Proceedings of the 10th International Conference on Economic Management and Green Development
DOI: 10.54254/2754-1169/2026.GT39434

ESG Disclosure Quality and Debt Financing Costs: Evidence from Highly Polluting Listed Companies in China

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Abstract. With growing regulatory and market attention to environmental, social and governance (ESG) issues, ESG disclosure has become increasingly important for corporate financing decisions. This study examines whether ESG disclosure quality affects debt financing costs among highly polluting listed companies in China and whether this relationship varies with firm size. Based on the 674 firm-year observations of A-share listed companies in the eight highly polluting industries from 2020 to 2024, multiple linear regression analysis will be carried out to investigate the effect of ESG ratings on financing costs. Based on the above results, a high ESG rating is associated with a lower debt financing cost, and this relationship is not affected by changes in firm size, leverage, profitability, growth rate and audit quality. According to the above analysis of heterogeneity, the negative impact of ESG disclosure on financing costs is relatively more serious for large enterprises than for small enterprises.The lagged one period ESG regression also indicates the validity of the results. In this case, the high quality of ESG disclosures can alleviate information asymmetry and creditors' risk perceptions and thus enhance the financing conditions of firms, whereas firm size can enhance the financing effects of ESG disclosures. The results can be used to provide evidences for high polluting firms to improve their ESG disclosures and for policymakers to encourage sustainable financing of firms.

Keywords: ESG disclosure, debt financing costs, highly polluting industries, firm size, China

1. Introduction

With the increase in attention to environmental, social and governance (ESG) issues, so too has the demand for corporate financing based on ESG performance been rising. High-polluting industries are associated with higher environmental and social risks for the company; thus, high-quality ESG disclosure can help address information asymmetry, improve creditors' risk assessment of the company, and reduce the cost of debt [1, 2]. Financing costs will thus provide a reference point for assessing the economic effects of ESG disclosure.

Listed companies in highly polluting industries in China will be under increasing pressure from regulators, investors and other parties to improve their ESG performance and disclosure. High-quality ESG disclosure can provide creditors with more all-round information on a company's environmental risks, governance quality and long-term operating conditions, reduce information

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asymmetry and perceived default risk [3, 4]. There is no clear indication of whether the increased ESG disclosures can decrease the cost of capital of a firm and whether it differs across firms.

Although previous studies have investigated the relationship between ESG and some financial variables, little attention has been paid to the effects of quality of ESG disclosures on financing costs of high polluting firms listed in China. Quality of ESG disclosure differs across firms. Larger firms have better ability in disclosing, more transparency in the market and safer relationship with financiers; thus, ESG information is more likely to be considered by investors and thus enhance the credit of ESG [5, 6].

In order to address these issues, the study will analyze A-share firms in eight high polluting industries in China from 2020 to 2024. ESG scores can be used to measure the quality of ESG disclosures, and operating debt is used to measure financing costs; thus, multiple regressions will be employed to analyze the relationships. The relationship between firm size should also be analyzed. Provide empirical evidence on whether ESG disclosures affect the level of firm debt and whether the effect is stronger for larger firms in this study.

2. Related work

Recent studies have investigated the correlation between ESG performance and a firm's financial outcomes. Based on signaling theory and information asymmetry, current research suggests that superior ESG disclosures serve as mechanisms for corporations to convey non-financial stability to capital markets [1, 2]. By reporting specific details regarding environmental protection, social responsibility, and internal corporate governance, the entity can enhance transparency and alleviate the uncertainty faced by creditors [2, 7]. This decrease in information asymmetry lowers the assessed default risk, consequently diminishing the risk premium required by financial institutions and bond holders, and ultimately lowering corporate debt financing costs [1, 7]. Nevertheless, the genuine impacts remain unclear; they fluctuate from region to region and depend on various regulatory frameworks [1, 7].

The Economic benefits of ESG disclosure are relatively higher for enterprises in environmentally sensitive and highly polluting sectors. Highly polluting enterprises face stricter environmental regulations and higher legal risks, are now required to undergo green transformation, and thus their environmental disclosures have become important indicators for banks' credit decisions and risk assessment [3, 4]. Good ESG disclosure by large-scale polluters can show that they comply with environmental regulations and engage in green innovation efforts; thus, credit risk is reduced and favourable loan terms are obtained [3, 4]. Based on a systematic review of the existing literature, Bauer et al. have gathered empirical evidence to show that environmental performance and disclosure work together to reduce perceived risk; thus, all-encompassing environmental disclosure generally lowers the cost of debt for listed companies [8]. However, creditors have become more discerning in their assessment of high-polluting enterprises to avoid "symbolic compliance" or "greenwashing", and thus the quality of ESG disclosure now affects debt financing costs [4, 8].

A large number of firms vary in size and thus show different financial results under ESG initiatives. According to the resource-based view and market visibility theory, larger enterprises generally have more administrative resources to publish detailed, standardised ESG reports; they attract the attention of financial analysts more readily and maintain good relationships with credit institutions [9]. The above institutional capacities increase the credibility and market coverage of ESG signals, thus enhancing the risk reduction effect of ESG disclosure on corporate debt costs [4-6]. Liu and others have found that firm size and structural characteristics are associated with changes in economic performance under ESG practices; that is to say, higher market exposure and stronger

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organisations can boost the financial benefits of green innovation [6]. On the other hand, smaller enterprises are often budget-constrained and receive less attention from the market, thus reducing the credibility and capital-market-absorption ability of their ESG disclosures [5, 6].

Although a large number of studies have examined the financial effects of ESG performance, empirical research that specifically investigates how the quality of ESG disclosure affects actual interest expenses in the context of Chinese highly polluting A-share listed companies is lacking. Expand the research scope to determine whether the moderating effect of firm size on debt financing results is explicit. Based on the above research deficiencies, this paper investigates whether a higher quality of ESG disclosure reduces corporate debt financing costs for Chinese heavy polluters and whether this effect is systematically amplified by firm size.

3. Research method

3.1. Data sources

This research utilized data from the CSMAR database, a highly authoritative and extensive database for financial and governance disclosure by Chinese listed firms. The initial pool included A-share firms on both the Shanghai and Shenzhen Stock Exchanges during the five-year interval from 2020 to 2024, focusing on the financial implications of corporate social responsibility on financing costs. To bolster the sample's representativeness and data quality, rigorous screening procedures were executed on the raw dataset: (1) Only enterprises from eight major polluting industries were selected: ferrous metal smelting and rolling, petroleum processing, coking, and nuclear fuel processing, chemical raw materials and chemical products manufacturing, and non-ferrous metal mining and beneficiation; (2) Firms classified as 'ST', '*ST', or 'PT' during the study period were dismissed to avoid financial anomalies from skewing regression findings; (3) Cases with significant or evidently abnormal data for vital factors were discarded. After these procedures, a final valid sample of 674 firm-years was collected.

3.2. Variable definitions

3.2.1. Dependent variable: financing costs (Cost)

In this study, the actual financing cost is used as the dependent variable, which is measured by dividing annual interest payment of a firm by its average annual interest debt. It directly measures the actual interest cost of a firm and is an objective measure of the financing cost level.

3.2.2. Independent variable: quality of ESG disclosure (ESG)

In this study, the ESG scores provided by Shangdao Ronglü for listed firms are used to measure the level of corporate social responsibility and quality of ESG disclosures. Shangdao Ronglü ESG scores include Environment (E), Social (S) and Governance (G). They are based on a comprehensive scoring system using data available from various sources such as annual reports, CSR reports and penalty notices, and thus can accurately measure the overall ESG performance of an entity.

3.2.3. Control variables

In order to control the biases due to inherent financial characteristics of the firm and external control system related to capital spending, the following control variables are used in the study: Firm size

DOI: 10.54254/2754-1169/2026.GT39434

(Size): measured as natural log of total assets at the end of the fiscal year to control the lending route and credit advantages of different sizes of the firm; Debt to Asset Ratio (Lev): Total liabilities at terminal date/Total assets at terminal date; it shows the overall monetary leverage and debt risk of the firm, which has a great influence on the risk premium of lenders; Return on Assets (ROA): Net income for quarter/Total assets at terminal date; it shows the overall efficiency of assets of a firm and depicts its inherent debt liquidity; Net Profit Growth Rate (Growth): ((Current period earnings – Last quarter earnings)/Last quarter earnings); it shows the opportunity of earnings growth of a firm and depicts the expectation of future strategic growth of the firm; Audit Quality (Audit): 1 if the auditing company of the firm for the fiscal year is one of the Big Four international auditing companies, else 0. Audit by the Big Four is more professional independent and has better data verification, thus leading to lower market information friction and hence influences the cost of capital.

Table 1. Definitions of research variables

Variable types	Variable Name	Variable symbols	Explanation of Variable Definitions
Dependent variable	Cost of capital	Cost	Annual interest expense / average annual interest-bearing liabilities: measures a company's actual cost of capital
Independent variable	Quality of ESG disclosure	ESG	Shangdao Ronglv`s comprehensive ESG rating for listed companies, scored from 1 to 9; a higher score indicates better ESG performance
Control variable	Company size	Size	Natural logarithm of the company's total assets at year-end
	Debt-to-equity ratio	Lev	Total liabilities at period-end ÷ Total assets at period-end, reflecting the company's level of financial leverage
	Return on total assets	ROA	Net profit for the period ÷ Total assets at period-end, measuring the company's return on assets
	Net profit growth rate	Growth	(Net profit for the current year – Net profit for the previous year) ÷ Net profit for the previous year, representing the company's profit growth potential
	Audit quality	Audit	Dummy variable: set to 1 if the auditor is one of the Big Four accounting firms, otherwise set to 0

4. Research model

To investigate the influence of corporate social responsibility on firm financial expenses, this research utilizes a multiple linear regression framework for empirical investigation. Within this model, financing costs (Cost) serve as the outcome variable, while the primary independent factor is the caliber of ESG reporting (ESG). Control variables encompass firm size (Size), debt-to-asset ratio (Lev), asset turnover (ROA), net income expansion rate (Growth) and audit reliability (Audit). Ordinary Least Squares (OLS) is adopted for parameter estimation.

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5. Result

5.1. Descriptive statistical analysis

Table 2 illustrates the summary measures for all primary research indicators within this study. Table 1 offers comparable data for all analytical elements. The mean financing cost for the investigated corporations was 0.018; however, the total expenditure on debt was relatively modest, featuring substantial fluctuations among various entities. The mean ESG score was 4.614, suggesting a balanced degree, yet distinct tiers of ESG progress and reporting were observed across different firms. Regarding the control factors, the variance of corporate capital holdings was extremely broad, signifying a vast gap in magnitude between major, medium and small listed organizations; the variations for debt-to-equity ratio, total asset return and net income expansion rates are high, encompassing a broad spectrum of extreme figures; there is a profound gap in the financial leverage, profitability and developmental capacity of the target corporations, featuring numerous extreme cases. The mean value of the audit quality binary variable is merely 0.073, signifying that merely 7.3 per cent of the sample entities utilize one of the Big Four accounting firms, suggesting inadequate distribution of superior external reviews.

Table 2. Descriptive statistics analysis results for study variables

Variable	Mean	SD	Min	Max
Cost	0.018	0.111	0	2.415
ESG	4.614	1.293	2	8
Size	2.70E+10	5.63E+10	1.34E+07	4.38E+11
Lev	0.767	6.854	0.070	178.346
ROA	-0.015	1.052	-27.046	1.408
Growth	-2.705	30.093	-474.344	267.539
Audit	0.073	0.260	0	1

5.2. Correlation analysis

Table 3 displays the Pearson correlation table for the current research indicators. Initial findings indicate that the coefficient of financing costs (Cost) regarding ESG assessments amounts to −0.145, indicating a substantial negative association at the 1% threshold. This implies that, given all other factors remain unchanged, an increase in the quality of a company's ESG reporting leads to decreased debt capital costs—a pattern aligned with the theoretical predictions of this investigation. ESG is also markedly positively associated with firm size (lnsize) at the 1% critical boundary (coefficient 0.232) and distinctly negatively related to the debt-to-asset ratio (Lev) at the 10% critical boundary (coefficient −0.080). This suggests that enterprises with larger scales typically have superior ESG evaluations, whereas those with extremely high debt levels tend to show relatively worse comprehensive ESG performance.

The parameter for financing expenses (Cost) and corporate size (lnsize) is –0.122, which is highly significant at the 1 per cent threshold, suggesting that enterprises with larger capital volumes face reduced debt capital costs; Cost is highly positively related to the debt-to-asset ratio (Lev) (0.099, $p < 0.05$), indicating that extremely indebted organizations bear a greater interest load on

DOI: 10.54254/2754-1169/2026.GT39434

their debt; Cost is highly negatively related to return on assets (ROA) (-0.106, $p < 0.01$), implying that companies with stronger profitability possess lower capital costs; these all match financial logic. The correlation coefficient between net profit expansion rate (Growth) and financing cost (Cost) is merely -0.019, failing the significance test, indicating that there is no significant simple linear connection between the two. The correlation coefficient between audit quality (Audit) and Cost is –0.039, which is not statistically significant; Audit is significantly positively linked with both ESG and firm size at the 1 per cent level, implying that larger corporations with robust ESG performance are more likely to choose one of the Big Four accounting firms to perform their audits.

Table 3. Correlation analysis results among study variables

Variable	1	2	3	4	5	6	7
Cost	-						
ESG	-0.145***	-					
lnsize	-0.122***	0.232***	-				
Lev	0.099**	-0.080*	-0.167***	-			
ROA	-0.106***	0.088**	0.183***	-0.993***	-		
Growth	-0.019	-0.019	0.014	0.000	0.017	-	
Audit	-0.039	0.199***	0.363***	-0.010	0.020	0.024	-

Note: *p<0.1, **p<0.05, ***p<0.01.

5.3. Regression analysis

Table 4 presents the results of the empirical tests for the benchmark regression models in this paper. Model (1) includes only the core explanatory variable, ESG, whilst Model (2) incorporates all control variables to conduct a comprehensive regression; the dependent variable in both cases is financing costs (Cost).

The regression results for Model (1), which includes only the core variable, show that the regression coefficient for ESG is −0.012, which is significantly negative at the 1 per cent significance level. This provides preliminary evidence that an improvement in a firm's ESG rating can significantly reduce financing costs. The constant term in Model (1) is 0.075 and passes the 1 per cent significance test. With a total of 674 sample observations, the model's coefficient of determination (R^2) is 0.020, indicating that the explanatory power of the single ESG variable alone on financing costs is limited.

In Model (2), which incorporates control variables such as firm size, debt-to-asset ratio, return on total assets, net profit growth rate and audit quality, the coefficient for the core explanatory variable, ESG, is –0.010 and remains significantly negative at the 1 per cent level. Even after controlling for firm characteristics such as financial performance, size and external audit, the mitigating effect of ESG performance on debt financing costs still holds, thereby validating the main effect hypothesis of this paper. Judging by the regression results for the control variables, the coefficient for firm size (lnsize) is −0.006, which is significantly negative only at the 10 per cent level, indicating that larger firms enjoy a certain advantage in terms of financing costs; whereas the regression coefficients for debt-to-asset ratio (Lev), return on assets (ROA), net profit growth rate (Growth) and audit quality (Audit) all failed to pass the significance test, implying that, within the scope of this sample, the

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aforementioned financial and audit characteristics do not exert a significant linear influence on financing costs.

A comprehensive analysis of the results from the two sets of baseline regressions reveals that, regardless of whether control variables are included, an improvement in the quality of ESG disclosure significantly reduces firms' financing costs, demonstrating the robustness of the main regression findings.

Table 4. Results for the benchmark regression analysis model

Variable	(1)	(2)
	Dependent Variable: Cost	
ESG	-0.012***	-0.010***
	(-3.796)	(-3.062)
lnsize		-0.006*
		(-1.949)
Lev		-0.005
		(-0.849)
ROA		-0.038
		(-1.084)
Growth		-0.000
		(-0.369)
Audit		0.009
		(0.489)
Constant	0.075***	0.212***
	(4.779)	(2.922)
N	674	674
R2	0.020	0.029

Note: *p<0.1, **p<0.05, ***p<0.01.

5.4. Heterogeneity test

Table 5 presents the results of the heteroskedasticity test based on firm asset size. In this study, the sample was divided into a small-asset-size group and a large-asset-size group according to the median firm asset size; both groups comprised 337 observations, with 'Cost' (financing costs) serving as the dependent variable for both. The regression results show that the regression coefficients for ESG are significantly negative at the 1 per cent level in both sample groups, indicating that, regardless of a firm's asset size, an improvement in ESG ratings can significantly reduce financing costs. However, there is a marked difference between the coefficients of the two groups: the ESG coefficient for small-scale firms is –0.003, whilst that for large-scale firms reaches –0.017, with the latter exhibiting a far stronger mitigating effect than the former. This result suggests that the role of ESG disclosure in reducing debt financing costs is more pronounced in large

DOI: 10.54254/2754-1169/2026.GT39434

enterprises. Large enterprises possess more sophisticated information dissemination channels, making it easier for creditors such as banks to recognise ESG signals, thereby fully realising the risk-mitigating value of such disclosures; in contrast, small and medium-sized enterprises have limited information dissemination channels, resulting in a relatively weaker effect of ESG disclosure on optimising financing costs.

Table 5. Heterogeneity test by asset size

Variable	Small asset Size	Large asset Size
	Dependent Variable: Cost	
ESG	-0.003***	-0.017***
	(-2.719)	(-2.648)
lnsize	-0.002	-0.026*
	(-1.501)	(-1.949)
Lev	0.035***	-0.005
	(3.746)	(-0.532)
ROA	0.019	-0.034
	(1.160)	(-0.592)
Growth	-0.000**	0.000
	(-2.505)	(0.056)
Audit	-0.001	-0.032
	(-0.139)	(-0.415)
Constant	0.061*	0.662**
	(1.705)	(2.311)
N	337	337
R2	0.085	0.027

Note: *p<0.1, **p<0.05, ***p<0.01.

5.5. Robustness test

Table 6 presents the results of robustness regression analyses using the core explanatory variable lagged by one period, with the dependent variable remaining financing costs (Cost). To mitigate potential bidirectional causal endogeneity in the model, this study re-conducted the regression using the one-period lagged ESG rating (L.ESG) as the core explanatory variable, thereby effectively avoiding estimation bias arising from the reverse influence of current-period financing costs on firms' current-period ESG disclosure levels. The regression results show that the regression coefficient for one-period-lagged ESG (L.ESG) is –0.018, which is significantly negative at the 1 per cent significance level. This indicates that the better a firm's ESG performance in the previous period, the lower its financing costs in the current period. This is entirely consistent with the conclusions drawn from the baseline regression, thereby fully demonstrating the strong robustness of this paper's core findings.

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Table 6. Results of robustness tests based on a one-period lag of the independent variables

Variable	(1)
	Dependent Variable: Cost
L.ESG	-0.018***
	(-3.017)
lnsize	-0.011*
	(-1.811)
Lev	0.046
	(1.221)
ROA	-0.134
	(-1.560)
Growth	0.000
	(0.128)
Audit	0.021
	(0.675)
Constant	0.332**
	(2.521)
N	370
R2	0.050

Note: *p<0.1, **p<0.05, ***p<0.01.

6. Conclusion

This article investigates the connection between ESG reporting quality and financing costs for A-share Chinese enterprises operating within high-pollution sectors from 2020 to 2024. Empirical findings indicate that a superior ESG grade correlates with a decreased capital cost; this inverse link remains evident even when considering factors like firm scale, debt, earnings, expansion and audit credibility. Heterogeneous analysis additionally reveals that the impact is more pronounced for larger corporations; therefore, company size could be positively linked to the monetary advantages of ESG reporting. Nevertheless, this study exhibits certain limitations. Primarily, the data pool is restricted to highly polluting firms within China, and hence the findings may lack broad applicability. Second, the exclusive use of a single ESG rating provider for data integrity might introduce measurement errors. Third, owing to the modest sample size and the usage of Ordinary Least Squares, endogeneity and hidden firm-specific variability may not have been adequately resolved. Subsequent investigation could broaden the dataset to encompass diverse sectors and nations, utilize diverse ESG datasets, and apply panel fixed-effects, instrumental-variables or quasi-experimental techniques to strengthen the causal connections. Additionally, further analysis may explore the causes for a lower ESG-lending cost for large corporations.

DOI: 10.54254/2754-1169/2026.GT39434

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