Sig. BS	(0.790)	(0.961)
LEV	0.000	0.000
Sig. LEV	(0.002)*	(0.007)
ROA	0.000	0.000
Sig. ROA	(0.042)*	(0.051)

Notes: COD = cost of debt; BINDP = board independence; BG = board gender; CE = carbon emission; BINDP*CE = the interaction of board independence and carbon emission; BG*CE = the interaction of board gender and carbon emission; FS = firm size; BS = board size; LEV = leverage; ROA = return on assets; IS = intensive sector. *p < 0.05

According to Table 4, Model I demonstrates that cost of debt is unaffected by board independence (β = 0.011; p = 0.223) and the number of females on board members is unrelated to cost of debt (β = 0.009; p = 0.129). Then, in Model II test the moderating variable of carbon emissions. Model II shows that the influence of independent commissioners on cost of debt cannot be moderated by carbon emissions (β = 0.003; p = 0.262). However, the influence of women on the board and cost of debt can be moderated by carbon emissions (β = 0.008; p < 0.05). Conversely, the test results for the control variables shown in Model I in Table 4 indicate that firm size (β = 0.001; p = 0.175) and board size (β = -0.001; p = 0.790) are not significant for the cost of debt. However. leverage (β = 0.000; p < 0.05) and return on assets (β = 0.000; p < 0.05) significantly influence cost of debt positively.

Table 5. Robustness Test

Variables	**Model I Non-moderation**	**Model II Moderation**
Constant	0.518	0.098
BINDP	0.011	-0.024
Sig. BINDP	(0.225)	(0.522)
BG	0.009	-0.071
Sig. BG	(0.149)	(0.036)
CE		-0.001
Sig. CE		(0.036)
BINDP*CE		0.003
Sig. BINDP*CE		(0.295)
BG*CE		0.008
Sig. BG*CE		(0.015)*
FS	0.001	0.001
Sig. FS	(0.144)	(0.231)
BS	-0.001	0.000
Sig. BS	(0.777)	(0.958)
LEV	0.000	0.000
Sig. LEV	(0.005)*	(0.013)
ROA	0.000	0.000
Sig. ROA	(0.058)	(0.065)

Notes: COD = cost of debt; BINDP = board independence; BG = board gender; CE = carbon emission; BINDP*CE = the interaction of board independence and carbon emission; BG*CE = the interaction of board

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gender and carbon emission; FS = firm size; BS = board size; LEV = leverage; ROA = return on assets; IS = intensive sector. *p < 0.05

This research added additional tests related to robustness tests in Table 5, which shows that in Model I, board independence (β = 0.011; p = 0.235) and board gender diveristy (β = 0.009; p = 0.149) are not related to cost of debt. In Model II, indicates that carbon emission not moderates the relationship between board independence and cost of debt (β = 0.003; p = 0.295), while board gender diveristy to cost of debt is moderated by carbon emission (β = 0.008; p = 0.015). For control variables, it shows in Model I that firm size (β = 0.001; p = 0.144), board size (β = -0.001; p = 0.777), and return on assets (β = 0.000; p = 0.058) are not influence the cost of debt. However, leverage could effected the cost of debt (β = 0.000; p = 0.005).

DISCUSSION

Board Independence And Cost Of Debt. This result rejects H1, which states that board independence has a significant negative effect on cost of debt. This finding is inconsistent with agency theory and with previous studies (Desender et al., 2013), which state that the presence of an independent board can better evaluate financial reports, foster investor confidence, and increase financial transparency, thereby reducing information asymmetry and corporate credit risk (Naseem et al., 2017). However, some research in accordance with the finding of this study (Bacha, 2019; Stefany & Joni, 2020), arguing that board independence has no influence on cost of debt due to doubts about the board's competence in overseeing management performance, which does not significantly affect the quality of the company's financial reporting. Furthermore, the lack of prioritization regarding the importance of independent commissioners' roles in the implementation of good corporate governance often leads to their presence being regarded merely as a regulatory compliance obligation in Indonesia. This can also provide a lesson for companies regarding the importance of selecting an independent board of directors who are proficient in skills, expertise, and experience as independent supervisors.

Board Gender Diversity And Cost Of Debt. Hypothesis H2, which states that a diverse mix of gender on board members has a significant negative effect on cost of debt, is also rejected. This result contrasts with resource dependency theory and with previous studies (Pandey et al., 2020; Usman et al., 2019), which suggest that the presence of women on boards can reduce cost of debt with lower interest rates by minimizing the information gap between borrowers and lenders. However, in the context of corporate governance in Indonesia, the number of women contributing is still low, resulting in a lack of women's roles in the decision-making process (Jonty & Mokoteli, 2015). One of the possible reasons for the lack of women's role in leadership is because Indonesia tends to still have gender-related stereotypes where people perceive that women have a soft and emotional nature that is less suitable as leaders while men are more suitable to be leaders because they have a firm and rational attitude. Additionally, greater gender diversity can lead to more internal conflict and slower decision-making processes (Darmadi, 2013), so companies may not place much importance on the leadership role of women in managing the company.

Carbon Emission, Board Independence, And Cost Of Debt. The influence of independent commissioners on cost of debt cannot be moderated by carbon emissions, thus H3 is not supported. This result contrasts with stakeholder theory and with previous studies (Jung et al., 2018; Maaloul, 2018), which state that lower carbon intensity decreases debt financing costs and that board independence negatively affects cost of debt. A possible reason for this result is that board independence, as a supervisory function, is not directly involved in the company's operational activities, and their presence is still considered an obligation for fulfilling regulations in Indonesia (Stefany & Joni, 2020). Therefore, their contribution to carbon reduction is likely to be insignificant. Additionally, there may be a lack of board independence who are experts in accounting and the environment so that not many companies can realize it because it is hampered by knowledge, technology, and costs (Boiral et al., 2012).

Carbon Emission, Board Gender Diversity, And Cost Of Debt. The result indicates that carbon emissions is consistent with previous research (Jung et al., 2018; Zhou et al., 2018) and strengthens the influence of women's contributions on cost of debt, thus supporting H4. This finding

is consistent with stakeholder theory, which states that more women's contributions provide a more diverse and environmentally oriented perspective, meeting stakeholders' demands for environmental performance. Women's participation on boards can improve environmental performance (Elsayih et al., 2021) because women are more communicative and build connectivity with stakeholders, making them more aware of social and environmental responsibility (Hussain et al., 2018).

The characteristics that women have are an advantage because they are able to meet the demands of stakeholders in reducing carbon emissions so that it will affect loan interest rates which will effectively reduce the cost of debt. Moreover, as a form of corporate responsibility related to reducing carbon emissions, the company's sustainability report will report the intensity of energy use and emissions generated. That way, easy access to carbon emission information can build stakeholder loyalty and trust (Liesen et al., 2015), increase transparency, decrease the information gap between stakeholders and management, and enhance corporate commitment to sustainability practices (Y. J. Zhang & Liu, 2020). This commitment will help the company comply with government regulations regarding the maximum average limit of emissions that must be produced so that the company will not be subject to fines which will have an impact on the company's high costs.

Variables Control And Cost Of Debt. The result shows that firm size and board size are not significant on cost of debt. This is not in line with previous research (Lorca et al., 2011; Pandey et al., 2020) which says that usually companies with large scale and extensive board size have good access to funding and low financial risk. However, in this study, company scale is not a determining factor in accessing funding at a low cost so it is necessary to look at other factors whose impact is related to environmental sustainability. In addition, the greater number of board members in the board structure also allows for communication that may be less effective and hinder the company's decision-making process. The results of this study are supported by research from (Lim, 2011; Xu et al., 2021).

Additionally, the robustness test using Robustness Standard Errors as an alternative test to detect and correct standard errors, making them more robust. In addition, this test is useful for addressing heteroscedasticity and autocorrelation issues. The results of robustness test in this research is consistent with the main analysis, except for the return on assets.

This study has several limitations and suggestions. To begin with, the research sample is limited because it does not use the financial sector so that future research can expand the research sample for financial companies. Additionally, many companies do not have carbon emission information and some company websites are difficult to access. Therefore, future research can use other alternative carbon emission database sources, such as the Carbon Disclosure Project (CDP). Furthermore, we need to be careful in interpreting the interaction test results for moderating variables. With the same issue, understand well the relationship for each variable and look for several research models with similar test results to adjust the interpretation. Subsequently, in this study the board characteristic variable is only limited to the quantity of the board structure so that future studies may be able to examine the quality of the board such as experience, expertise, and the level of independence of board members.

CONCLUSION

This paper aims to shed lights on the workings of corporate governance within the context of Indonesia's two-tier system. More specifically, it focuses on the interplay of board characteristics, carbon emissions, and cost of debt. The findings revealed that the emission of carbon and the reduction of gender diversity in boards has a positive impact on the cost of debt. This demonstrates that women's contribution to the leadership of corporations is not limited to her being an different from a man, but extends also to being able to reduce the cost of business financing for the company, especially when such financing is availed through debts. Therefore, women's participation on the board can reduce cost of debt in companies that are able to reduce their carbon emission intensity.

This result suggests that companies in Indonesia not only need to increase women's participation in leadership roles but also start considering environmental performance to obtain long-term financial benefits. The advantages of women's characteristics enable better management of

environmental performance, leading to more transparency and accountability in reporting environmental responsibilities to external parties. Additionally, building a positive image as an entity that cares about the environment and supports public policies, such as the Kyoto Protocol, is an effort made by various countries to reduce carbon intensity and mitigate climate change.

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