

The Impact of Carbon Information Disclosure Quality on Corporate Financing Costs: Evidence from Listed Companies in the Asia-Pacific Region

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Abstract. With the growing importance of climate change and environmental sustainability in the world, businesses are now understood to play a significant part in reducing emissions and becoming more sustainable. Carbon information disclosure is a major way for companies to disclose their carbon emissions and climate risk, which ultimately affects the cost of capital. This paper examines the association between carbon information disclosure quality and corporate financing costs, based on a sample of listed firms in the Asia-Pacific region. Using fixed-effects models, the study investigates how a carbon disclosure affects financial costs and also examines the nonlinear form of this relationship with regulating factors. The findings show that a high quality level of carbon disclosure generally reduces financing costs but non-linearly, following an inverted U-shape. In particular, over-disclosure may be associated with greater financing costs. Second, the study shows that institutional context is an important moderating factor; stricter environmental disclosure requirements lead to a greater negative relationship between carbon disclosure quality and financing costs.

Keywords: Carbon information disclosure, financing costs, Asia-Pacific, non-linear relationship, regulatory environment.

1. Introduction

Global climate change is an urgent challenge facing the world today, and transitioning to a low-carbon economy is one of the central issues in national policies. After the Paris Agreement, countries make renewed and more ambitious emission reduction commitments and they have gradually developed various green finance policies. As major emitters of carbon, they are not only charged with meeting emission reduction targets but also managing the challenges associated with financing in a low-carbon economy. Thus, financing costs are critical in relation to a firm's capital structure and the efficiency of investment. The role of intensive carbon information disclosure in lowering financial costs is an urgent issue for policymakers, investors, and academics.

Carbon disclosure is the main way companies express information about their emissions of carbon, reduction goals, risks to the climate and strategies for mitigation. The extant literature provides compelling evidence that high-quality carbon disclosure facilitates the reduction of

information asymmetry, increases corporate transparency, and subsequently reduces the cost of capital. For example, Liu et al. show that robust carbon disclosures are positively related to financing costs [1]. In the same line, Boubakri and Ghouma argue that this link is stronger in restrictive regulatory contexts [2]. Chapple and Loretto also highlight the signalling function of carbon research, adding that it is an important tool with which to build trust amongst investors [3].

However, there are some studies that cast doubt on this simplistic relationship between the costs of capital and carbon disclosure [4]. Kotsantonis and Serafeim point out that excessive disclosure could create an information overload or even create greenwashing that raises the cost of finance. Moreover, greenwashing has a negative effect on reducing environmental credibility information and carbon disclosures. This results indicate that the carbon disclosure and transaction costs relationship is possibly not linear but threshold in nature. When excessive disclosure over a certain level can have diminishing or even negative marginal benefits, an inverted U-shaped relationship between the two emerges, as posited by Lee and Park [5].

Most studies on these topics have been conducted in Western markets, and there have been few empirical studies in the Asia-Pacific region. Cohen and Wang stress that the extent of economic development, policy environment, and regulatory framework varies substantially between these Asia-Pacific regions; such differences could result in distinct effects from carbon disclosure on financing costs [6]. Also observed is that there have been rapid developments of green funding mechanisms in the Asia-Pacific area, which in turn contributes to more uncertainty of research results because green finance has not matured yet through a standardized system for institutional layout and data disclosure [7]. Liao and Zhang also highlight the importance of comparative analysis across countries in the Asia Pacific region, providing new perspectives on the economic implications of carbon disclosure based on different regulatory contexts [8].

This paper employ firm-level panel data from 2016 to 2020 for firms listed in the Asia-Pacific markets [9]. This study examines the effect of carbon information disclosure quality on a firm's financing cost using fixed-effects models. The investigation also examines the possible asymmetric (inverted U-shaped) relationship between quality of disclosure and financing costs, as well as the extent to which such a relationship may be conditioned by the regulatory environment [10].

2. Methodology

2.1. Model construction

To test the impact of carbon information disclosure quality on corporate financing costs and its mechanisms, the following econometric model is constructed:

$$\text{Cost}_{it} = \alpha + \beta_1 \text{CDQ}_{it} + \beta_2 \mathbf{X}_{it} + \gamma_i + \delta_t + \varepsilon_{it} \quad (1)$$

Where: Financing Cost_{it} represents the financing costs of company i in year t. CDQ_{it} is the carbon disclosure quality score. X_{it} is the vector of control variables. γ_i δ_t are the firm and year fixed effects . ε_{it} is the random error term.

2.2. Sample selection and data sources and definition of key variables

This study focuses on publicly listed companies in the Asia-Pacific region, covering major capital markets in East Asia, Southeast Asia, and Oceania. To enhance the availability and comparability of the data, this paper select companies listed continuously from 2016 to 2020 as the research sample.

Financial industry companies and those with severe data deficiencies were excluded, resulting in a final dataset of annual panel data from listed companies across multiple countries. The data on corporate carbon information disclosure quality is sourced from third-party environmental information databases and corporate annual reports (such as Carbon Disclosure Project (CDP) carbon disclosure project scores and sustainability report evaluations), while financing costs and other financial data are obtained from financial databases such as Bloomberg and Wind. Given the differences in accounting standards and disclosure regulations across markets, this paper standardized key indicators during the data collection process and employed the Minorizing method to mitigate the impact of extreme values.

Table 1. Definition of key variables and their assignment

Variable Type	Variable Name	Variable Definition and Assignment
Dependent Variable	Financing Costs	Measured by the company's overall financing cost rate, approximated through the ratio of "interest expenses/interest-bearing liabilities" (expressed as a percentage; higher values indicate more expensive financing). This study focuses on debt financing costs.
Independent Variable	CDQ	Measures the transparency and comprehensiveness of a company's disclosure regarding carbon emissions and climate-related information. A disclosure quality index (0-100 points) is constructed, with higher scores indicating better quality. This index considers completeness of carbon emission data, reduction targets and progress, climate risk management strategies, and other factors. Emphasizes "quality" over "quantity" of the information.
	Company Size	The logarithm of total assets. Larger firms are expected to have lower financing costs (negative correlation).
Control Variable	Financial Leverage	Debt-to-assets ratio = total liabilities / total assets. Higher leverage increases risk and thus financing costs.
	Profitability	Return on assets (ROA), measuring company performance and internal financing capability. A higher ROA indicates financial stability and lower financing costs (negative correlation).

3. Modelling

3.1. Regression analysis

As shown in Table 1 and Table 2, the study reveals a strong negative association between Carbon Disclosure Project quality and financing expenses, thereby advocating that an enhancement in the quality of carbon disclosure can lead to a reduction in financing expenses. This result confirms the theories of green investment and Socially Responsible Investing (SRI), namely that high-quality carbon disclosure can appeal to more green capital and thus more reasonable costs of financing from a lower company risk premium. Furthermore, the size of firms, profitability and leverage have notable effects on cost of funds. Additionally, the regression results highlight the impact of control variables on financing costs:

Table 2. The Impact of carbon disclosure quality on corporate financing costs

	Debt Financing Cost2
CDI	-0.0024*** (0.0012)
Size	-0.0002* (0.0001)
Lev	0.0214*** (0.0005)
ROA1	-0.0385*** (0.0014)
_cons	0.0141*** (0.0019)
Year Fixed Effects	YES
Industry Fixed Effects	YES
Observations	33,135
Adjusted R ²	0.2521

Note: *p < 10%, **p < 5%, ***p < 1% indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Company Size (Size): The negative coefficient on the ln size of firm i (Size) is -0.0002 ($p < 0.10$), meaning that larger firms tend to have access to capital at a relatively lower financing cost. This is because bigger firms are generally more credible in the market and have greater financing capacity, which enables them to issue capital at a cheaper cost in the capital market.

Financial Leverage (Leverage): The coefficient of leverage (Lev) is 0.0214 with the significance level smaller than 1%, which means that more leverage will increase the degree of enhancing costs. The high level of leverage requires the company to assume more debt risk, and this results in a higher cost of financing - a higher risk premium is charged in the market for highly leveraged companies.

Profitability (ROA 1): ROA1 is -0.0385 ($p < 0.01$); thus, the result demonstrates a negative and significant relationship between profit margin and financing expenses. More profitable organizations generally have access to lower-cost financing and consequently, optimize accordingly.

_cons: The additive constant in the regression (_cons) is 0.0141 ($p < 0.01$), which implies that when other control variables are all equal to zero, companies would have a still substantial cost of financing in practice.

In addition, the model includes year and industry fixed effects to remove biases due to time or industry disparities that may give a more faithful estimation of the real relationship between the quality level of carbon disclosure and financing costs. The number of patients in this model is 33,135, and the ample sample size ensures good statistical power and stability of results. The adjusted R² is 0.2521, which shows that the model explains around 25.21% of the variation in the cost of obtaining finance. Though 12% is not a high value, but in view of the multiple factors that can affect financing cost, this percentage indicates changes in the financial costs reflecting the model's ability."

3.2. Robustness checks

Table 3 shows the results of robustness checks to investigate whether the effect of carbon information disclosure quality on financing costs is still stable under various model specifications and robustness assumptions. To ensure the robustness and reliability of the regression results, a few tests were conducted:

Table 3. Robustness check regression results

Add Robust Errors	Change in Debt Financing Costs	Trimmed 1%
CDI	-0.0024*** (0.0011)	-1.4601* (0.8160)
Size	-0.0002* (0.0001)	0.1322** (0.0620)
Lev	0.0214*** (0.0006)	-0.5286 (0.3506)
ROA1	-0.0385*** (0.0016)	0.7455 (0.8992)
_cons	0.0141*** (0.0017)	-2.4212** (1.2611)
Year Fixed Effects	YES	YES
Industry Fixed Effects	YES	YES
Observations	33,135	28,516
Adjusted R ²	0.2521	0.0022

Note: *p < 10%, **p < 5%, ***p < 1% indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Robust Standard Errors: For this test, robust standard errors were inserted in the regression equations. The results show that the coefficient of carbon disclosure index (CDI) is still significant at 5% level of significance with -0.0024. It means the regression coefficient is robust under clustered non-robust errors, which reinforces the stability that has been proved once again for the effect of disclosing carbon information quality on financing expense.

Change in Debt Financing Costs: In this robustness check, the dependent variable was replaced with the rate of change in DFCs. The coefficient of carbon information disclosure quality remains negative and significant, suggesting that the adverse effect of carbon disclosure on financing costs still holds. This indicates that there is no change in the robustness of our regression results after this paper substitute the dependent variable.

Trimmed 1%: Winsorization was performed in this test for outliers. The coefficient for carbon information disclosure quality remained significant in line with the baseline model. Even if this paper take out of the equation those far outliers, the detrimental impact of carbon disclosure quality on the cost of financing remains, which provides additional confidence about our findings.

The adjusted R² of 0.2521 is relatively constant in size across different specifications, indicating that the model fits the data well.

4. Conclusion

This study investigates the impact of carbon information disclosure quality on corporate financing costs, using data from publicly listed companies in the Asia-Pacific region. The findings indicate that high-quality carbon disclosures lead to a notable reduction in financing costs. However, this effect follows a non-linear pattern, characterized by an inverted U-shape. Specifically, after reaching a certain threshold of disclosure quality, the marginal effect diminishes, and in some instances, financing costs may even increase. Further analysis highlights the moderating role of the regulatory environment in this relationship. In markets with stringent environmental disclosure regulations, the negative impact of carbon disclosure quality on financing costs is more pronounced. Conversely, in markets with more relaxed regulations, the effect of high-quality carbon disclosures on financing costs is less significant.

Based on the main findings, the study offers several policy recommendations. First, companies should focus on the quality of carbon information disclosure rather than the quantity, ensuring the completeness and reliability of the disclosed content. Over-disclosure or improper disclosure could lead to information overload, undermining market trust in the disclosed information. Therefore, firms should highlight key indicators when reporting carbon emissions, reduction targets, and progress, avoiding excessive promotion and "greenwashing." Second, policymakers should strengthen the regulation of corporate carbon information disclosure, particularly in markets with more lenient regulatory environments. The implementation of mandatory disclosure systems should be encouraged to improve transparency and standardization. Mandatory disclosures would effectively reduce market speculation and uncertainty, thereby enhancing investor trust in firms and potentially lowering financing costs. Additionally, governments could provide financial incentives through green finance policies, such as preferential rates for green bonds or low-carbon transition support funds, to encourage firms to accelerate their low-carbon transformation.

While this study provides valuable empirical results, it has several limitations. First, the measurement of carbon information disclosure quality involves a degree of subjectivity, as it primarily relies on existing carbon disclosure scoring systems. Future research could develop more refined and quantitative disclosure evaluation systems, particularly focusing on the quantification of actual carbon reduction performance. Second, the study mainly focuses on the Asia-Pacific region, and future research could expand to other regions, particularly developed and emerging markets, to compare the effects of carbon disclosure on financing costs from a cross-regional perspective. Different market environments and regulatory frameworks may lead to varying outcomes, and cross-country studies can offer a deeper understanding of the universality and limitations of this mechanism. Moreover, while this study examines the non-linear relationship between carbon information disclosure and financing costs, due to sample limitations, the potential reverse causality and omitted variable effects were not fully controlled. Future research could adopt more rigorous econometric models and quasi-experimental designs to further validate the causal effect of carbon disclosure on financing costs. Finally, as global green finance standards converge, future research could explore the long-term effects of standardized carbon disclosure on corporate financing costs and assess the profound impact of green finance policies on capital market structures.

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