

THE EFFECT OF CARBON EMISSION INTENSITY, GREEN INVESTMENT AND CSR DISCLOSURE ON FINANCIAL PERFORMANCE WITH GOOD CORPORATE GOVERNANCE AS A MODERATING VARIABLE (STUDY ON ENERGY AND MINING SECTOR COMPANIES LISTED ON THE IDX 2019-2024)

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Abstract

This study aims to examine the effect of Carbon Emission Intensity, Green Investment, and Corporate Social Responsibility Disclosure on financial performance, with Good Corporate Governance proxied by the Board of Directors as a moderating variable. This study is motivated by the increasing global pressure on sustainability issues, especially in the energy and mining sectors which have a large contribution to carbon emissions. Sustainability strategies such as green investment and CSR disclosure are seen as solutions to environmental and reputational risks. However, previous studies have shown inconsistent results regarding their effect on financial performance. This study uses a quantitative approach with panel data regression methods and Moderated Regression Analysis on energy and mining sector companies listed on the Indonesia Stock Exchange for the period 2019–2024. The results show that Carbon Emission Intensity has a significant negative effect on financial performance, while Green Investment has a significant positive effect. Meanwhile, CSR disclosure has no significant effect. In terms of moderation, the Board of Directors does not moderate the relationship between CEI and CSRD on financial performance, and actually weakens the effect of Green Investment on financial performance. This finding indicates the need to strengthen sustainability capacity at the board level so that environmental policies can be implemented strategically and have an impact on company performance.

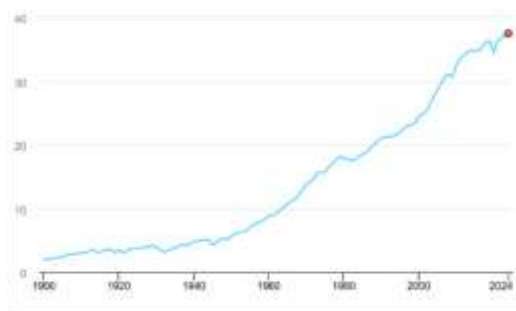
Keywords: Carbon Emission Intensity, Green Investment, Corporate Social Responsibility Disclosure, Financial Performance, Good Corporate Governance

INTRODUCTION

Financial performance is one of the important indicators in assessing the operational success of a company because it reflects the effectiveness of management and business achievements. Apart from being the main objective, financial performance is also used as a basis by management to evaluate and formulate future strategies. However, along with economic developments and increasingly complex global issues, the company's orientation is no longer only focused on profit, but also pays attention to sustainability through a triple bottom line approach, namely profit, people, and planet (Budiawan, 2019). This approach encourages companies to care more about environmental and social aspects in every business activity.

Environmental issues are a major concern globally, particularly regarding the increase in carbon dioxide (CO₂) emissions which have a major impact on climate change.

Figure 1. Global CO₂ Emissions Graph



Source: International Energy Agency (IEA)

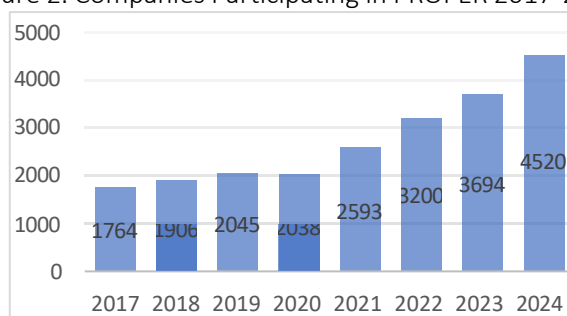
Based on a report from the International Energy Agency (IEA), carbon dioxide (CO₂) emissions resulting from energy combustion and industrial processes have increased significantly over the past few decades. In 2024, total global emissions reached a historic high of 37.6 billion tons of CO₂. Of this amount, the energy sector is the main contributor with a proportion of 75.7% of total global emissions (World Resources Institute, 2025). In Indonesia itself, CO₂ emissions in 2023 were recorded at 733.23 million tons, and are estimated to increase to 1.4 Giga Tons of CO₂ equivalent in 2030 (LCDI, 2024). This condition is exacerbated by the high dependence on coal-based energy, especially in the energy and transportation sectors. Therefore, the energy and mining sectors have a strategic role in supporting the transition to a cleaner and more sustainable energy system.

To address the problem of carbon emissions, the Indonesian government has formulated various strategic policies, one of which is through Presidential Regulation No. 61 and 71 of 2011 which aims to encourage business involvement in reducing greenhouse gas emissions. This involvement can be realized through corporate transparency in disclosing carbon emissions in sustainability reports. One indicator that is often used to assess the environmental efficiency of a company's operations is Carbon Emission Intensity (CEI), which is the ratio of carbon emissions to the output produced (Vaicondam et al., 2025). However, studies on the effect of CEI on financial performance still show inconsistent results, some find positive, negative, or even no effect at all.

Previous studies have shown mixed results regarding the relationship between Carbon Emission Intensity (CEI) and financial performance. Some of them found that CEI is positively correlated with financial performance (Rokhmawati et al., 2015; Vaicondam et al., 2025; and Marselita et al., 2021). This finding is likely due to the suboptimal enforcement of regulations and the still strong role of the carbon-based sector in the national economy (Senna & de Araujo Moxotó, 2025). On the other hand, the results of research by Läger et al. (2024), Włodarczyk et al. (2024), and Ganda & Milondzo (2018) actually show a negative relationship between CEI and indicators such as ROA and Tobin's Q. Meanwhile, Kurnia et al. (2020) and Dewantoro & Hasnawati (2024) concluded that the effect of CEI on firm value was insignificant. Busch et al. (2022) even emphasized that the negative effects of carbon emissions on financial performance are more short-term, considering that some investors do not yet consider emissions as a major risk factor in making investment decisions.

To overcome the increase in emissions, the green economy approach has begun to be used as an alternative, by encouraging business actors to allocate their funds to environmentally oriented activities or what is known as green investment (Zhang & Berhe, 2022). Regulations regarding this have been stated in Law Number 25 of 2007 concerning Investment. As a form of supervision and assessment of corporate environmental performance, the government through the Ministry of Environment and Forestry also implements the PROPER program.

Figure 2. Companies Participating in PROPER 2017-2024



Source: Ministry of Environment and Forestry

In 2024, the Ministry of Environment and Forestry recorded a significant increase in the number of companies involved in the PROPER program, increasing by 22.3% from 3,694 entities in 2023 to 4,520 companies. However, this increase in participation has not been accompanied by adequate environmental performance quality, considering that only 85 companies received a gold rating, while 1,313 others were still in the red category. This condition reflects that the implementation of sustainable investment by corporations is still relatively low and requires further attention. Several studies have stated that green investment can have a positive impact on financial performance (Indriastuti & Chariri, 2021; Khalid et al., 2023; Chen & Ma, 2021). However, there are also studies that show different results, especially when green investment is carried out only to comply with regulations without integration into long-term business strategies (Putri & Regina, 2023; Meiyana & Aisyah, 2019; Novia & Candy, 2023).

Corporate social responsibility Disclosure (CSRD) is an important element in a company's sustainability strategy, as regulated in Law No. 40 of 2007 and Government Regulation No. 47 of 2012. CSR reflects a company's long-term commitment to carry out ethical business practices and support economic development, while continuing to strive to improve the welfare of employees, local communities, and the general public (The World Business Council for Sustainable Development/WBCSD). In Indonesia, CSR disclosure is generally conveyed through sustainability reports prepared by companies. The role of CSR is not only limited to social responsibility alone, but also becomes a strategic means of building legitimacy and a positive image of the company in the eyes of the public. Several studies indicate that CSR can have a positive influence on a company's financial performance (Fitriaty et al., 2021; Agustin & Rosdiana, 2022; Mulyani & Rafliis, 2024). However, there are also studies that show that CSR does not always have a significant impact, especially when the programs implemented do not receive a significant response from the community, so that the social goals and business impacts of the initiative have not been fully achieved (Kaat & Sofian, 2023; Monalisa & Serly, 2023).

The role of good corporate governance (GCG) is crucial in ensuring that sustainability strategies such as green investment and CSR disclosure can optimally contribute to the company's financial performance. GCG functions as an internal control system that directs management to act in accordance with sustainability principles. However, a report from the Asian Corporate Governance Association (2023) shows that the implementation of GCG in Indonesia is still not optimal, with an effectiveness score of only 35.7%. The main problem identified is the weak independence of the company's management structure, which has the potential to reduce the objectivity of decision-making. Several studies, such as those conducted by Ramadhani et al. (2022) and Simon et al. (2022), indicate that GCG can strengthen the correlation between sustainability practices and financial performance. However, on the contrary, other studies have found that strengthening GCG can have a counter-productive effect due to the high administrative burden and compliance costs required (Rachmayanti & Achyani, 2024; Noval et al., 2021).

So far, many studies have focused more on the direct influence of carbon emission intensity (CEI), green investment, and corporate social responsibility disclosure (CSR disclosure) on financial performance. However, few have highlighted how the role of good corporate governance (GCG) can

strengthen or weaken this relationship. Considering this gap, this study is directed to investigate in more depth the influence of CEI, green investment, and CSR disclosure on corporate financial performance, as well as to examine the extent to which GCG functions as a moderating variable in relation to the three sustainability factors. The study focuses on the energy and mining sectors listed on the Indonesia Stock Exchange (IDX) during the period 2019 to 2024, considering that this sector is a significant contributor to national carbon emissions and faces high pressure to carry out sustainable transformation.

LITERATURE REVIEW AND HYPOTHESIS FORMULATION

A. Legitimacy Theory

Dowling & Pfeffer (1975) stated that from the perspective of legitimacy theory, the sustainability of a company's operations depends on the extent to which the company's activities are in line with the social values prevailing in society. Therefore, companies need to adapt in order to continue to gain legitimacy and be considered socially legitimate (Rokhlinsari, 2015). One form of this adjustment is realized through the implementation of social responsibility, especially related to environmental issues, in order to gain public support and acceptance (Chariri et al., 2018; Meiyana & Aisyah, 2019). Through the disclosure of social responsibility in annual reports and sustainability reports, companies strive to show that their policies and operations have taken social and environmental interests into account.

B. Stakeholder Theory

Stakeholder theory emphasizes that corporate responsibility is not only limited to shareholders or investors, but also includes all parties who have an interest in the company's activities (Freeman, 2004). In the view of Ghozali and Chariri (2014), companies are seen as part of a social system that has an obligation to create benefits not only for internal parties, but also for external stakeholders such as creditors, consumers, suppliers, employees, government, and the wider community. The implementation of this theory aims to build harmonious relationships with all stakeholders so that the company is able to minimize risks and maximize profits in the long term (Kaat & Sofian, 2023).

In stakeholder theory, corporate social responsibility towards stakeholders is manifested through disclosure of Carbon Emission Intensity (CEI), implementation of Corporate Social Responsibility (CSR), and commitment to green investment. The communication media between companies and stakeholders is formed through disclosure of social and environmental information. The greater the power of stakeholders, the higher the adjustments demanded from the company (Rokhlinsari, 2015). To meet these expectations, companies are driven by this theory to carry out various initiatives, such as increasing the portion of investment in the environmental sector, conducting periodic evaluations of environmental performance, and expanding the scope of CSR disclosure.

C. Agency Theory

Conflicts of interest and information imbalance often color the contractual relationship between company owners (principals) and management (agents), as explained in agency theory. However, due to differences in interests and unequal access to information between the two, deviant behavior from the agent has the potential to occur. To minimize this risk, an effective monitoring system needs to be implemented (Jensen & Meckling, 1976). The implementation of good corporate governance mechanisms can be used to overcome agency conflicts. Management actions that are oriented towards personal interests can be suppressed through the existence of a strong board structure, an incentive system that is aligned with long-term goals, and adequate internal supervision (Walls et al., 2012). The allocation of resources for green investment tends to

be carried out more carefully by companies with high quality governance, and disclosure of CSR programs is also carried out more transparently.

D. Financial Performance

Financial performance is an analysis conducted to evaluate the company's achievements in using financial resources appropriately and effectively. According to Novia and Candy (2023), the level of achievement of the company in the use of appropriate and appropriate funds can be reflected through financial performance analysis. Business activities carried out by the company will be reflected in the results of its financial performance (Meiyana and Aisyah, 2019). Increasing profits through revenue optimization is a real form of business goals that are oriented towards financial performance. Employees are encouraged to achieve company targets and comply with applicable behavioral standards through financial performance evaluations, which will ultimately result in profits as expected (Rachmayanti & Achyani, 2024).

E. Carbon Emission Intensity

Carbon Emission Intensity (CEI) represents the amount of carbon emissions generated from each unit of economic activity or energy consumed by a company. CEI is usually expressed in grams of carbon dioxide per kilowatt-hour (gCO₂/kWh), or it can also be expressed in tons of CO₂ per unit of revenue or production volume. According to Senna & de Araujo Moxotó, (2025), CEI is used to measure carbon emission efficiency and is a direct reflection of how much a company contributes to climate change through its operational activities. Based on the legitimacy theory, companies that demonstrate emission efficiency and report CEI transparently will gain legitimacy from the public. This is important in maintaining operational sustainability, especially amidst increasing awareness of climate change. Companies with low CEI are considered more efficient and responsible in sustainability, making them more attractive to investors, especially those oriented towards ESG (Environmental, Social, and Governance) portfolios.

F. Green Investment

Green investment is a form of investment that is directed at preserving natural resources and implementing sustainable business practices. Huang and Lei (2021) stated that this investment has a long-term goal to support environmentally friendly company activities and maintain the balance of nature for future survival. Green investment is an effort to maintain environmental sustainability carried out by companies through the allocation of special funds aimed at improving environmental performance (Indriastuti and Chariri, 2021). Viewed from the perspective of legitimacy theory, companies will adjust their policies and operational practices to align with prevailing social values, so that they can gain legitimacy from the community. The strategy of managing environmental impacts by reducing energy consumption and carbon emissions is realized in the form of green investment (Yannan et al., 2022). In addition, the implementation of green investment allows companies to meet stakeholder expectations regarding social responsibility, as well as strengthen the company's image and reputation in the eyes of the public.

G. Corporate Social Responsibility Disclosure

Corporate Social Responsibility Disclosure (CSRD) describes the extent to which a company conveys information related to its social activities to the public. The level of transparency and accountability of a company for the social and environmental impacts of its operational activities is reflected through this index. Based on guidelines from the International Organization for Standardization (ISO 26000:2010), CSR is seen as a contribution to sustainable development carried out through ethical and open behavior. From the perspective of legitimacy theory, public legitimacy towards a company can be strengthened through adequate CSR disclosure, which in turn can also improve the company's reputation and create competitive advantage. Meanwhile, stakeholder theory emphasizes that CSR disclosure can also provide economic benefits to the company, both

directly and indirectly, for example through increasing consumer trust, customer loyalty, and investor attraction.

H. Good Corporate Governance

Good Corporate Governance (GCG) is a mechanism that regulates the relationship between various parties in a company in order to determine the right direction and policies (Organization for Economic Cooperation and Development/OECD). In Indonesia, the obligation to implement good governance principles has been regulated in Law Number 40 of 2007 concerning Limited Liability Companies. In this study, GCG is proxied through one indicator, namely the existence of the Board of Directors. The selection of this indicator is based on its important role in the corporate governance structure, especially in influencing strategic decision making. Based on the Financial Services Authority Regulation (POJK) Number 33/POJK.04/2014 concerning the Board of Directors and Board of Commissioners of Issuers of Public Companies, the board of directors is positioned as part of the organizational structure that has full responsibility for the management of the company as a whole.

I. The Impact of Carbon Emission Intensity on Financial Performance

Carbon Emission Intensity (CEI) represents the level of efficiency of a company in producing output compared to the amount of carbon emissions released. Several studies have shown that high CEI has a negative impact on financial performance because it reflects low operational efficiency and increases environmental risks which ultimately increase cost burdens. Companies with high carbon emission intensity tend to earn lower sales profits and returns on assets than companies with lower emission intensity (Włodarczyk et al., 2024). Similar things were conveyed by Lager et al. (2024) who stated that companies with low CEI tend to have higher company value because they are considered to care more about environmental aspects. Similar findings also show a negative relationship between carbon emissions and financial performance (Busch & Lewandowski, 2018; Busch et al, 2022; Ganda & Milonzo, 2018; Lestari et al., 2024; and Oestreich & Tsiakas, 2024). Thus, companies that are able to reduce emissions tend to have better financial performance. Based on this explanation, the first hypothesis proposed is as follows:

H1: Carbon Emission Intensity (CEI) has a negative effect on the financial performance of energy and mining sector companies in Indonesia.

J. The influence of green investment on financial performance

The role of green investment in improving operational efficiency, reducing environmental risks, and improving corporate profitability has been widely discussed in various studies. A positive and significant relationship between green investment and financial performance was found by Chen & Ma (2021), especially in energy sector companies. Improved financial performance was also stated as an impact of green investment by Indriastuti & Chariri (2021), who emphasized that this type of investment supports the company's long-term sustainability. Better financial performance tends to be achieved by companies that increase the allocation of funds to green investment, as shown by research by Chariri et al. (2018). The company's competitiveness can also be strengthened through reducing environmental risks and compliance with sustainability regulations. Additional evidence is presented by Rosyid & Mulatsih (2023), who confirm the significant influence of green investment and environmental performance on the financial performance of companies in the energy and mining sectors. In addition, Khalid et al. (2023) found that corporate profitability is driven by the allocation of funds to environmentally friendly investment activities. From all these findings, it can be concluded that the increase in green investment made by companies in general has a positive correlation with their financial performance. Therefore, the second hypothesis proposed in this study is:

H2: Green Investment has a positive effect on the financial performance of energy and mining sector companies in Indonesia.

K. The influence of Corporate Social Responsibility Disclosure on financial performance

Corporate Social Responsibility (CSR) disclosure is considered strategic in building a company's reputation, strengthening relationships with stakeholders, and increasing consumer and investor trust. Several studies, such as by Okafor et al. (2021), found that a company's profitability and income are positively influenced by CSR disclosure. A similar thing was also expressed by Fitriaty et al. (2021), who stated that CSR contributes to improving the financial performance of mining companies. The CSR disclosure index (CSRDI) is known to have a significant effect on financial performance based on the results of research by Devie et al. (2020), which shows that openness to corporate social initiatives can strengthen corporate image and increase long-term competitiveness. Additional support comes from Agustin & Rosdiana (2022) and Misutari & Ariyanto (2021), who found a positive correlation between CSR and profitability. With increasing awareness of the importance of social responsibility, more and more companies are realizing that CSR can contribute to financial performance. Therefore, the third hypothesis in this study is:

H3: Corporate Social Responsibility Disclosure has a positive effect on the financial performance of energy and mining sector companies in Indonesia.

L. The influence of GCG as a moderating variable in the relationship between Carbon Emission Intensity and financial performance

From the perspective of legitimacy theory, companies with high levels of carbon emissions are considered to have violated the social contract between business entities and society. In this context, the existence of a board of directors as a representation of good corporate governance is expected to play a role as a strategic policy director, including in efforts to mitigate carbon emissions and respond to external pressures. Viewed from agency theory, the board of directors has a supervisory function over management, which can minimize conflicts of interest between owners and managers of the company (Naciti, 2019). Through its authority, the board of directors can encourage policies that support transparency and sustainability, so as to reduce the level of CEI and reduce its impact on financial performance. Luo & Tang's (2020) research shows that companies with good governance tend to be more effective in reducing carbon emissions and at the same time improving financial performance. Ramadhani et al. (2022), Simon et al. (2022), Rachmayanti & Achyani (2024), found that good GCG practices increase the effectiveness of environmental issue management, including emission reduction. Based on this description, the fourth hypothesis in this study is:

H4: Board of Directors as a proxy for Good Corporate Governance weakens the influence of Carbon Emission Intensity on the financial performance of companies in the energy and mining sectors in Indonesia.

M. The influence of GCG as a moderating variable in the relationship between green investment and financial performance

From a stakeholder theory perspective, the board of directors has a responsibility to balance the company's financial interests with the expectations of other stakeholders, including society, regulators, and the environment (Chams & García, 2019). The composition of the board that includes members with environmental expertise can strengthen the company's ability to assess and direct green investments (de Villiers et al., 2011). The presence of a board with such a background provides more confidence in making sustainable investment decisions. In addition, Shahid & Abbas (2019) found that good GCG practices increase the effectiveness of supervision of investment allocation, while Bhatt & Bhattacharya (2015) emphasized that large boards tend to encourage ESG disclosure, including green investment, as part of an effort to maintain the company's legitimacy. Based on this description, the fifth hypothesis in this study is:

H5: Board of Directors (BoD) as a proxy for Good Corporate Governance strengthens the positive influence of Green Investment on the financial performance of companies in the energy and mining sectors in Indonesia.

- N. The influence of GCG as a moderating variable in the relationship between CSRD and financial performance

The board of directors plays a key role in strategic decision-making and corporate oversight to remain accountable, not only to shareholders, but also to respond to broader stakeholder expectations. As companies focus on sustainability, board responsibilities also expand to include non-financial performance, including CSR disclosure. Strategic decision-making related to CSR requires a diversity of views, cross-disciplinary insights, and the ability to read external dynamics. In this context, the size of the board of directors becomes crucial because larger boards generally have diverse experiences, broad oversight coverage, and access to external resources that can support the implementation of CSR programs (Said et al., 2009). Galbreath (2015) found a positive correlation between board size and the level of CSR disclosure, while the study by Mahmood et al. (2018) emphasized that large boards are able to minimize agency conflicts and encourage better quality sustainability reporting. Therefore, a large and diverse board of directors is believed to be able to strengthen the positive influence of CSR on a company's financial performance.

H6: Board of Directors (BoD) as a proxy for Good Corporate Governance strengthens the influence of Corporate Social Responsibility (CSR) disclosure on the financial performance of energy and mining sector companies in Indonesia.

RESEARCH METHODS

1. Research Design

This study uses a quantitative approach because it aims to test the theory through measuring variables in the form of numbers and analyzed using statistical procedures (Sugiyono, 2013). The main focus of this study is to analyze the effect of carbon emission intensity, green investment, and disclosure of corporate social responsibility (CSR) on financial performance, with good corporate governance (GCG) as a moderating variable.

2. Population And Sample

All energy and mining sector companies listed on the Indonesia Stock Exchange (IDX) during the 2019–2024 period were used as the population in this study. The research sample was determined using the purposive sampling method, a technique that selects samples based on certain criteria determined by the researcher. The criteria used include:

1. The company must be from the energy and mining sector and listed on the IDX in 2019 to 2024.
2. The company must publish a complete annual financial report and sustainability report during the period.
3. The sustainability report must provide information on carbon emission intensity (CEI), environmental investment (green investment), CSR disclosure, and corporate governance indicators (GCG).

3. Data Sources and Data Collection Techniques

The data in this study were obtained indirectly through annual reports and sustainability reports of companies listed on the Indonesia Stock Exchange (IDX). Data collection was carried out using two methods, namely documentation and literature study. Literature study is used by researchers to explore theories and previous research findings that are relevant to the topic. Meanwhile, quantitative data related to the research variables were collected by researchers from company documents, such as sustainability reports and annual reports, to be analyzed according to research needs.

Variable Measurement

In this study, financial performance is set as the dependent variable and measured using the Tobin's Q ratio. This ratio represents the management's ability to utilize company assets efficiently and describes the growth potential and investment prospects of a company. A Tobin's Q value <1 indicates undervalued stock conditions and less than optimal management performance. A value = 1 indicates average conditions without significant growth, while a value > 1 reflects overvalued stocks and high growth prospects (Sudiyatno & Puspitasari, 2010). Tobin's Q is calculated using the formula:

$$\text{Tobin's Q} = \frac{\text{MVS} + \text{Debt}}{\text{Total Assets}}$$

In this study, Carbon Emission Intensity (CEI) is defined as the level of carbon dioxide (CO₂) emissions produced for each unit of a company's revenue. This measure is obtained by dividing the company's total carbon emissions (in tons of CO₂ equivalent) by the total revenue earned (Khatib, et al (2024), Oestreich & Tsiakas (2024), Lestari, et al (2024), Vaincondam, et al (2025), Włodarczyk, et al (2024)). Revenue is chosen as the divisor because it represents the total value of the company's economic activities, thus providing a comprehensive picture of the intensity of emissions generated in creating economic value.

$$\text{CEI} = \frac{\text{Total Carbon Emissions (TCO}_2\text{e)}}{\text{Revenue}}$$

This study measures green investment based on the total funds spent by companies on activities related to environmental management. All forms of expenditure that reflect efforts to maintain environmental sustainability are classified as green investment, as explained by Eyraud et al. (2013). This approach is reinforced by several previous studies, such as those conducted by Putri and Regina (2023), Khalid et al. (2022), and Saher et al. (2023), which use the amount of environmental investment funds as the main indicator in assessing green investment. To avoid differences in scale between variables that can cause bias in the analysis, the green investment data in this study were first converted into natural logarithm form.

$$\text{Green Investment} = \text{Ln (Environmental investment fund)}$$

Corporate Social Responsibility Disclosure (CSRDI) in this study shows the extent to which a company conveys its social and environmental activities to the public. The assessment is carried out by reviewing official company documents such as sustainability reports, annual reports, and information published through the company's website. The standards used refer to the Global Reporting Initiative (GRI) G4, which covers three main dimensions: economic, environmental, and social, with a total of 91 indicators (9 economic, 34 environmental, and 48 social). Each disclosure point is assessed using a scoring system, 1 point if information is available, and 0 if not disclosed.

$$\text{CSRDI}_j = \frac{\sum X_{ij}}{N_{ij}}$$

CSRDI_j : Corporate social responsibility disclosure index

N_{ij} : Number of CSR disclosure items

$\sum X_{ij}$: The number of disclosures made by the company

In this study, Good Corporate Governance (GCG) is represented through the board of directors. The board of directors plays an important role as the main driver in corporate governance because it has the responsibility to manage the company as well as determine strategic policies. The use of the size of the board of directors as a proxy for GCG is strengthened by the findings of various studies, including by Rahmawati & Subardjo (2017), Nicolo et al. (2023), and Tjahjadi et al. (2021), which show that the number of board members affects the effectiveness of governance and influences decision-making related to environmental issues, implementation of corporate social responsibility, and financial performance.

$$\text{Board of Directors} = \text{Number of Members of the Board of Directors}$$

4. Data Analysis Techniques

In this study, the analysis method used is panel data regression. Data processing and testing are carried out using EViews 12 software to obtain accurate analysis results. The stages used in this

study are: descriptive analysis, panel data regression model selection test, namely the chow test, hausman test, and lagrange multiplier test, classical assumption testing including multicollinearity test and heteroscedasticity test, determination coefficient test (r^2), F test, t-test and moderate regression analysis (MRA) test. So the regression model in this study is as follows:

$$FP = \alpha + \beta_1 CEI + \beta_2 GI + \beta_3 CSRD + \beta_4 CEI * BoD + \beta_5 GI * BoD + \beta_6 CSRD * BoD + \varepsilon$$

RESULTS AND DISCUSSION

Descriptive Statistical Analysis

Table 1. Descriptive Statistical Analysis

	TOBIN'S Q	CEI	GI	CSRD	BoD
Mean	1.163677	0.001268	154645786373.26	0.464225	5.188889
Median	1.018671	0.000552	35874660257	0.461538	5.000000
Maximum	2.685756	0.014020	1814997000000	0.725275	10.000000
Minimum	0.596547	0.000015	699693552	0.175824	3.000000
Std. Dev.	0.409598	0.002065	269665328719.67	0.155611	1.668576

Source: Data processed with Eviews 12

The results of descriptive statistical analysis using EViews 12, show that the financial performance variable, as measured by the Tobin's Q ratio, has an average of 1.16 with a standard deviation of 0.41. The maximum value of this ratio was recorded at PT Petrosea Tbk. in 2024 with a figure of 2.69, while the minimum value of 0.60 was found at PT Harum Energy Tbk. in 2019. The Carbon Emission Intensity (CEI) variable has an average of 0.0013 and a standard deviation of 0.0021. The highest CEI value was obtained by PT Harum Energy Tbk. in 2024, which was 0.0140, while the lowest value was found at PT Apexindo Pratama Duta Tbk. in 2022 at 0.000015.

The green investment variable shows an average value of IDR154.6 billion, with a level of data spread indicated by a standard deviation of IDR269.7 billion. The maximum value of IDR1.81 trillion was recorded at PT Indo Tambangraya Megah Tbk. in 2024, while the minimum value of IDR699.6 million was recorded at PT Apexindo Pratama Duta Tbk. in 2019. For the Corporate Social Responsibility Disclosure (CSRD) variable, an average score of 0.464 and a standard deviation of 0.156 were obtained. The company with the highest level of disclosure was PT Indo Tambangraya Megah Tbk. in 2024, while the lowest disclosure of 0.176 was found at PT Harum Energy Tbk. in 2019. As for the board of directors variable, it is known that the average number of board members is 5.19 people, with a standard deviation of 1.67. The highest number, namely 10 people, was found at PT Indo Tambangraya Megah Tbk. in 2024, while the lowest number of members, namely 3 people, was consistently recorded in several companies, such as PT Petrosea Tbk., PT Harum Energy Tbk., PT Energi Mega Persada Tbk., and PT ABM Investama Tbk. in several years of observation.

Panel Data Model Selection Test

1. Chow Test

Table 2. Chow Test

Effects Test	Statistic	d.f	Prob.
Cross-section F	5.411402	(14.71)	0.0000
Cross-section Chi-Square	65.350461	14	0.0000

Source: Data processed with Eviews 12

The Cross-section Chi-square probability value displayed in the table 2 shows a figure of $0.0000 < 0.05$. This result indicates that the use of the Fixed Effect model is more appropriate than the Common Effect model. Thus, further analysis will be continued through the Hausman test to choose the best model between Fixed Effect and Random Effect.

2. Hausman Test

Table 3. Hausman Test

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f	Prob.
Cross-section random	3.724877	5	0.5897

Source: Data processed with Eviews 12

The random cross-section probability value listed in table 3 is $0.5897 > 0.05$. Based on these results, it can be concluded that the Random Effect model is more appropriate than the Fixed Effect model. Therefore, further analysis is needed through the Lagrange Multiplier test to determine whether the Common Effect or Random Effect model is most appropriate to use in this study.

3. Lagrange Multiplier Test

Table 4. Lagrange Multiplier Test

	Test Hypothesis		
	Cross-section	Time	Both
Breusch-Pagan	27.91606 (0.0000)	0.260851 (0.6095)	28.17692 (0.0000)

Source: Data processed with Eviews 12

Based on the table 4, it can be seen that the Breusch-Pagan probability value is 0.0000. This value is smaller than the significance level of 0.05, so it can be concluded that the Random Effect model is more appropriate than the Common Effect Model, so this study will use the Random Effect Model.

Classical Assumption Test

Table 5. Multicollinearity Test

	CEI	GI	CSRD
CEI	1.000000	-0.087826	-0.405738
GI	-0.087826	1.000000	0.347643
CSRD	-0.405738	0.347643	1.000000

Source: Data processed with Eviews 12

The multicollinearity test in this study was conducted through correlation analysis between independent variables. The results showed that all correlation values were < 0.85 . This finding indicates that there are no symptoms of multicollinearity in the regression model built.

Table 6. Heteroscedasticity Test

Variabel	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.552068	0.566659	-0.974250	0.3327
CEI	-31.78711	17.10374	-1.858489	0.0665
GI	0.040989	0.024209	1.693154	0.0940
CSRD	-0.254600	0.213042	-1.195069	0.2353

Source: Data processed with Eviews 12

Referring to the test results presented in table 6, the Glejser method shows that all independent variables have a probability value > 0.05 . Thus, it can be concluded that this regression model does not indicate any symptoms of heteroscedasticity.

Test Of Coefficient Of Determination

Table 7. Coefficient Of Determination Test

Weighted Statistic			
R-squared	0.122005	Mean dependent var	0.471261
Adjusted R-squared	0.091377	S.D. dependen var	0.320665
S.E of regression	0.305664	Sum squared resid	8.035012
F-statistic	3.983463	Durbin-Watson stat	1.333412

Prob (F-statistic) 0.010430

Source: Data processed with Eviews 12

The regression results show an R-squared value of 0.122 and an Adjusted R-squared value of 0.091. This means that the CEI, green investment, and CSRD variables only explain 12.2% of the variation in Tobin's Q, while the remaining 87.8% is influenced by other factors outside the model.

F Test

The results of the F test in table 7 show a significance value of $0.010 < 0.05$, which means that CEI, green investment, and CSR disclosure simultaneously have a significant effect on the company's financial performance.

t-Test

Table 8. t-Test

Variabel	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.667826	0.921112	-0.725022	0.4704
CEI	-68.74629	24.53214	-2.802295	0.0063
GI	0.088623	0.039274	2.256522	0.0266
CSRD	-0.530746	0.297135	-1.786213	0.0776

Source: Data processed with Eviews 12

The t-test results show that CEI has a significant negative effect on financial performance ($p = 0.0063 < 0.05$), so H1 is accepted. GI has a significant positive effect on financial performance ($p = 0.0266 < 0.05$), so H2 is accepted. Meanwhile, CSRD does not have a significant effect on financial performance ($p = 0.0776 > 0.05$), so H3 is rejected.

MRA Test

Table 9. MRA Test

Variabel	Coefficient	Std. Error	t-Statistic	Prob.
C	-7.712526	2.233443	-3.453201	0.0009
CEI	0.293381	72.79905	0.004030	0.9968
GI	0.387641	0.102431	3.784410	0.0003
CSRD	-1.666811	1.068173	-1.560432	0.1225
BOD	1.481574	0.421185	3.517634	0.0007
CEI_BOD	-16.30107	14.71712	-1.107626	0.2713
GI_BOD	-0.061959	0.019140	-3.237132	0.0017
CSRD_BOD	0.211554	0.197973	1.068600	0.2884

Source: Data processed with Eviews 12

Based on table 18, the results of the Moderated Regression Analysis (MRA) test form the following panel data regression equation:

$$FP = -7.712526 + 0.293381CEI + 0.387641GI - 1.666811CSRD - 16.30107CEI*BoD - 0.061959GI*BoD + 0.211554CSRD*BoD + \varepsilon$$

The MRA test shows that GCG is unable to moderate the relationship between CEI and financial performance ($p = 0.2713 > 0.05$), so H4 is rejected. Although GCG moderates the relationship between GI and financial performance ($p = 0.0017 < 0.05$), the negative coefficient direction actually weakens the influence of GI on financial performance, so H5 is also rejected. Meanwhile, the interaction between CSRD and GCG is not significant ($p = 0.2884 > 0.05$), indicating that H6 is rejected because GCG does not act as a moderator.

Discussion

1. The Influence of Carbon Emission Intensity (CEI) on Financial Performance

The results show that Carbon Emission Intensity (CEI) has a negative and significant effect on company value as measured using the Tobin's Q ratio. High levels of carbon emissions from a company are viewed negatively by investors, because they are considered risky to reputation, vulnerable to regulatory sanctions, and indicate a weak commitment to sustainable practices. In other words, if a company produces higher carbon emissions, its financial performance tends to decline.

These results support the legitimacy theory which emphasizes the importance of the company's operational activities being in line with social norms and community expectations in order to maintain its legitimacy. If a company is known to produce high carbon emissions, then this can be interpreted as a form of neglect of environmental issues that are of concern to the public and stakeholders. This condition has the potential to reduce the level of investor trust, which ultimately has a negative impact on the company's financial performance. The instillation of sustainability values is increasingly appreciated by today's investors, who are more likely to give added value to companies that demonstrate environmental concern as part of their long-term strategy.

Research by Ganda and Milondzo (2018) shows that reducing carbon emissions tends to be easier for companies with healthy financial conditions. This emission reduction, according to their findings, will have a positive impact on financial performance in the following period. The same thing was also shown by Lager et al. (2024), who found that companies that successfully reduce their carbon footprint are able to build an image as companies that care about the environment, open up new market opportunities, and increase customer loyalty. All of these factors indirectly drive increased financial performance. In addition, Włodarczyk et al. (2024) together with Kumar and Firoz (2018) revealed that high levels of carbon emission intensity are correlated with lower sales profits and returns on assets compared to companies with better emission efficiency.

2. The Influence of Green Investment (GI) on Financial Performance

The results of the second hypothesis test show that green investment has a significant effect on financial performance. This means that spending on environmental conservation has a positive impact, not a long-term financial burden. Energy efficiency, reduced operational costs, and increased investor confidence are driving factors for this increased performance. In theory, this finding is in line with the legitimacy perspective, which emphasizes the importance of companies in adjusting their operational policies to prevailing social values in order to gain public recognition.

In the mining industry which is high in environmental risk, green investment plays a role in strengthening the company's reputation and legitimacy in the eyes of stakeholders, including regulators and consumers. From a stakeholder theory perspective, companies that allocate funds for environmental sustainability are considered more responsive to the demands of various parties, while also showing management's attention to non-financial risks that affect long-term business sustainability.

Significant strengthening of the financial performance of companies in the energy and mining sector has been found to be related to increased green investment, as evidenced by research by Rosyid & Mulatsih (2023) and Khalid et al. (2023). Similar findings were also obtained by Chariri et al. (2018), which stated that high intensity of green investment tends to result in better financial performance. The contribution of green investment to increasing profitability has been confirmed in the studies of Chen & Ma (2021) and Indriastuti & Chariri (2021), where green investment practices have been shown to have a positive financial impact on companies. In other words, management that allocates funds for environmental conservation purposes is considered to have taken a strategic step, not just a regulatory obligation. In this context, Meiyana and Aisyah (2019) stated that spending on environmental activities should no longer be considered a burden. Instead, this strategy is a form of long-term investment that can build reputation and maintain business continuity, as well as have an impact on improving overall financial performance.

3. The Influence of CSRD on Financial Performance

The results of the analysis show that corporate social responsibility (CSR) disclosure does not have a significant effect on company value as measured using the Tobin's Q ratio. In other words, even though companies increase disclosure of information related to CSR, the market does not immediately respond to it in the form of increased financial value. Theoretically, this finding does not support the views of stakeholder theory or legitimacy theory which emphasize that CSR can improve investor reputation and trust. In practice, CSR disclosure may be carried out simply to comply with regulations, without being supported by the implementation of real and impactful programs. As a result, investors and the public do not see CSR as a sustainability indicator that is relevant to the company's financial performance.

When examined from the perspective of legitimacy theory, companies that only carry out CSR as a formality tend to fail to gain social acceptance. This happens because the activities carried out do not reflect real concern for social and environmental issues that are of public concern. When public expectations are not met, the company's efforts to build a positive image will not have a significant impact on improving its financial performance. This condition is clarified by the findings of Kaat and Sofian (2024), who stated that market players began to doubt the effectiveness of CSR reports because their contents were considered not to reflect real contributions. Monalisa and Serly (2023) also revealed that many companies implement social responsibility programs only to meet regulatory requirements, not as part of a long-term business strategy. As a result, these programs have little impact on investor perceptions or the company's financial performance.

Although companies have published various social programs such as environmental conservation or support for local communities, their impact on company value remains minimal if not adjusted to the needs and expectations of stakeholders. This is contrary to the results of other studies, for example by Yannan et al. (2022) and Buallay et al. (2020), which shows that CSRD that is managed strategically is actually able to provide added value to the company's financial performance and competitiveness.

4. The Role of GCG in Moderating the Influence of CEI on Financial Performance

The results of the Moderated Regression Analysis (MRA) analysis show that the size of the board of directors as an indicator of GCG does not have a significant effect in moderating the relationship between Carbon Emission Intensity (CEI) and financial performance. Although the board of directors is tasked with supervising and making strategic decisions, a larger number of members does not always increase effectiveness in dealing with carbon emission issues. A board that is too large can actually hinder coordination and rapid decision-making regarding environmental issues.

According to agency theory, the board should supervise management to avoid conflicts of interest. However, these results indicate that the supervisory function is not optimal, especially if the board is not yet responsive to sustainability issues. If the board is unable to direct environmental policies strategically, then its role in moderating the impact of CEI on financial performance becomes less significant.

The results of this study are in line with García Martín and Herrero (2020) who stated that the size of the board of directors does not significantly affect environmental performance. The success of a company in managing environmental issues depends more on the quality and understanding of the board of sustainability than on the number of its members. Therefore, responsive governance and integration of sustainability policies in decision-making are essential. This finding is also supported by Noval et al. (2021) who stated that GCG does not moderate the relationship between environmental performance and financial performance.

5. The Role of GCG in Moderating the Influence of Green Investment on Financial Performance

The results of the Moderated Regression Analysis (MRA) test show that the board of directors as a proxy for GCG significantly moderates the relationship between green

investment and financial performance in a negative direction. This means that the more board members there are, the weaker the positive effect of green investment on the profitability of companies in the energy and mining sector. This finding contradicts agency theory. According to agency theory, a good board of directors structure should be able to reduce conflicts of interest between management and shareholders, thereby strengthening strategic investment decision-making including green investment. Companies with good governance are expected to be more sensitive to stakeholder interests and more effective in allocating resources to sustainable investments that are profitable in the long term.

The role of the board of directors is very important in strengthening the company's focus on sustainability through supervision and strategic decision-making that considers social and environmental impacts. However, if the number of board members is too large, this can cause difficulties in coordination and effective decision-making, thus hampering the implementation of green investment in energy and mining sector companies. Green investment requires a long-term view and readiness to face inherent risks, but boards with many members tend to focus on efficiency and short-term risk avoidance. This condition makes the allocation of funds for projects that have not yet provided direct financial results less than optimal (Rachmayanti & Achyani, 2024). As a result, companies become less aggressive in facing sustainability challenges and less attractive to investors who prioritize environmental aspects.

Research by Zhu et al. (2024) supports this by showing that large boards have a negative correlation with funds allocated for ESG investment. The large number of board members with diverse views can slow down the decision-making process, resulting in less spending on sustainable investment. Studies by Guo and Kga (2012) and Bhatt and Bhattacharya (2015) also emphasized that excessive number of directors has the potential to increase agency costs and reduce the effectiveness of internal coordination. Therefore, companies need to reconsider the number of board members so that decision-making, especially in terms of green investment, can run more efficiently and optimally.

6. The Role of GCG in Moderating the Influence of CSRD on Financial Performance

Moderated Regression Analysis (MRA) analysis revealed that the number of board members as a representation of Good Corporate Governance (GCG) does not significantly moderate the relationship between Corporate Social Responsibility (CSR) disclosure and company financial performance. This shows that the role of the board of directors in strengthening or reducing the influence of CSR disclosure on the financial performance of companies in the energy and mining sector in Indonesia has not been statistically proven.

Within the agency theory framework, the board of directors functions as the main supervisor tasked with reducing information asymmetry and ensuring transparency in CSR reporting. Therefore, the existence of a board of directors is expected to optimize the role of CSR disclosure in building the company's reputation while improving financial performance. However, the findings of this study actually show that the moderating role of the board of directors is not significant.

This result is in line with the research of Tjahjadi et al. (2021) which states that the size of the board of directors does not affect the company's social performance, including CSR activities and disclosure. Some possible causes are the lack of understanding of board members about sustainability issues, minimal involvement in ESG strategies, and the size of the board that is too large so that it hinders the communication process and decision-making related to sustainability. In such conditions, CSR disclosure is often considered a formality or additional burden that does not have a direct impact on the company's profitability (Oktaviana & Achyani, 2024). Huang et al. (2021) also added that the number of board members does not guarantee the effectiveness of supervision of corporate social responsibility.

CONCLUSION

A. Research Conclusions

The results of the analysis and discussion show a number of conclusions as follows:

1. Carbon Emission Intensity (CEI) has a significant negative effect on the company's financial performance. The higher the level of carbon emissions produced per unit of revenue, the lower the financial performance achieved. This finding shows that carbon emission efficiency is a crucial factor in maintaining sustainability and profitability, especially in the energy and mining sectors which are heavily impacted by environmental issues.
2. Green Investment has a positive and significant effect on financial performance. These results indicate that companies that allocate more funds for investment in environmental management tend to show better financial performance.
3. Corporate Social Responsibility Disclosure (CSRD) does not have a significant effect on financial performance. Disclosure of corporate social responsibility is not strong enough to influence stakeholder perceptions of the company's economic value.
4. GCG proxied by the Board of Directors (BOD) does not moderate the relationship between CEI and CSRD on financial performance. This shows that the role of directors in managing carbon emission issues and social responsibility is still ineffective in driving financial achievement.
5. GCG proxied by Board of Directors (BOD) weakens the relationship between Green Investment and financial performance. This finding suggests that a large board structure can weaken the relationship between green investment and financial performance.

B. Implications

Based on the conclusions that have been described, this study has several implications that can be described as follows:

1. Practical Implications for Company Management

Companies, especially in the energy and mining sectors, need to pay serious attention to carbon emission efficiency. The finding that Carbon Emission Intensity (CEI) has a negative impact on financial performance shows that emission management is not only an environmental issue, but also has a direct impact on the company's financial performance. Therefore, emission reduction, use of low-carbon technology, energy efficiency, and emission transparency are important strategies that need to be integrated into business operations to support sustainability while maintaining profitability.

2. Implications for Corporate Governance (GCG)

The results of the study indicate that the Board of Directors has not played an optimal role in strengthening the relationship between sustainability practices and financial performance. Negative moderation towards green investment indicates that the dominant short-term orientation of the board of directors can weaken the potential economic value of environmental investment. Therefore, it is necessary to strengthen the capacity and long-term perspective at the board of directors level in order to be able to support the implementation of sustainability programs strategically.

3. Implications for Regulators and Policy Makers

Regulators such as the OJK and the Ministry of Energy and Mineral Resources can use these findings as a basis for strengthening the role of directors and commissioners in addressing sustainability issues. This step can be realized through mandatory training, sustainability-related certification, or by integrating ESG indicators into corporate governance evaluations. In addition, increasing transparency and accountability in carbon emission reporting and corporate social responsibility are also very important to improve the quality of information available to investors.

4. Academic Implications and Further Research

This study contributes to the development of literature related to the relationship between sustainability, governance, and financial performance in emerging markets. Further researchers can use these results as a basis for delving deeper into the dynamics of the role of GCG in the context of sustainability, by expanding indicators or using a qualitative

approach to understand the context of board decision-making.

C. Limitations and Suggestions

1. This study was only conducted on energy and mining sector companies listed on the Indonesia Stock Exchange for the 2019–2024 period. Further research is recommended to involve other industrial sectors outside of energy and mining, such as the manufacturing sector, primary consumption, or infrastructure, so that the findings can be more generalized. Differences in industry characteristics will open up the possibility of different patterns of relationships between sustainability and financial performance.
2. The sample used in this study is still small. This is because many energy and mining sector companies still do not include the total carbon emissions produced or the environmental investments made. Future research is expected to increase the number of samples by expanding the observation period.
3. Carbon Emission Intensity (CEI) measurement is carried out by dividing total carbon emissions by the company's revenue. However, this method has limitations because the revenue listed does not necessarily come entirely from operational activities that produce emissions, so this measure may be less accurate in representing the company's overall carbon efficiency level. It is recommended that Carbon Emission Intensity measurements not only be based on revenue, but also consider total production, or other activity units that better describe the operational process. This is important to obtain a more representative carbon efficiency measure of the company's main activities.
4. The measurement of Good Corporate Governance (GCG) in this study is limited to one indicator, namely the number of board members. To obtain a more comprehensive picture of the role of GCG in moderating the relationship between sustainability and financial performance, future research is suggested to use several other indicators such as the existence of an audit committee, frequency of board meetings, proportion of independent commissioners, ownership structure, and overall assessment of governance quality.

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