Do carbon emissions increase borrowing costs? Evidence from Indonesian SOEs

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Abstract

Climate-related risks have become increasingly relevant in corporate financing decisions. Yet, empirical evidence on how carbon emissions affect borrowing costs in state-owned enterprises (SOEs), particularly in developing countries, remains limited. In this study, borrowing costs are proxied by the cost of debt. This study analyzes the effect of carbon dioxide (CO_2) emissions on the cost of debt of Indonesian SOEs listed on the Indonesia Stock Exchange during the 2015–2024 period. Using a quantitative approach, the study employs firm-level data from LSEG Refinitiv and estimates fixed-effects panel-data regressions with clustered standard errors at the firm level. Robustness tests are conducted through winsorization and lagged independent variables. The results show that CO_2 emissions have a positive and significant effect on the cost of debt, indicating that creditors consider environmental risk when setting borrowing costs, even for state-owned firms. This relationship remains consistent in the winsorized specification, although the lagged emission variable is not statistically significant. The findings support the risk-based pricing, signaling, and legitimacy perspectives by showing that carbon emissions function as a relevant financial risk signal in debt markets. This study contributes to the sustainable finance literature by providing evidence from Indonesian SOEs, a context that remains underexplored in prior studies. In practice, the results imply that SOEs need to strengthen carbon-emission management, environmental governance, and transparency in disclosure to maintain more efficient access to debt financing.

Keywords: *Carbon emissions;Cost of debt; Environment; SOEs*

JEL Classification: C33, J64, O15, O47, R11

INTRODUCTION

Recently, climate change and carbon emissions have become among the most frequently discussed issues globally. This is because carbon risk poses an extraordinary threat compared to other risks (Mahmoudian et al., 2023). However, has this risk been effectively prevented or addressed? Creditors and investors are among those who pay close attention to environmental risks such as carbon emissions, as large corporations largely generate these. According to the Carbon Majors Database report, most of the world's carbon emissions are linked to a relatively small number of major companies.

Approximately 57 fossil fuel and cement producers are responsible for around 80% of global CO_2 emissions during the 2016–2022 period, with entities such as Saudi Aramco, Gazprom, Coal India, ExxonMobil, Chevron, and Shell accounting for the majority of these emissions. High levels of carbon emissions reflect the intensity of activities that have the potential to cause environmental harm and trigger stricter regulatory scrutiny. Creditors, such as banks, are likely to avoid lending to companies with high emissions due to reputational concerns (Ben-Nasr et al., 2025). These risks heighten creditors' perceptions of potential increases in operating costs and uncertainty in future cash flows; consequently, the various risks arising from a company's activities are reflected in the cost of debt, which is commonly used as a proxy for firms' borrowing costs (Caragnano et al., 2020; Chen, 2025; Hu & Liang, 2024). The cost of corporate debt is therefore one of the key implications of the growing focus on environmental risk. Lenders are increasingly incorporating environmental factors into their risk assessment processes, as high carbon emissions may signal potential exposure to regulatory risks, environmental penalties, future compliance costs, and reputational damage (Ehlers et al., 2022). This situation may increase the likelihood of default, prompting lenders to raise interest rates. Thus, carbon emissions can be a significant determinant of a company's cost of debt.

The relationship between carbon emissions and the cost of debt is becoming increasingly relevant for developing countries, including Indonesia, which is currently transitioning toward sustainable development. The Indonesian government has established various policies and commitments to reduce carbon emissions, including Nationally Determined Contribution (NDC) targets and stricter regulations related to emissions reporting and management (Ayuningsih et al., 2023). Indonesia is among the countries that have ratified the Paris Agreement and formalized its climate commitments through its NDC, which sets national greenhouse gas emission reduction targets as part of broader climate change mitigation efforts (Isah et al., 2025). Within this policy framework, companies are expected to play an active role in supporting the emissions-reduction agenda, both through operational efficiency and by adopting more environmentally sustainable business practices.

In theory, the relationship between CO_2 carbon emissions and the cost of debt can be explained through a risk-based pricing perspective, signaling theory, and legitimacy theory (Dowling & Pfeffer, 1975; Nguyen et al., 2025; Ross, 1997). From a risk-based pricing perspective, creditors determine the cost of debt by considering all risks inherent in a company, including environmental risks (IJFS). High carbon emissions indicate potential exposure to regulatory risk, environmental penalties, future compliance costs, and reputational damage, thereby increasing the probability of default and prompting creditors to raise the cost of debt (Meneses Cerón et al., 2024; Ren et al., 2025).

From the perspective of signaling theory, a company's environmental performance serves as a signal of management quality to external parties, helping to reduce information asymmetry. High carbon emissions signal weak risk management, low commitment to sustainability, and potential exposure to future regulatory and reputational risks. Several international studies show that creditors respond to these negative signals by increasing their credit risk assessments, which is ultimately reflected in a higher cost of debt (Cheng et al., 2025; Shi et al., 2025; G. Wang et al., 2022; L. Wang et al., 2025; Y. Yang et al., 2024).

Legitimacy theory emphasizes that companies must maintain social legitimacy by aligning their activities with prevailing social norms and expectations. In the context of carbon emissions, failure to manage or reduce emissions may be perceived as a deviation

from these norms and public expectations, thereby increasing pressure from stakeholders, including creditors. Research (Fujikura & Oe, 2023; Itan et al., 2025; Yao & Bao, 2024) shows that legitimacy gained through environmental disclosure and proactive sustainability practices can influence perceptions of risk and financing costs, including debt costs. In the context of state-owned enterprises (SOEs), failure to manage environmental impacts can further erode public legitimacy, as SOEs are viewed as extensions of the state in achieving sustainable development goals. Several previous studies, such as Al-Fakir Al Rabab'a et al. (2023) and Feng & Wareewanich (2024), which examine carbon emissions and the cost of debt, have largely focused on private companies in developed countries and have not specifically addressed the context of SOEs. In fact, SOEs possess unique institutional characteristics, in which the state acts as the controlling shareholder and establishes broader expectations that extend beyond financial performance to encompass social and environmental responsibilities (OECD, 2025; Q. Wang et al., 2022). State-owned enterprises are required not only to achieve optimal financial performance but also to ensure their operations are sustainable. Still, they are also expected to fulfill social functions, support economic stability, and serve as instruments for implementing government policies, including those related to environmental sustainability. Therefore, the environmental performance of SOEs has broader implications not only for the firms themselves but also for the state's legitimacy in the eyes of the public and international stakeholders.

Overall, these three theoretical perspectives complement one another in explaining the relationship between carbon emissions and borrowing costs. Risk-based pricing highlights the role of environmental risk in increasing financing costs; signaling theory explains how carbon emissions function as a signal of firm quality under conditions of information asymmetry; and legitimacy theory underscores the importance of social pressure and public expectations in shaping creditors' perceptions. Thus, environmental performance can influence the cost of debt through a combination of financial risk, informational signals, and legitimacy mechanisms.

Although the environmental finance literature shows that carbon risk is increasingly incorporated into corporate financing decisions, empirical evidence on state-owned enterprises (SOEs) remains relatively limited and inconclusive. Several studies indicate that government involvement can shape corporate environmental behavior through fiscal instruments, public governance, accountability mechanisms, and institutional oversight, particularly in SOEs operating in carbon-intensive sectors (Z. Yang et al., 2024; Hu & Liang, 2024). However, from a financing perspective, Al-Fakir Al Rabab'a et al. (2023) show that the effect of carbon information on debt costs tends to be weaker in SOEs than in private firms, suggesting that implicit government guarantees may obscure creditors' risk-based pricing mechanisms. At the same time, SOEs are also often associated with political intervention, operational inefficiency, and broader public accountability, which may increase creditors' perceived risk when environmental performance is poor. This creates an important theoretical ambiguity: whether carbon emissions are still priced as a financial risk by creditors when firms are state-owned but remain exposed to regulatory, reputational, and environmental pressures.

Based on this research gap, this study examines the effect of carbon emissions on the cost of debt for SOEs listed on the Indonesia Stock Exchange during the 2015–2024 period. This study contributes to the literature on environmental risk and corporate finance by positioning SOEs in a developing-country context as the primary research setting. This setting remains relatively underexplored in prior studies. It also extends the

application of risk-based pricing, signaling theory, and legitimacy theory by examining whether carbon risk remains financially material in firms with government ownership. In addition, this study uses CO_2-Equivalent carbon emissions data and a panel-data approach to capture firm-level dynamics over time. Based on theoretical foundations, prior empirical findings, and the institutional characteristics of SOEs, this study proposes the hypothesis that carbon dioxide (CO_2) emissions have a positive effect on SOE debt costs in Indonesia.

The remainder of this paper is organized as follows. Section 2 explains the methods, Section 3 presents the results, Section 4 discusses the findings, and Section 5 provides the conclusions, recommendations, and implications of the study.

METHODS

This study examines the impact of CO_2 emissions on the cost of debt for Indonesian state-owned enterprises (SOEs). The selection of SOEs is based on their significant role in the national economy and their distinct governance characteristics compared to private firms (Cardinalea et al., 2024). This study employs a quantitative approach using data from LSEG Refinitiv covering the period 2015–2024. The population comprises all SOEs listed on the Indonesia Stock Exchange. As not all data are available for each year, the study utilizes an unbalanced panel dataset.

Data analysis is conducted using a fixed-effects panel regression model to control for time-invariant heterogeneity across firms. Standard errors are adjusted using clustered estimation at the firm level to address potential autocorrelation and heteroscedasticity. The selection of the fixed-effects model is supported by the Hausman test, which indicates that it is preferable to the random-effects model. In addition, multicollinearity diagnostics using the Variance Inflation Factor (VIF) reveal no evidence of serious multicollinearity among the independent variables. Although additional control variables are commonly employed in the corporate finance literature, this study adopts a relatively parsimonious model in light of data limitations and to avoid overfitting, particularly given the limited sample size. The final sample consists of 20 firms.

Due to the limited availability of CO_2 emissions data for certain firms and periods, the dataset is unbalanced, and observations with incomplete data are excluded from the analysis. While this approach ensures consistency in the estimates, it may introduce potential selection bias. Nevertheless, the main findings remain robust across alternative model specifications. All analyses are performed using Stata MP 17. In general, the research model is specified as follows:

$$\mathrm{COD_{it}} = \alpha + \beta \mathrm{CO_{2it}} + \mathrm{XControl}_{it} + \mu_{\mathrm{i}} + \lambda_{\mathrm{t}} + \varepsilon_{\mathrm{it}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$\mathrm{COD_{it}}$ represents the dependent variable, namely the cost of debt for firm $i$in year t. The independent variable, $\mathrm{CO_{2it}}$ denotes carbon emissions. Furthermore, $\mathrm{XControl}_{it}$ is a vector of control variables, including return on equity, firm age, leverage, and firm size. The model also incorporates firm fixed effects. $\mu_i$to control for time-invariant firm-specific factors, as well as year fixed effects $\lambda_t$to account for annual macroeconomic variations. The term ε_{it}represents the error term.

This study also considers potential endogeneity in the relationship between CO_2 emissions and borrowing costs, as high-risk firms may simultaneously exhibit higher emissions and borrowing costs, and may also be influenced by unobserved industry characteristics. To mitigate this concern, the study employs lagged CO_2 emissions as a robustness check to introduce temporal separation between variables and applies

Winsorization to reduce the influence of outliers. Nevertheless, the results are interpreted as indicating an associative rather than a causal relationship.

Table 1. Variable description

Variables	Description
COD	The marginal cost of new debt is calculated as the weighted average of the short-term (1-year) and long-term (10-year) debt costs, based on the firm's credit curve.
CO_2	Total CO_2 emissions (in 10,000 tons of CO_2-equivalent), calculated as a combination of CO_2 and other greenhouse gases (CH_4, N_2O, HFCs, PFCs, SF_6, NF_3) in accordance with the GHG Protocol from LSEG Refinitiv.
ROE	Return on Equity, calculated as net income divided by total equity.
AGE	Firm age in years, calculated as the difference between the observation year and the year of establishment.
SIZE	Firm size, measured as the natural logarithm of total assets.
LEV	Leverage, measured as the ratio of total debt to total assets, reflects the extent to which a firm relies on debt financing.

Source: LSEG Refinitiv Eikon, processed by the author.

RESULTS AND DISCUSSION

Results

The initial summary of the data shows variation in both financial and environmental characteristics among the sampled SOEs. As shown in Table 2, the cost of debt (COD) has a mean value of 3.10 with a standard deviation of 1.87, while carbon emissions (CO_2-equivalent) have a mean value of 0.46 and a standard deviation of 1.18. Return on equity (ROE) averages 6.05% with a relatively high standard deviation of 19.99, indicating variation in firm profitability. The average firm age is 47.25 years, while the average firm size is 24.88, suggesting that the sample consists mainly of mature and large SOEs. Leverage has a mean value of 0.683, indicating that debt financing remains an important component of the capital structure of the sampled firms. Overall, the descriptive results indicate that the sample contains considerable variation in borrowing costs, emissions, profitability, firm characteristics, and leverage.

Table 2. Descriptive statistic

	N	Mean	Std. Dev	Min	Max
COD	199	3.099	1.868	0	15.272
CO_2	79	.464	1.180	.000	5.511
ROE	193	6.050	19.991	-144.1	47.64
AGE	200	47.25	17.082	1	78
SIZE	200	24.878	1.767	20.097	28.514
LEV	200	0.683	0.310	0.218	3.138
N	200				

The regression results provide evidence that carbon emissions are positively associated with the cost of debt. In Model (1), which is estimated without control variables, the coefficient of CO_2 emissions is positive and statistically significant at 0.526. In Model (2), after the inclusion of ROE, AGE, SIZE, and LEV as control variables, the coefficient decreases to 0.347 but remains statistically significant at the 5% level. This

result shows that the positive association between carbon emissions and the cost of debt remains present after firm-level financial characteristics are considered. Among the control variables in Model (2), ROE shows a positive and statistically significant coefficient, whereas AGE, SIZE, and LEV are not statistically significant. The details of these regression results are reported in Table 3.

Table 3. Impact of CO_2 on cost of debt

	(1)	(2)
CO_2	0.526***	0.347**
	(0.036)	(0.149)
ROE		0.048**
		(0.021)
AGE		0.051
		(0.113)
SIZE		1.271
		(1.181)
LEV		-1.256
		(2.084)
Constant	2.638***	-32.516
	(0.017)	(24.487)
Observations	78	78
R^2	0.054	0.293
Number of id	12	12

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

To assess the stability of the main regression results, two robustness specifications are estimated. In Model (1), which uses winsorized variables, the coefficient of CO_2_w remains positive and statistically significant at 0.350. ROE_w also shows a positive and statistically significant coefficient, while SIZE_w, AGE_w, and LEV_w are not statistically significant. In Model (2), which uses lagged CO_2 emissions, the coefficient of L.CO_2 is positive but not statistically significant. ROE remains positive and statistically significant, whereas SIZE, AGE, and LEV remain statistically insignificant. These results show that the positive association between carbon emissions and the cost of debt remains consistent in the winsorized specification, but not in the lagged specification. The details of the robustness results are presented in Table 4..

Table 4. Robustness test

	(1)	(2)
CO2_w	0.350**	
	(0.145)	
ROE_w	0.052**	
	(0.021)	
SIZE_w	1.515	
	(1.145)	
AGE_w	0.032	
	(0.108)	
LEV_w	-1.363	
	(2.082)	
L.CO2		0.005
		(0.198)
ROE		0.048**
		(0.021)

	(1)	(2)
SIZE		1.044
		(1.581)
AGE		0.066
		(0.169)
LEV		-1.908
		(2.757)
Constant	-37.810	-26.905
	(23.845)	(31.825)
Observations	78	66
R-squared	0.294	0.257
Number of id	12	10

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Discussion

The results of this study show that carbon emissions (CO_2) have a positive and significant effect on the cost of debt for state-owned enterprises listed on the Indonesia Stock Exchange. These findings indicate that the higher a company's carbon emissions, the higher its cost of debt. The results confirm that environmental risk is now a factor that creditors consider when determining financing costs, even for state-owned enterprises. This finding is supported by Bouchet and Crifo (2025), who confirm that although attention to climate transition risk is increasing, empirical studies on its impact on debt markets remain relatively limited. By developing a multidimensional transition risk index, their study finds that contemporary climate risks, reflected in emission intensity and energy portfolio composition, significantly increase debt costs.

In contrast, future-oriented risks become relevant after investor awareness increases following the Paris Agreement and the Intergovernmental Panel on Climate Change (IPCC) reports (2023). Similar evidence is found by Özşahin-Koç and Deran (2024), who show that total carbon emissions and emission intensity have a significant positive effect on debt costs for companies listed on sustainability indices, confirming that creditors actively price environmental risk. In addition, a cross-country study by Ririmasse et al. (2025) comparing emerging and developed markets finds that carbon-emission intensity is positively correlated with debt costs in countries with established emissions-reporting frameworks. Meanwhile, in emerging markets, emissions information continues to influence financing decisions, though it increasingly relies on third-party estimates.

State-owned enterprises (SOEs) differ from private companies in their institutional characteristics. As state-owned entities, SOEs focus not only on financial performance but also on a public mandate to support the sustainable development agenda and national environmental policy commitments. The OECD (2025) emphasizes that SOEs are major actors in the global economy and operate in strategic sectors that are vulnerable to environmental risks, such as energy, transportation, and heavy industry. Failure to manage carbon emissions can lead to reputational pressure, policy risk, and potential fiscal exposure for the state as the owner (OECD, 2025). In this context, high carbon emissions in SOEs can be viewed as a failure to meet public expectations and regulatory requirements, ultimately increasing creditors' risk perceptions and driving up debt costs. In line with this argument, the bibliometric study by Curi et al. (2025) shows that sustainability issues in SOE governance and financial strategy are relatively new but increasingly relevant, underscoring the importance of integrating sustainability considerations into SOE financial decision-making. Therefore, the findings of this study

reinforce the argument that carbon emissions constitute a material risk factor in the formation of SOE debt costs, particularly given SOEs' dual role as business entities and instruments of public policy.

The results of this study are consistent with the risk-based pricing perspective, in which creditors incorporate environmental risk into their assessment of corporate risk (Nguyen et al., 2025). Arian and Sands (2025) find that companies with higher carbon emissions exhibit greater idiosyncratic risk, thereby increasing the cost of debt. This becomes an important consideration in capital market risk assessments because such firms have greater potential to cause environmental harm. In addition, companies with high emissions pay higher average debt financing costs than less polluting firms (Meneses Cerón et al., 2024; Owolabi et al., 2024). Al-Fakir Al Rabab'a et al. (2023) find that companies with better carbon performance face lower debt costs, indicating that carbon risk is perceived as affecting a company's default risk and financial stability. In developing countries, Nasih et al. (2024) show that carbon disclosure reduces debt costs by lowering information asymmetry and meeting public expectations, thereby lowering the risk premium demanded by creditors. Furthermore, a study by Sukoco et al. (2025) of Indonesian companies finds that, following the tightening of environmental regulations, creditors began to internalize carbon risk more systematically into their debt cost assessments. Overall, these findings confirm that carbon risk is an important factor in determining debt costs through risk-based debt pricing mechanisms.

From a risk-based pricing perspective, although SOEs are often associated with implicit government guarantees, this study's results show that such guarantees do not eliminate creditors' sensitivity to carbon risk. Creditors continue to consider potential regulatory risks, compliance costs, and climate policy uncertainties that could affect SOEs' cash flows and repayment capabilities. These findings are consistent with Dong et al. (2025), who document a carbon risk premium in the corporate loan market: firms with higher carbon intensity face larger loan spreads, reflecting the internalization of carbon risk in debt pricing. In addition, Altavilla et al. (2024) show that banks systematically charge higher interest rates to firms with high carbon emissions, even after controlling for default probability, and that the carbon risk premium is even stronger among lenders committed to decarbonization. This evidence suggests that carbon risk is viewed as a real economic risk and is explicitly priced by lenders.

Theoretically, these findings can be explained through signaling theory, as developed by Ross (1997). This theory states that companies signal their quality and managerial responsibility to the market through costly actions. In the environmental context, carbon emissions reflect a company's risk management quality. High carbon emissions signal weak environmental risk management to creditors. This condition encourages lenders to raise the cost of debt to compensate for the perceived higher risk. Multi-stakeholder signaling studies show that strong environmental performance can reduce financing costs by reflecting operational efficiency and lower financial risk. However, a company's proximity to the government may weaken this signal (Li et al., 2025). In the context of SOEs, when carbon emissions remain high despite public mandates and state support, creditors tend to interpret this as a negative signal, which increases risk perception and drives up the cost of debt.

Drawing on legitimacy theory developed by Dowling and Pfeffer (1975), a company's failure to manage its environmental impact can erode its legitimacy in the eyes of stakeholders, including fund providers. In the context of financing, high carbon emissions increase the potential for transition, litigation, and reputational risks, which

ultimately reflect in higher debt costs (Dowling & Pfeffer, 1975). In the context of SOEs, legitimacy derives not only from the market but also from society and the government, which represent the public interest. When carbon emissions increase, the social legitimacy of SOEs may decline, leading creditors to assess that the company faces higher non-financial risks. These findings are consistent with those of Aryani et al. (2025), who found that poor environmental performance is associated with higher financing costs, particularly for companies with significant environmental exposure.

Unlike private companies, SOEs have unique institutional characteristics stemming from the state's role as a controlling shareholder. SOEs are expected not only to pursue financial performance but also to perform social functions and support the government's sustainable development agenda. Meanwhile, Hu and Liang (2024) indicate that the impact of environmental performance on debt costs tends to be more significant for non-state-owned enterprises than for state-owned enterprises, reflecting differences in creditors' sensitivity to environmental risk between the two types of firms. Therefore, high carbon emissions in SOEs can be perceived as a failure to meet public expectations and national environmental policies (OECD, 2025; Q. Wang et al., 2022). Overall, this study's findings confirm that environmental risks, particularly carbon emissions, are relevant factors in SOE debt financing decisions. These results imply that efforts to control emissions and improve environmental performance not only affect sustainability outcomes but also have the potential to reduce corporate financing costs.

Nevertheless, this relationship is not entirely free from alternative explanations. In the context of SOEs, an implicit government guarantee may reduce creditors' sensitivity to corporate risks, including environmental risks. As a result, carbon risks may not always be fully reflected in borrowing costs. Furthermore, differences in sectoral characteristics may also influence this relationship, as SOEs operating in carbon-intensive sectors, such as energy, may face greater pressure than those in other sectors. Therefore, the findings of this study should be interpreted in light of the institutional factors and sectoral heterogeneity inherent to SOEs.

The robustness test results show that the effect of carbon emissions on the cost of debt remains consistent. The positive significance of CO_2_w indicates that carbon emissions are perceived as a source of risk by creditors, thereby increasing debt financing costs. This finding reinforces the study's main results. The insignificance of L.CO_2 suggests that creditors are more responsive to carbon emission conditions in the current period than in the previous period. Overall, the robustness test results confirm that the research findings are not sensitive to changes in model specifications and are sufficiently reliable.

CONCLUSION AND RECOMMENDATIONS

Conclusion

This study analyzes the effect of carbon emissions on the cost of debt in Indonesian state-owned enterprises (SOEs) during the 2015–2024 period. The findings show that carbon emissions positively affect the cost of debt, indicating that creditors continue to consider environmental risk in their assessments of corporate financing, even for state-owned firms. This result suggests that implicit government guarantees do not fully eliminate creditors' sensitivity to carbon risk, particularly when firms face potential regulatory risk, reputational risk, and future compliance costs.

Theoretically, these findings support risk-based pricing, signaling theory, and legitimacy theory by showing that environmental performance serves as a relevant risk

signal in debt financing decisions. Empirically, this study contributes to the sustainable finance literature by providing evidence from SOEs in a developing country, a context that remains relatively underexplored. The findings also show that carbon risk is not merely a symbolic sustainability issue, but a financially material factor in corporate borrowing costs.

Recommendations

Based on these findings, SOEs need to strengthen carbon emission management as part of their financial and sustainability strategies. Efforts to reduce emissions, improve environmental governance, and increase transparency in carbon reporting may help lower creditors' risk perceptions and support more efficient access to debt financing. For policymakers, the findings highlight the importance of integrating environmental performance into SOE governance and financial supervision frameworks, so that sustainability commitments are reflected not only in policy targets but also in corporate financing practices.

This study has limitations related to data coverage, the availability of carbon emission information, and the use of selected financial control variables. Future studies may extend the observation period, include broader institutional and policy variables, and conduct sectoral analysis to capture differences between carbon-intensive and non-carbon-intensive SOEs better. This future direction may provide a more comprehensive understanding of how environmental risk influences debt financing in firms with state ownership.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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