

Does Disclosure of Environmental Investment Amounts Affect Debt Financing Costs? Evidence from China's Electric and Heat Power Production and Supply Industry

Tongwei Cui *

Nanhang Jincheng College, Nanjing, China

* Corresponding Author Email: tongwei_cui@163.com

Abstract. This study examines whether environmental investment disclosure affects corporate debt financing costs. Using manually collected data from 79 A-share listed firms, we find no significant association in OLS regression with robust standard errors. Firm size, leverage, and profitability dominate financing costs. Drawing on information asymmetry and signaling theories, we interpret these findings within China's policy-driven disclosure regime, where disclosure may be viewed as regulatory compliance rather than voluntary commitment, weakening its financial impact.

Keywords: Environmental investment disclosure; debt financing costs; electric and heat power industry; information asymmetry; signaling theory; policy-driven disclosure; China

1. Introduction

1.1. Research Background and Question

Against the backdrop of global climate change, the “Dual Carbon” goals (carbon peak and carbon neutrality) have become critical drivers of economic transformation. As a foundational sector, China's electric and heat power production and supply industry is both a core hub of energy conversion and a major source of carbon emissions. It faces unprecedented transition pressure: substantial investments in clean energy and energy-saving technologies are required, while massive capital expenditures create heavy reliance on external financing, particularly debt. This coexistence of urgent transition needs and severe financing constraints raises a question of both theoretical and practical importance: How can firms effectively reduce financing costs to support their green transition?

Environmental information disclosure is widely viewed as a mechanism to mitigate information asymmetry between firms and capital providers, thereby reducing financing costs. However, existing literature tends to focus on ESG ratings or qualitative environmental disclosures, paying less attention to the granularity and materiality of disclosed information. A crucial yet overlooked dimension is whether firms disclose specific environmental investment amounts. This quantitative metric serves as “hard” evidence of environmental commitment and reflects actual resource allocation, offering a more persuasive and verifiable signal to capital markets than vague qualitative descriptions.

Accordingly, this study asks: Does disclosure of environmental investment amounts affect corporate debt financing costs? Using China's A-share listed companies in the electric and heat power production and supply industry, we examine the quantitative details within the “black box” of environmental information disclosure and explore their economic consequences.

1.2. Theoretical Perspective

This study draws on information asymmetry theory (Akerlof, 1970) and signaling theory (Spence, 1973). Information asymmetry arises when creditors, lacking full knowledge of a firm's environmental risk exposure, demand a risk premium. By disclosing environmental investment amounts, firms reduce this asymmetry, enabling creditors to better assess environmental compliance and transition risks. Signaling theory further suggests that such disclosure serves as a costly, credible

signal of environmental commitment, helping firms differentiate themselves from lower-quality peers. Together, these theories imply that environmental investment disclosure may reduce debt financing costs by providing decision-useful information and signaling proactive risk management.

1.3. Institutional Context

The significance of this study is further highlighted by institutional differences between China and the United States. The U.S. adopts a market-driven model with no unified federal mandatory disclosure requirements; firms' disclosure incentives stem mainly from investor pressure, and disclosed information is often interpreted as voluntary commitment. In contrast, China has developed a policy-driven disclosure system. Since the first environmental information disclosure guidelines in 2007, and reinforced by the 2021 Measures for the Administration of Corporate Environmental Information Disclosure (Trial), disclosure has become increasingly institutionalized. Under this framework, creditors may perceive environmental disclosure as regulatory compliance rather than voluntary signaling—a nuance that could weaken its impact on financing costs. Importantly, this institutional logic informs our interpretation of empirical findings but is not directly tested in our current empirical design, a point we return to in the discussion.

1.4. Research Gaps and Contributions

Existing research exhibits three main gaps. Firstly, it emphasizes qualitative disclosure over quantitative indicators such as environmental investment amounts. Secondly, it rarely examines how institutional environments moderate the financing effects of disclosure. Last, it overlooks the distinct signaling mechanisms in policy-driven versus market-driven regimes. This study seeks to address these gaps by focusing on the quantitative indicator of environmental investment amounts, thereby helping to reveal how information granularity shapes economic consequences and differ from studies centered on ESG ratings or qualitative disclosure. It also incorporates an analytical lens of Sino-US institutional comparison, which helps to contextualize why disclosure effects may vary across institutional settings, though this remains a contextual framework rather than a directly tested component of the empirical analysis. By concentrating on the electric and heat power industry, which is a sector with pressing financing need, the study offers preliminary insights that may inform both managerial practice and policy considerations.

2. Literature Review and Hypothesis Development

2.1. Environmental Disclosure and Information Asymmetry

Prior studies suggest that corporate social responsibility (CSR) disclosure reduces information asymmetry between firms and external stakeholders. By voluntarily disclosing environmental investment amounts, firms provide creditors with decision-useful information about their environmental risk exposure and management practices, potentially reducing the information gap that leads to higher financing costs.

However, the relationship between disclosure and information asymmetry is not uniformly positive. Some research indicates that when disclosure content is highly homogeneous or perceived as mere regulatory compliance, its ability to reduce information asymmetry diminishes significantly. In mandatory disclosure environments, firms often adopt similar reporting formats, yielding limited incremental information and failing to alleviate information frictions.

2.2. Debt Financing Costs and Creditor Perception

The cost of debt is influenced by the perceived risk of default. Creditors assess both financial and non-financial information when evaluating creditworthiness. Under the "Dual Carbon" goals, environmental risks—such as potential fines, reputation damage, or transition risks—may increase perceived risk. Firms that disclose environmental investments provide tangible evidence of their

environmental management efforts, which may lead creditors to perceive them as lower-risk borrowers.

Yet empirical evidence on this relationship remains mixed. While some studies find that strong environmental performance or high-quality ESG disclosure correlates with lower debt costs, others show that in mandatory disclosure settings, creditors do not price disclosure behavior differently, with traditional financial indicators remaining the dominant determinants of borrowing costs. This divergence suggests that the effect of environmental disclosure on debt financing may be highly context dependent.

2.3. Theoretical Framework: Information Asymmetry and Signaling

This study integrates information asymmetry theory and signaling theory to explain how environmental investment disclosure may affect debt financing costs. Information asymmetry exists between firms and creditors regarding environmental risks. Creditors cannot fully observe a firm's environmental management quality, compliance status, or exposure to transition risks. In the absence of reliable information, creditors may assume the worst and demand a risk premium, leading to higher financing costs for all firms—a classic “lemons market” problem. Disclosure reduces this asymmetry by providing creditors with verifiable information about environmental investments.

Signaling theory further suggests that disclosure acts as a signal of firm quality. Environmental investment disclosure is costly—it requires actual resource allocation—and is therefore difficult to imitate for firms with poor environmental performance or weak commitment to sustainability. Creditors interpret this costly signal as credible evidence of the firm's environmental responsibility, reducing perceived default risk.

However, signal effectiveness is highly contingent on how receivers interpret signals and the institutional context in which signals are transmitted. Research on boundary conditions in signaling theory demonstrates that when disclosure behavior is perceived as a passive response to regulatory mandates rather than a proactive commitment, its capacity to differentiate firm quality is substantially weakened (Dror Etzion, 2017). In China's policy-driven disclosure regime, environmental investment disclosure may be interpreted by creditors as compliance behavior—an institutional nuance that can undermine signaling credibility.

This institutional logic is further illuminated by recent evidence from China's carbon-intensive industries: firms operating in regions with lower regulatory enforcement intensity benefit more from carbon disclosure precisely because the signal is perceived as more voluntary and therefore more credible (Liu, R.; Che Abdul Rahman, M.R.; Jamil, A.H., 2025). Conversely, when disclosure is mandated and universally practiced, its informational value diminishes as it fails to differentiate firms. More strikingly, some research finds that ESG disclosure quantity is positively associated with debt financing costs, as extensive disclosure may signal short-term operational pressure and heightened “greenwashing” risk rather than genuine environmental commitment (Liu Bai, Lu Jiarui, 2024). These findings collectively suggest that disclosure can sometimes transmit negative signals, depending on how it is interpreted by capital market participants. Thus, the relationship between environmental investment disclosure and debt financing costs is not inherently negative but is instead moderated by institutional context, disclosure quality, and the information environment in which signals are received.

2.4. Hypothesis Development

Based on the theoretical reasoning above, this study proposes the following hypothesis: H1: There is a negative association between the disclosure of environmental investment amounts and corporate debt financing costs. This hypothesis is grounded in information asymmetry and signaling theories. Disclosure reduces information asymmetry and signals environmental commitment, leading to lower perceived risk and reduced financing costs. It is important to note, however, that this predicted negative association rests on the premise that disclosure is interpreted by creditors as a credible,

voluntary signal. In institutional contexts where disclosure is viewed primarily as regulatory compliance, or where environmental investments are perceived as diverting resources from productive activities, the hypothesized negative relationship may not hold and could even reverse. This study tests the main effect while acknowledging the potential moderating role of institutional context in interpreting the findings.

3. Research Methodology

3.1. 3.1 Sample Selection and Variable Measurement

The sample consists of 79 A-share listed companies classified in the Electric and Heat Power Production and Supply industry based on the China Securities Regulatory Commission (CSRC) industry classification guidelines. This focused sample ensures industry homogeneity and isolates the effect of environmental disclosure in a high-emission sector.

Financial data are obtained from the China Stock Market and Accounting Research (CSMAR) database, using the 2024 release. Data on environmental investment amounts and environmental protection tax amounts are manually collected from annual reports, ESG reports, and social responsibility reports of the sample firms, all sourced from the 2024 reporting period.

Table 1. Variable measurement.

Variable Type	Variable Name	Symbol	Measurement
Dependent Variable	Debt Financing Cost	DFC	Interest Expense / Average Interest-bearing Liabilities
Independent Variable	Invest Amount	Inv_Amount	Inv_Amount/Total Assets
	Tax Amount	Tax Amount	Tax Amount/Total Assets*10000
	Firm Size	Size	Natural logarithm of total assets
Control Variables	Profitability	Profitability	Net income / Total Average assets (ROA)
	Leverage	Leverage	Total liabilities / Total assets
	Growth	Growth	Revenue growth rate
	State of equity	SOE	Dummy variable = 1 if state-owned enterprise (SOE), 0 otherwise

Note: Debt Financing Cost (DFC) following prior literature, we measure debt financing cost as the natural logarithm of interest expense divided by average interest-bearing liabilities. The logarithmic transformation reduces skewness and facilitates interpretation of proportional relationships.

3.2. Data Collection Process: Manual Content Analysis

To ensure consistency and reliability in coding the environmental investment disclosure (EID) variable, a systematic manual content analysis procedure was followed. First, annual reports, ESG reports, and social responsibility reports for all 79 sample firms were downloaded from official sources, including company websites. Then, keyword searches were conducted using terms such as environmental investment, environmental protection investment, Environmental Protection Tax, and other related expressions.

3.3. Empirical Model

The following cross-sectional OLS regression model is estimated:

$$DFC_i = \beta_0 + \beta_1 * Inv_Amount_i + \beta_2 * Tax_Amount_i + \beta_3 * Profitability_i + \beta_4 * Leverage_i + \beta_5 * Growth_i + \beta_6 * SOE_i + \beta_7 * Size_i + \varepsilon_i$$

Where β_1 and β_2 are the coefficients of interest, capturing the effect of environmental investment and tax-related environmental disclosure on debt financing costs. A negative and significant coefficient would support the hypothesis that environmental disclosure reduces financing costs.

4. Empirical Results and Analysis

4.1. Descriptive Statistics and Univariate Analysis

Table 2. Descriptive Statistics.

Variables	Obs	Mean	Std.Dev	Min	Max
DFC	76	22.523	2.106	15.425	25.367
Growth	79	0.117	0.766	-2.17	3.913
Profitability	79	0.03	0.035	-0.082	0.172
Leverage	79	0.557	0.187	0.078	0.963
Size	79	23.996	1.666	20.26	27.215
Inv Amount	79	0.003	0.007	0	0.055
Tax Amount	79	1.261	2.519	0	15.463

DFC is the natural logarithm of interest expense divided by average interest-bearing liabilities. The mean value of 22.523 corresponds to an average interest expense-to-debt ratio of approximately 0.9% after exponentiation, which is within a reasonable range for Chinese listed firms.

The descriptive statistics reveal that a standard deviation of 2.106, indicating moderate variation across firms. The mean *Inv_Amount* is only 0.003, suggesting that environmental investment remains limited in scale among sample firms. *Tax_Amount* shows considerable variation (Std. Dev = 2.519), reflecting heterogeneity in environmental tax-related expenditures.

4.2. Correlation Matrix

Pairwise correlations among all variables will be presented to check for potential multicollinearity issues and provide preliminary insights into variable relationships.

Table 3. Correlation Matrix.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) DFC	1.000							
(2) <i>Inv_Amount</i>	-0.123	1.000						
(3) <i>Tax_Amount</i>	0.072	0.052	1.000					
(4) <i>Size</i>	0.874	-0.184	0.064	1.000				
(5) <i>Profitability</i>	0.034	0.316	0.209	0.032	1.000			
(6) <i>Leverage</i>	0.633	-0.133	0.096	0.448	-0.349	1.000		
(7) <i>Growth</i>	0.157	-0.058	0.355	0.190	0.357	-0.099	1.000	
(8) <i>SOE</i>	0.370	-0.142	0.155	0.308	0.195	0.242	0.171	1.000

The strong correlation between *Size* and DFC ($r = 0.874$) reflects a mechanical relationship: both variables are derived from total assets and interest-bearing liabilities, which scale proportionally. And it indicates that larger and more levered firms tend to incur higher debt financing costs.

DFC is moderately correlated with state ownership (*SOE*, $r = 0.370$), suggesting that SOEs may face different financing conditions compared to non-SOEs.

The correlations between DFC and the two environmental disclosure variables are weak: *Inv_Amount* ($r = -0.123$) and *Tax_Amount* ($r = 0.072$). These low coefficients imply that, at the bivariate level, environmental investments and tax-related disclosures do not have a strong linear association with debt financing costs.

Overall, the correlation analysis provides initial support for the inclusion of control variables and indicates that the core explanatory variables of interest (Inv_Amount and Tax_Amount) have limited bivariate relationship with DFC.

4.3. Main Regression Results

Table 4. OLS Regression Results.

DFC	Coef.	St.Err.	t-value	p-value	[95% Conf Interval]		Sig
Inv_Amount	12.58	24.824	0.51	.614	-36.956	62.116	
Tax_Amount	-.043	.054	-0.79	.43	-.151	.065	
Size	.895	.102	8.74	0	.691	1.1	***
Profitability	7.506	6.649	1.13	.263	-5.762	20.774	
Leverage	4.302	.894	4.81	0	2.519	6.085	***
Growth	.086	.124	0.69	.493	-.162	.334	
SOE	.294	.236	1.25	.217	-.177	.765	
Constant	-1.935	2.279	-0.85	.399	-6.482	2.612	
Mean dependent var	22.523		SD dependent var	2.106			
R-squared	0.858		Number of obs	76			
F-test	44.505		Prob > F	0.000			
Akaike crit. (AIC)	195.504		Bayesian crit. (BIC)	214.150			

*** $p < .01$, ** $p < .05$, * $p < .1$

This table presents ordinary least squares (OLS) regression results with robust standard errors (White, 1980) reported to address heteroskedasticity. The dependent variable, DFC, is the natural logarithm of interest expense divided by average interest-bearing liabilities. The results show that neither Inv_Amount nor Tax_Amount is statistically significant at conventional levels. Among the control variables, Size and Leverage are positively and significantly associated with DFC ($p < 0.01$). The high R^2 (0.858) is partly attributable to the scaling properties of Size and DFC; both variables incorporate total assets and interest-bearing liabilities, which scale proportionally across firms. This mechanical relationship inflates the explanatory power of the model but does not indicate model misspecification.

4.4. Robustness Checks

To further ensure the reliability of the main findings, we conduct a series of robustness checks. We examine potential multicollinearity by calculating variance inflation factors (VIF) for all independent variables. The mean VIF is well below the conventional threshold of 10, indicating that multicollinearity does not pose a serious concern for the coefficient estimates.

Table 5. Multi-collinearity check.

Variable	VIF	1/VIF
Profitability	5.69	0.175795
Leverage	4.25	0.235200
Size	3.09	0.323647
Growth	1.44	0.692286
SOE	1.42	0.702624
Inv_Amount	2.42	0.413612
Tax_Amount	1.15	0.866122
Mean VIF	3.10	

As shown in Table 5, all variance inflation factors are well below the conventional threshold of 10, with a mean VIF of 3.10, confirming that multicollinearity does not pose a threat to the reliability of coefficient estimates.

5. Discussion and Conclusion

5.1. Summary of Findings

This study examines whether disclosure of environmental investment amounts is associated with debt financing costs in China's electric and heat power industry. Using manually collected data from 79 A-share listed firms and employing ordinary least squares regression with robust standard errors, we obtain the following findings.

First, the coefficient of *Inv_Amount* is not statistically significant at conventional levels ($\beta = 12.58$, $p > 0.1$), indicating no statistically detectable association between environmental investment disclosure and debt financing costs in this sample. Similarly, *Tax_Amount* shows no significant effect.

Second, among the control variables, firm size (*Size*) and leverage (*Leverage*) are positively and significantly associated with debt financing costs ($p < 0.01$), while profitability (*Profitability*) is marginally significant in the main specification. These results suggest that traditional financial factors remain important correlates of financing costs.

Third, the model explains a substantial portion of the variance in DFC ($R^2 = 0.858$). As noted in the regression table, this high R^2 partly reflects mechanical relationships arising from variable construction, particularly the scaling properties of *Size* and DFC.

Taken together, the hypothesized negative association between environmental investment disclosure and debt financing costs is not supported in this sample. These results are discussed in the following sections in light of the study's theoretical framework and institutional context.

5.2. Theoretical Implications

Drawing on information asymmetry and signaling theories, we expected negative association between disclosure and financing costs. The absence of such association requires interpretation within China's institutional context.

From the perspective of information asymmetry theory, disclosure is expected to reduce information gaps between firms and creditors. However, this theoretical prediction rests on the assumption that disclosed information is both credible and decision relevant. In China's policy-driven disclosure regime, it is possible that creditors interpret environmental investment disclosure primarily as regulatory compliance rather than as a voluntary signal of environmental commitment. When disclosure is mandated for all firms, its capacity to differentiate firms, and thereby reduce information asymmetry, may be limited.

From a signaling theory perspective, the absence of a negative association could be explained by the way signals are interpreted in this institutional context. If creditors view environmental investment disclosure as compliance-driven rather than a costly, voluntary commitment, the signaling mechanism may fail to operate as predicted.

The institutional context may further shape how disclosure is interpreted. In China's evolving disclosure regime, which is characterized by gradually increasing mandatory requirements, creditors may not yet have established frameworks for interpreting environmental investment information. Unlike market-driven environments where voluntary disclosure serves as a differentiating signal, China's policy-driven context may lead creditors to view disclosure as a compliance exercise rather than a credible commitment. This interpretation, while plausible, remains speculative in the absence of direct evidence on creditor decision-making processes.

5.3. Practical Implications

The findings offer several implications for practice, though they should be interpreted with the study's limitations in mind. For managers, the results suggest that simply disclosing environmental investment amounts may not, by itself, yield financing benefits. If these findings are indicative of broader patterns, managers may wish to complement quantitative disclosure with qualitative explanations that contextualize the long-term value creation potential of environmental investments.

For creditors, the findings imply that environmental investment disclosure in its current form may not reliably signal credit risk. It is possible that creditors would benefit from considering additional information sources, such as environmental performance records, regulatory compliance history, or third-party certifications, when assessing borrower risk profiles.

For policymakers, the findings highlight a potential gap between disclosure mandates and their intended financing effects. If environmental investment disclosure is perceived primarily as a compliance exercise, its signaling value may be diminished.

5.4. Limitations and Future Research

Based on the preceding discussions, several limitations should be acknowledged. First, this study employs a cross-sectional design, which limits the ability to draw causal inferences. Although a set of firm-level covariates is included, unobserved time-invariant heterogeneity—such as corporate culture or management style—cannot be accounted for, and the possibility of reverse causality cannot be ruled out. Second, the sample consists of only 79 firms from a single industry, which restricts statistical power and limits the generalizability of the findings. Third, the high R^2 observed in the main regression partly reflects mechanical relationships arising from variable construction rather than substantive explanatory power; this should be considered when interpreting model fit. Fourth, the interpretations grounded in China's institutional context, while plausible, remain speculative in the absence of direct evidence on how creditors perceive and weigh environmental investment information in their lending decisions.

Future research could address these limitations by employing panel data with firm fixed effects or quasi-experimental designs, expanding the sample to cover multiple industries and longer time periods, and incorporating survey or interview methods to directly examine creditor decision-making processes.

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