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Beyond Compliance: Integrating Carbon Risk Management for Sustainable Growth in Indonesia

Dedi Haryadi[1)]; Hengky Leon[2*)]; Vito Apriyanto[3)]; Ricky Ricky[4)]

[1,2,4)] Program Studi Akuntansi, Fakultas Ekonomi dan Bisnis, Universitas Widya Dharma Pontianak
[3)]Program Studi Akuntansi, Fakultas Ekonomi dan Bisnis, Universitas Bina Nusantara

***Corespondent Author: hengkyleon11@gmail.com**

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Sustainable growth rate; carbon risk; firm size; financial performance.

ABSTRACT

Purpose: *This study aims to examine the effect of carbon risk on the sustainable growth rate (SGR) of non-financial companies listed on the Indonesia Stock Exchange during 2021–2024. The research is important as climate-related risks increasingly influence corporate sustainability and long-term performance, particularly in emerging markets.* ***Methodology:*** *The methodology employs a quantitative approach using purposive sampling, resulting in 138 firms (552 firm-year observations). Data were analyzed using regression with Robust Least Squares (RLS) to address heteroscedasticity.* ***Results:*** *The results show that carbon risk has a negative and significant effect on sustainable growth, indicating that higher carbon emissions reduce firms' growth potential. Additionally, financial performance indicators—ROA, DER, TATO, and firm size—positively influence SGR.* ***Findings:*** *The findings highlight that carbon risk not only affects financial stability but also constrains long-term corporate growth.* ***Novelty:*** *The novelty of this study lies in linking carbon risk directly to sustainable growth rate, a relationship rarely explored in prior literature.* ***Originality:*** *Its originality is reflected in the focus on non-financial firms in Indonesia as a developing country context.* ***Conclusion:*** *In conclusion, effective carbon risk management is crucial for sustaining corporate growth. The study provides implications for policymakers and managers to strengthen environmental strategies and reporting practices.* ***Type of Paper:*** *Research article*

INTRODUCTION

The relationship between carbon risk and sustainable corporate growth is becoming increasingly important in the contemporary business environment, where climate change poses a significant threat to operational stability and financial performance. The existing literature shows that effective carbon risk management is essential in aligning corporate strategy with sustainable growth objectives. (Tila & Augustine, 2019) highlights the importance of corporate governance in identifying and managing carbon risk, especially for industries that rely on fossil fuels. Furthermore, Zhou et al. (2018) argue that companies that excel in carbon risk management not only reduce losses but also open up new market opportunities through innovation and efficiency improvements, which can result in lower capital costs. However, carbon risk also has significant financial implications, such as reduced investment levels and increased uncertainty (Souguir et al., 2024) as well as higher equity and debt costs for companies with large carbon footprints (Wang et al., 2022). The implications of carbon risk extend to investor decisions, where investors are increasingly concerned about companies carbon risk profiles, demanding higher risk-adjusted returns from

companies with lower emissions and sustainable practices (Lassoued et al., 2025). This encourages companies to adopt transparent carbon disclosure practices to enhance investor confidence and company valuation. Therefore, companies face a dual challenge: managing increased operational costs associated with carbon mitigation strategies while simultaneously transitioning to sustainable business practices that appeal to environmentally conscious consumers and investors (Cheng et al., 2021). Ultimately, research shows that organizations that fail to properly assess and manage carbon risks may face financial pressure and reputational damage (Luo & Tang, 2021) while companies that are proactive in carbon risk management will be better prepared to adapt to market fluctuations, invest in green technologies, and gain a competitive advantage (Chakrabarty & Nag, 2023).

Previous studies have examined carbon risk in relation to company-specific risk (Matsumura et al., 2024), lending behavior (Aslan et al., 2022), bank lending costs (Javadi & Masum, 2021), stock prices and returns (Faccini et al., 2023), financial distress (Ding et al., 2023), corporate investment (Phan et al., 2022)and the broader financial market (Gao et al., 2023) and (Tedeschi et al., 2024). Interestingly, much of the existing research has focused on bank financial stability (Fan & Gao, 2024) and (Le et al., 2023), even though banks are generally low-carbon emitters (Chabot & Bertrand, 2023). None of these studies have specifically assessed sustainable growth, which is crucial for the long-term impact on companies. Our research uses data collected from the Indonesia Stock Exchange on non-financial companies from 2021 to 2024. We empirically analyze how carbon risk affects sustainable growth rates. This study makes several contributions. First, we contribute to the development of literature related to carbon risk with the sustainable growth rate of companies, which has never been highlighted in previous studies. Second, we highlight how developing countries, namely Indonesia, mitigate carbon risk for the future sustainability of companies. Finally, we reveal how non-financial companies that are suspected of being more exposed to carbon risk play a role in this matter.

The theory of transition risk in the context of carbon emissions highlights a critical intersection between environmental issues and corporate strategies for sustainable growth, encompassing financial and operational risks as the global economy shifts toward low-carbon solutions. Transition risk arises from shifts in regulation, technology, and markets; companies with high carbon emissions often face adverse stock performance due to increased transition risk (Bolton & Kacperczyk, 2021). Failure to address transition risk can result in significant financial losses (Rözer et al., 2025). Companies that proactively invest in low-carbon technologies gain a competitive advantage, avoid reputational consequences and technological shifts amid changing growth (Penzin et al., 2025), and position themselves better in the eyes of investors through transparent carbon disclosure (Palea & Drogo, 2020). Therefore, transition risk serves as a catalyst for innovation and improved sustainability practices, with corporate governance driving better practices and higher carbon emissions disclosure (Tila & Augustine, 2019).

Climate-related risks present unique agency problems, where executives may prioritize personal gain over long-term sustainability goals supported by shareholders (Dow & Raposo, 2001) and (Jensen & Zajac, 2004). Effective corporate governance mechanisms, such as independent boards and performance-based incentives, can play a crucial role in mitigating agency costs associated with carbon risk, aligning managerial incentives with sustainable growth objectives (Margotta, 2011) and (Ooko, 2024). Investors are increasingly advocating for transparency in carbon emissions, encouraging companies with strong governance around environmental practices to enhance reputation and market valuation (Sgrò et al., 2025). Investing in human capital to implement sustainable practices can also reduce agency costs (Cao et al., 2023), while diversity in corporate governance can improve the ability to manage climate risk (Zou & Adams, 2008). However, there are differing views on the extent to which agency costs are related to environmental strategies, with some arguing that an excessive emphasis on shareholder value may hinder adequate investment in sustainability (Haryadi et al., 2025). Ultimately, aligning managerial interests with the sustainability goals of stakeholders and shareholders is crucial for companies to succeed in an increasingly carbon-conscious environment.

Based on existing theory, this study hypothesizes a negative relationship between carbon risk and sustainable growth rate. Companies that can reduce carbon risk, thereby lowering carbon emissions, have the potential to achieve better sustainable growth. Previous studies have not examined the relationship between carbon risk and sustainable growth rate, but there are studies that link carbon risk to financial stability (Owusu et al., 2025), which found a negative relationship. We consider financial stability to be one of the factors that enable companies to achieve good sustainable growth, but in this study, we are more specifically examining this aspect directly, leading us to hypothesize that carbon risk has a negative effect on sustainable growth rate.

H_1: Carbon risk negatively affects the sustainable growth rate in Indonesian companies.

METHOD

The sample selection process was conducted to ensure the accuracy of the data we used in testing the relationship between carbon risk and sustainable growth rate.

Table 1. Sample Selection

	Number of firms
Total companies listed on Indonesian stock exchanges (IDX) for the period 2021–2024	945
Less: Financial Sector Companies	107
Less Companies that went public after the year of research	223
Less Companies that did not consistently fiscal year ending December 31	64
Less Companies that did not payed dividend of year research	413
Total Companies that passed the sample selection	138
Remaining Data (138 Companies x 4 Years)	552

Source: Data Processed, 2025

Table 1 shows the process of selecting data samples from an initial population of 945 companies, starting with the criterion companies in the financial sector were eliminated, leaving 838 companies. Next, companies that went public after the year of research were eliminated, leaving 615 companies. Next, companies that did not consistently use the fiscal year ending on December 31 were excluded, leaving 551 companies. Finally, companies that did not distribute dividends were excluded, resulting in a final number of 138 companies. With a total of 4 years of research (2021-2024 period), the total research data (n) used in this analysis is 552 data.

$$SGRit = \alpha 0 + \beta 1CRIit + \beta 2ROAit + \beta 3DERit + \beta 4TATOit + \beta 5SIZEit + eit$$

Where:
SGR : Sustainable growth rate proxied by retention (100% - DPR) x return on equity;
CRI : Total greenhouse gas emissions in tCO_2e to total income;
ROA : Net income divided by total assets;
DER : Total debt divided by total equity;
TATO : Sales divided by total assets;
SIZE : Natural log of total assets.

RESULTS AND DISCUSSION

RESULTS

The variables studied, which include SGR, CRI, ROA, DER, TATO, and SIZE, all show significant deviations from normal distribution based on descriptive statistical analysis and the Jarque-Bera test. SGR, with a mean of 0.0041 and a median of 0.0581, and CRI, with a mean of 0.1090 and a median of 0.0000, both show highly skewed distributions (SGR to the left, CRI to the right) and leptokurtic, which is reinforced by extreme skewness and kurtosis values. ROA has a mean of 0.0988 and a median of 0.0745, also showing positive skewness and leptokurtosis. DER, with a mean of 1.2819 and a median of 0.6461, displays extremely right-skewed and sharply peaked distributions. TATO, which has a mean of 1.0151 and a median of 0.8854, also tends to be right-skewed and leptokurtic. Although SIZE, with a mean of 29.4799 and a median of 29.3067, shows the most normal distribution compared to the other variables.

Table 2. Descriptive Statistics

Variables	SGR	CRI	ROA	DER	TATO	SIZE
Mean	0.0041	0.1090	0.0988	1.2819	1.0151	29.4799
Median	0.0581	0.0000	0.0745	0.6461	0.8854	29.3067
Maximum	1.3653	32.3352	0.6163	190.3070	3.8222	33.7900
Minimum	-16.6343	0.0000	-0.0962	0.0057	0.0351	25.2156
Std. Dev	0.8168	1.6761	0.0916	8.1434	0.7292	1.6087

Note(s): SGR:

Source: EVIEWS Output Version 12, 2025

The Pearson correlation between the variables SGR, CRI, ROA, DER, TATO, and SIZE shows varying linear relationships. The strongest correlation is seen between SGR and DER (-0.8544), indicating a very significant negative relationship: an increase in SGR tends to be followed by a decrease in DER. The strong negative correlation between SGR and DER (-0.8544) is indeed a noteworthy finding; however, it does not necessarily indicate a serious multicollinearity problem within the model. Conceptually, this relationship remains theoretically explicable: companies with a high sustainable growth rate (SGR) tend to exhibit lower dependence on external debt-based financing, as reflected by a lower Debt-to-Equity Ratio (DER). In other words, firms capable of financing their growth through internal sources generally do not require high leverage, thereby producing a strong negative correlation. Furthermore, to confirm the absence of multicollinearity that could distort model estimation, supplementary diagnostic tests were conducted – including the Variance Inflation Factor (VIF) – which indicated that all variables remained below the acceptable threshold. Accordingly, although the correlation value is high, it more accurately reflects a logically grounded economic relationship rather than a statistical deficiency within the model. ROA has a moderate positive correlation with TATO (0.2408), indicating that asset efficiency (TATO) is positively correlated with asset profitability (ROA). The other variables generally show very weak correlations with each other. For example, SGR has only a very weak correlation with CRI (0.0020), ROA (0.0150), TATO (0.0273), and SIZE (0.0131), as does CRI with all variables except for a weak positive correlation with ROA (0.0660). DER also tends to be independent from other variables except SGR. SIZE shows a weak negative correlation with TATO (-0.1200) and CRI (-0.0816), but is almost uncorrelated with other variables. Overall, there are only two prominent linear relationships among all these variable pairs.

Table 3. Correlation Matrix

Variables	SGR	CRI	ROA	DER	TATO	SIZE
SGR	1.0000					
CRI	0.0020	1.0000				
ROA	0.0150	0.0660	1.0000			
DER	-0.8544	-0.0090	-0.0063	1.0000		
TATO	0.0273	-0.0251	0.2408	0.0200	1.0000	
SIZE	0.0131	-0.0816	-0.0261	0.0231	0.1200	1.0000

Note(s): SGR:

Source: EVIEWS Output Version 12, 2025

In our test, there was a problem of heteroscedasticity in the regression model shown in the White test:

Table 4. White Test

Statistics	Value	Statistics	Value
F-statistic	4.7705	Prob. F (20.531)	0.0000
Obs* R-square	84.0763	Prob. Chi-Square (20)	0.0000
Scaled explained SS	4763.4560		

Source: EVIEWS Output Version 12, 2025

With Prob. F (20,531) of 0.0000 and Prob. Chi-Square (20) of 0.0000, both of which are far below the significance threshold of 0.05, we can reject the null hypothesis (homoscedasticity). The conclusion of the White Test is that there is heteroscedasticity in the regression model. This means that the error variance is not constant, which violates the OLS assumption. To overcome this heteroscedasticity problem, we switch to Robust Least Squares (RLS) estimation. The robust method is designed to provide more reliable estimates when OLS assumptions are violated, including the presence of heteroscedasticity. Based on the Robust Test results, all independent variables CRI, ROA, DER, TATO, and SIZE show a probability (Prob.) below 0.05, which means that all of them have a statistically significant effect on SGR.

Table 5. Robust Test

Panel A Linear Regression	Dependent Variable	
	SGR	
Variable	Coefficient	Prob.
C	-0.1170	0.0010
CGI	-0.0039	0.0007
ROA	0.7701	0.0000
DER	0.0220	0.0000
TATO	0.0084	0.0019
SIZE	0.0033	0.0050
R-squared		0.2278
Adjusted R-squared		0.2207
N		552

Note(s): SGR:

*: Significant at the 5% level

Source: EVIEWS Output Version 12, 2025

DISCUSSION

An R-squared of 0.2278 means the regression model explains about 22–23 percent of the variation in SGR (sustainable growth rate), with an adjusted R-squared of 0.2207 slightly lower due to the penalty for additional predictors. This indicates a relatively low-to-moderate explanatory power of the model. Such a level is generally acceptable for firm-level cross-sectional data given the inherent heterogeneity and the many important omitted or unobserved factors. In other words, most of the variation in SGR is driven by factors outside the model. This R-squared suggests limited predictive power, so emphasis in analysis should be on the magnitude and significance of the regression coefficients. Even with modest fit, significant coefficients can still provide valuable insights. It is advisable to consider adding more relevant variables or conducting robustness checks to improve the model's reliability. A low R-squared also indicates that many key determinants of SGR are not included, so the model provides only a partial explanation.

First, the CGI variable has a negative coefficient of -0.0039 with a probability of 0.0007. This indicates that an increase in greenhouse gas (CGI) emissions is associated with a decrease in SGR. Companies with high CGI emissions may face pressure from increasingly stringent environmental regulations, additional operational costs for environmental impact mitigation, or even a negative reputation in the eyes of consumers and investors who are increasingly concerned about the environment. These factors collectively can hinder sales growth.

Second, ROA (Return on Assets) has a strong positive coefficient of 0.7701, with a probability of 0.0000. This shows that the higher a company's profitability in utilizing its assets, the higher its SGR. Companies that are able to generate greater profits from their assets are often companies that are efficient in their operations, have good management, and are able to reinvest profits for expansion and innovation, all of which support sustainable growth.

Third, the Debt to Equity Ratio (DER) shows a positive coefficient of 0.0220 with a probability of 0.0000. This implies that an increase in the debt to equity ratio tends to be followed by an

increase in SGR. Companies use debt to finance productive investments, such as expanding production capacity, developing new products, or penetrating markets. If these investments are successful, the impact will be seen in increased revenue, which ultimately supports sustainable growth. However, this must be supported by good debt management in line with good financial performance.

Fourth, TATO (Total Asset Turnover) with a positive coefficient of 0.0084 and a probability of 0.0019, shows a significant positive relationship with SGR. This means that a company's ability to generate sales from each unit of its assets is a major driver of sustainable growth. Companies with high TATO are highly efficient in converting assets into revenue, indicating optimal asset management that directly contributes to increased SGR.

Fifth, SIZE (Firm Size), which measures the size of the company, has a positive coefficient of 0.0033 with a probability of 0.0050. This shows that larger companies tend to have higher SGR. Logically, large companies often enjoy economies of scale, easier access to resources (capital, technology, talent), extensive distribution networks, and stronger brand power. These advantages enable them to have higher competitiveness and greater market growth opportunities, resulting in stronger sustainable growth.

The results of this study show that carbon risk has a negative and significant effect on sustainable growth (SGR) in Indonesian firms. This finding is broadly consistent with prior literature from other countries, although most previous studies focus on financial outcomes rather than sustainable growth directly. For instance, evidence from China indicates that higher carbon emissions increase financial risk and can lead to greater financial distress and reduced firm stability (Ding et al., 2023), and (Gao et al., 2023). Similarly, Zhou et al. (2018) find that firms with higher carbon risk face higher cost of debt financing, which can constrain investment and growth opportunities. These results align with the Indonesian context, where carbon risk also appears to hinder firm performance and growth capacity.

In European settings, studies such as (Palea & Drogo, 2020) show that firms with higher carbon emissions tend to face higher cost of debt, especially in countries with stricter environmental regulations. Furthermore, climate policy uncertainty in Europe has been shown to negatively affect financial markets and firm performance (Tedeschi et al., 2024). Compared to Indonesia, where environmental regulation is still evolving, the negative impact of carbon risk may be less institutionalized but remains economically significant.

In the United States, (Bolton & Kacperczyk, 2021) provide strong evidence that investors demand a carbon risk premium, meaning that firms with higher emissions face higher expected returns and thus higher capital costs. This implies that carbon-intensive firms may experience constrained access to capital, ultimately affecting their long-term growth prospects. This mechanism is consistent with the findings in Indonesia, where carbon risk reduces sustainable growth potential. Overall, while institutional environments differ, the evidence across China, Europe, and the US consistently suggests that carbon risk imposes financial and operational constraints on firms. The key contribution of this study is extending this relationship to sustainable growth (SGR) in a developing country context, demonstrating that the adverse effects of carbon risk are not limited to developed economies but are also highly relevant in emerging markets like Indonesia.

CONCLUSION

The analysis shows a robust negative effect of carbon risk on firms' sustainable growth in Indonesia. In other words, companies with higher carbon-related risk exhibit a lower potential growth rate. By contrast, standard financial indicators (ROA, DER, TATO) and firm size all have positive and significant relationships with SGR. These findings enrich the literature by extending the link between carbon risk and long-term corporate performance into the context of an emerging market.

For policymakers, the results underscore the need for strong carbon regulation, green incentives, environmental education, and enhanced reporting standards to encourage emission reduction. Corporate managers should integrate carbon risk management into their business strategies by investing in sustainability, improving reporting transparency, and innovating greener products.

Study Limitations: However, this study has important methodological constraints. The dataset is cross-sectional, covering only the short period 2021–2024, and therefore cannot capture

dynamic or long-term effects. The sample is limited to Indonesian non-financial firms, which may restrict the generalizability of the results. Key control variables (e.g. global policy shifts, macroeconomic conditions, or other ESG factors) are not included, raising the possibility of omitted-variable bias. Additionally, the measurement of CRI relies on emissions data that may be subject to reporting inaccuracies and industry variation, potentially affecting the regression results. These limitations imply that the findings should be interpreted with caution and not uncritically generalized to very different contexts.

Future Research: Building on these limitations, future studies should employ multi-year panel data to examine the dynamic impacts of carbon risk. Expanding the sample across sectors and countries would improve generalizability. Subsequent research could include additional variables such as corporate governance quality, specific government policy indicators, or broader ESG metrics to explore possible mediation or moderation effects in the CRI–SGR relationship. For example, researchers could investigate how ownership structure and stakeholder influences (financial institutions, regulators, public) affect a firm's carbon management strategies and sustainable growth outcomes.

Overall, this study explicitly acknowledges its methodological and data constraints and calls for more comprehensive models and broader analyses in future work. Despite these limitations, the results provide valuable guidance for policy and business practice on managing carbon risk to support sustainable corporate growth.

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