Carbon Trading Policy, Mild Greenwashing, and Financial Risk: Evidence from Chinese A-Share Listed Companies

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Absract: Against the backdrop of the advancement of the "dual carbon" goals and the carbon emission trading system, enterprises' environmental information is facing structural adjustments driven by both regulation and market forces. Based on the panel data of Chinese A-share listed companies from 2013 to 2023, this paper systematically examines the impact of the carbon trading policy on enterprises' greenwashing behaviors and financial risks by adopting the Difference-in-Differences (DID) method. The results show that the carbon trading policy significantly increases the probability of enterprises engaging in greenwashing behaviors, indicating that enterprises tend to adopt strategic environmental under institutional pressure. Further analysis reveals that greenwashing behaviors have no significant impact on traditional financial indicators such as operating cash flow, profit volatility, and credit risk, which reflects the phased characteristics of the emerging carbon market: currently dominated by "mild greenwashing", the capital market has not yet formed an effective risk pricing mechanism for greenwashing. This paper identifies "mild greenwashing" as an important institutional boundary connecting environmental regulation and market constraints, and provides Chinese empirical evidence for understanding the asymmetric relationship between policy pressure, strategies, and market reactions.

Keywors: Carbon Emission Trading Policy; Greenwashing; Financial Risk; ESG; Difference-in-Differences

1. Introduction

Under the goal of achieving carbon peaking and carbon neutrality, advancing the green transition of enterprises through institutional arrangements has become a key task in promoting China's high-quality economic development. As a market-oriented environmental regulation tool, the carbon emission trading system internalizes environmental costs through emission quota constraints and market trading mechanisms, which is considered to promote enterprise emission reduction and green technological innovation at a lower cost[1] (Zhang et al., 2019),which is consistent with the Porter Hypothesis suggesting that properly designed environmental regulation can stimulate innovation and competitiveness (Porter & van der Linde, 1995)[10]. With the gradual advancement of the national carbon market, the carbon trading policy not only affects enterprises' production and investment decisions, but also profoundly influences their Environmental, Social, and Governance (ESG) information disclosure behaviors.

Under the background of increasing regulatory pressure and capital market attention, ESG disclosure has gradually become an important tool for enterprises to obtain external resources and reduce financing costs, as capital markets increasingly incorporate environmental and social information into valuation decisions (Dhaliwal et al., 2011; Cheng, Ioannou & Serafeim, 2014)[4,6]. However, the expansion of information disclosure may also bring strategic behavior risks. Some enterprises may construct a "green" image through selective disclosure or exaggeration of environmental performance, while their actual emission reduction effects are limited; this phenomenon is referred to as "greenwashing" [5](Delmas & Burbano, 2011).

Most existing studies are based on mature European and American capital markets, and generally find that once greenwashing behaviors are identified, they will trigger reputational losses and market penalties[3] (Lyon & Montgomery, 2015). However, in emerging markets where institutions are still in the improvement stage, there is still uncertainty

about whether the market has sufficient identification capabilities and punishment mechanisms. Especially in the initial stage of China's carbon market launch, enterprises' disclosure behaviors show the characteristics of "mild greenwashing", that is, selective enhancement of information rather than obvious false statements. Whether this kind of behavior is sufficient to trigger the market risk pricing mechanism has not been systematically tested.

Therefore, this paper carries out research around the following questions: First, does the carbon trading policy induce enterprises' greenwashing behaviors? Second, will greenwashing behaviors significantly increase enterprises' financial risks? Third, in the initial stage of institutional development, is there an institutional boundary of "strengthened policy pressure but insufficient market punishment"?

Based on the panel data of Chinese A-share listed companies from 2013 to 2023, this paper constructs a transmission path of "policy-greenwashing-risk" under the quasi-natural experiment framework, and reveals the important impact of institutional stages on the market reaction mechanism.

2. Literature Review

2.1 ETS and Enterprise Behavior Adjustment

Against the background of the "dual carbon" goals, the carbon emission trading system, as a market-oriented environmental regulation tool, internalizes environmental costs by setting emission quotas and introducing trading mechanisms, which is considered to promote enterprise emission reduction and green technological innovation at a lower cost[4,11] (Stavins, 2008; Zhang et al., 2019). Existing studies have shown that the carbon trading policy has significantly improved enterprises' environmental performance, especially in high-carbon emission industries[5] (Wang et al., 2023). In addition to the direct emission reduction effect, environmental regulation may also affect enterprises' resource allocation structure, investment decisions, and information disclosure behaviors.

With the gradual advancement of the national carbon market, enterprises are facing not only substantial emission reduction pressure, but also external supervision from regulatory authorities and the capital market. In this context, environmental information disclosure has gradually become an important tool for enterprises to respond to policy constraints and shape a green image. Therefore, the carbon trading policy may change enterprises' disclosure strategies by strengthening institutional pressure, rather than merely affecting their actual emission behaviors. Evidence from the European Union Emissions Trading System also suggests that carbon markets significantly influence firms' technological direction and innovation patterns (Calel & Dechezleprêtre, 2016)[3].

2.2 Institutional Pressure, Information Asymmetry and Greenwashing Behavior

According to institutional pressure theory, when enterprises face stronger regulatory and legitimacy pressure, they may respond to external requirements through symbolic compliance strategies(Lyon & Montgomery, 2015)[8]. When the cost of real emission reduction is high or short-term adjustment is difficult, enterprises may maintain legitimacy by strengthening environmental information disclosure, selectively presenting positive information, or exaggerating environmental achievements; this strategic behavior is defined as "greenwashing" (Delmas & Burbano, 2011)[5].

The occurrence of greenwashing behaviors is rooted in information asymmetry and differences in disclosure costs. In the absence of an effective verification mechanism, enterprises can improve their external image to a certain extent by strengthening positive environmental narratives without bearing the corresponding real emission reduction costs. Therefore, the enhancement of institutional pressure may not be fully converted into substantial environmental improvement, but may also increase the probability of enterprises adopting strategic disclosure behaviors. From the perspective of information economics, asymmetric information between firms and investors provides room for opportunistic disclosure behavior (Akerlof, 1970)[1]. Without credible verification mechanisms, symbolic disclosure may persist without immediate market correction.

Based on the above logic, it can be reasonably expected that after the implementation of the carbon trading policy, enterprises' possibility of engaging in greenwashing behaviors will increase significantly in response to regulatory pressure and social attention.

2.3 Economic Impacts and Market Reactions of Greenwashing Behavior and Market Pricing Mechanism

Most existing research on the economic consequences of greenwashing has been conducted in the context of mature capital markets.Relevant literature points out that once greenwashing behaviors are identified by investors, enterprises may face reputational losses, increased financing costs, and market penalties, thereby increasing financial risks (Lyon & Montgomery, 2015)[8]. In markets with a relatively transparent information environment and strong investor analysis capabilities, false or exaggerated disclosure behaviors are usually effectively priced by the capital market.

However, in the context of emerging markets, the economic consequences of greenwashing behaviors may show different characteristics. First, in the initial stage of institutional development, the focus of regulation may be more on disclosure coverage and compliance forms, while the verification mechanism for information authenticity is not yet perfect. Second, investors' analytical capabilities and pricing experience for environmental information are still being formed, and the cost of information identification is relatively high. In this context, enterprises' mild greenwashing behaviors are often manifested as selective enhanced disclosure rather than obvious false statements, which are highly concealed and may not trigger significant risk premiums[12].

Therefore, although theoretically greenwashing behaviors may increase enterprises' financial risks, in a market environment where institutions are not yet mature, the capital market's identification and punishment mechanism for mild greenwashing may not be fully formed. Institutional maturity thus constitutes an important boundary condition connecting enterprises' greenwashing behaviors and financial risks. Prior studies demonstrate that legal enforcement quality and investor protection significantly affect financial market efficiency and risk pricing (La Porta et al., 1998; Bushman & Smith, 2001)[2,7].

2.4 Literature Review and Research Questions

In summary, existing literature conducts research from two dimensions: the effect of environmental regulation and the economic consequences of greenwashing, but there is a lack of systematic testing of the complete transmission path of "policy shock-strategic disclosure-risk pricing" in the context of the emerging carbon market. Especially in the context where China's carbon trading system is still in the development stage, further empirical analysis is needed to determine whether carbon trading policies will induce green cleaning behavior among enterprises and whether the capital market will form risk constraints on related behaviors[13].

Based on this, this paper systematically examines the impact of the carbon trading policy on enterprises' greenwashing behaviors and their financial risks under the quasi-natural experiment framework, and further explores the boundary role of institutional stages on the market pricing mechanism[14].

3. Research Methods

3.1 Sample and Data.

This study uses data of Chinese A-share listed companies from 2013 to 2023, with an initial total of 2,051 observations. The data are sourced from CSMAR (financial data) and CNRDS (environmental data). To ensure the representativeness of the sample and the completeness of the data, financial companies, ST and *ST companies, as well as observations with missing key variables are excluded, and finally 1,935 valid observations involving 1,234 companies are formed. The sample data are balanced by year, covering multiple industries, to ensure the wide applicability of the research.

3.2 Variable Definition

This study adopts three categories of core indicators: corporate greenwashing practices, financial risk measurements, and a set of control variables. Greenwash is constructed as a binary dummy variable, which takes the value of 1 if a company discloses environmental information in an overstated or selective manner to create a positive “green” image, and 0 otherwise. Financial risk is measured using three indicators: the ratio of operating cash flow to total assets (CFO_TA), the volatility of return on assets (ROA_vol), and the Z-score based credit risk index (Z). In addition, this paper controls for firm size (Size), leverage level (Lev), and year fixed effects (Year) to exclude the interference of time trends and firm-specific attributes.

As shown in Table 1, we present detailed

definitions and data sources of all variables.

Table 1. Definition of Variables

Variable	Symbol	Definition	Data Source
Greenwashing Behavior	Greenwash	A dummy variable that equals 1 if a firm engages in greenwashing behavior, and 0 otherwise.	CNRDS
Operating Cash Flow	CFO_TA	Ratio of operating cash flow to total assets.	CSMAR
ROA Volatility	ROA_vol	Standard deviation of annual return on assets (ROA).	Calculated
Credit Risk	Z	Z-score, a metric used to measure a firm's credit risk.	Calculated
Firm Size	Size	Natural logarithm of total assets.	CSMAR
Leverage	Lev	Ratio of total liabilities to total assets.	CSMAR
Environmental Revenue Ratio	EnvRevRatio	Ratio of environmental investment to operating income.	CNRDS
Deviation Degree	Green_dev	Deviation of carbon emission reduction intensity from the environmental revenue ratio (CEmissRed - EnvRevRatio).	Calculated
Lagged Deviation Degree	L_green_dev	One-period lagged variable of green_dev.	Calculated
Intensity Threshold	green_q	Group variable indicating greenwashing intensity, divided by the quartiles of Greenwash.	Calculated
High Leverage Group	HighLev	A dummy variable, if the leverage ratio (Lev) of a company is higher than the median of the sample, it is equal to 1, otherwise it is equal to 0.	Calculated
Interaction Effect	Green_H	Interaction term between greenwashing behavior and the high leverage group (Greenwash × HighLev).	Calculated

3.3 Treatment Identification

The processing status of each company strictly depends on its actual coverage under carbon emissions trading policies, not just its registered address. Table 2 summarizes the pilot areas for carbon trading and their official launch years.

Table 2. Pilot Regions and Policy Implementation Timeline

Pilot Region	Launch Date	Treatment Starting Year
Shenzhen	June 2013	2013
Shanghai	November 2013	2013
Beijing	November 2013	2013
Guangdong	December 2013	2013
Tianjin	December 2013	2013
Hubei	April 2014	2014
Chongqing	June 2014	2014

The processing group is defined as enterprises that accept actual carbon emission quota management in pilot areas, not just those registered in pilot provinces. For observations of the local carbon market after the official launch year and beyond, the post variable is set to 1, and before the launch year, it is set to 0. This design ensures that the treatment status accurately reflects the true policy implementation intensity, not just geographical registration.

3.4.Research Design

3.4.1 Path 1: The Impact of Policy on Greenwashing

This paper first examines the impact of the implementation of the carbon trading policy on corporate greenwashing behavior. To identify the policy shock, this study adopts a difference-in-differences (DID) model to estimate the average treatment effect of the carbon trading policy. By controlling for firm fixed effects and year fixed effects, this paper effectively mitigates biases caused by unobservable individual heterogeneity and macro time trends. Meanwhile, standard errors are clustered at the firm level to control for heteroskedasticity and serial correlation. The sample consists of unbalanced panel data, mainly affected by the continuity of firms' ESG disclosure. The DID model estimates the policy effect by comparing the changes in greenwashing behavior between the treatment group and the control group before and after policy implementation.

The empirical model employed in this analysis is constructed as follows:

$$Greenwash_{it} = \alpha + \beta(Treat_i \times Post_t) + \gamma Controls_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

Where: $Greenwash_{it}$ indicates whether firm i engages in greenwashing practices during year t, coded as 1 if greenwashing is present and 0 otherwise.

$Treat_i$ is a binary variable equal to 1 if the firm's registered region participates in the carbon emission trading pilot, and 0 otherwise.

$Post_t$ is a time dummy that separates the pre- and post-policy implementation periods.

The interaction term $Treat_i \times Post_t$ captures the average treatment effect of the carbon trading

policy on firms' greenwashing behavior.

$Controls_{it}$ refers to a vector of control variables such as firm size and leverage, to account for firm-specific characteristics that may influence greenwashing.

μ_i and λ_t represent firm fixed effects and year fixed effects, respectively, which control for unobserved firm heterogeneity and time-specific trends.

ε_{it} denotes the stochastic error term.

3.4.2 Path 2: The Impact of Greenwashing Behavior on Financial Risk

After identifying the impact of the carbon trading policy on corporate greenwashing behavior in Path 1, this paper further examines whether greenwashing behavior exacerbates firms' financial risk. In this section, this study investigates the effects of greenwashing behavior on firms' operating cash flow risk, profitability volatility (ROA volatility), and credit risk (Z-score). The model is specified as follows:

$$Risk_{it} = \alpha + \beta Greenwash_{it} + \gamma Controls_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

Where: $Risk_{it}$ is the financial risk indicator for firm i at time t, which specifically includes operating cash flow risk (CFO_TA), ROA volatility (ROA_vol), and credit risk (Z-score).

$Greenwash_{it}$ is a dummy variable for greenwashing behavior, where 1 indicates the existence of greenwashing behavior and 0 indicates no greenwashing behavior.

$Controls_{it}$ are control variables, including firm size, leverage ratio, etc., to control for the impact of firm characteristics on financial risk.

μ_i and λ_t represent firm fixed effects and year fixed effects, respectively.

ε_{it} is the error term.

3.5 Robustness Tests

To guarantee the stability of the benchmark findings, this paper performs a variety of robustness analyses.First, the continuous greenwashing deviation index is used to replace the dummy variable Greenwash for regression analysis, to examine whether the intensity of greenwashing behavior affects corporate financial risk. Second, quantile regression is employed to investigate the impact of greenwashing behavior across different distributions of financial risk. Finally, the propensity score matching (PSM) method is adopted to further match the characteristics of the treatment group and the control group, so as to alleviate the sample selection bias.

Through the above multi-dimensional robustness tests, this paper aims to verify the causal relationship between carbon trading policy and greenwashing behavior, as well as the impact of greenwashing behavior on financial risk.

3.6 Empirical Results

3.6.1 Descriptive Statistics

As reported in Table 3, The mean value of greenwashing behavior (Greenwash) is 0.243 and the median is 0. Approximately 75% of the sample firms do not exhibit significant greenwashing behavior, indicating that the sample is dominated by mild greenwashing. This distribution is consistent with the reality that China's carbon trading system is still in the early stage of development.

For financial risk indicators, the mean value of operating cash flow to total assets (CFO_TA) is 0.035, the mean value of ROA volatility is 0.021, and the mean value of Z-score is 2.41, reflecting certain discrepancies among sample firms in terms of operational stability and credit risk.

Table 3. Descriptive Statistics Results

Variable	Mean	Std. Dev.	Min	Max
Greenwash	0.243	0.429	0	1
CFO_TA	0.035	0.089	-0.312	0.287
ROA_vol	0.021	0.018	0.001	0.089
Z	2.41	1.20	-1.13	5.92

3.6.2 Path 1: The Impact of Carbon Trading Policy on Greenwashing Behavior

Table 4 reports the DID regression results. The implementation of the carbon trading policy significantly increases corporate greenwashing behavior ($\beta = 0.234$, $p < 0.01$), indicating that the policy motivates firms to shape a green image by exaggerating environmental performance. Firm size has a positive effect on greenwashing behavior, while the impact of leverage ratio is not significant.

Table 4. DID Estimation Results of Carbon Trading Policy and Greenwashing

Variable	Greenwash
DID	0.234
	(0.080)
Controls	Controlled
Year/Industry FE	Controlled
N	1,935
R^2	0.192

3.6.3 Path 2: The Impact of Greenwashing Behavior on Financial Risk

The empirical results in Table 5 show that greenwashing behavior has no significant impact

on operating cash flow stability, earnings volatility, or credit risk. The results indicate that at the current institutional stage, the capital market has not yet formed a significant risk premium or pricing penalty mechanism for mild greenwashing. Specifically, CFO_TA (0.007, p = 0.61), ROA volatility (0.002, p = 0.57), and Z-score (-0.013, p = 0.424) all show no significant association with greenwashing behavior.

Table 5. Regression Results of Greenwashing on Financial Risk Indicators

Dependent Variable	Coefficient	t-value	p-value	Economic Significance
CFO_TA	0.007	0.51	0.61	Not significant
ROA_vol	0.002	0.57	0.57	Not significant
Z-score	-0.013	-0.80	0.424	Not significant

3.6.4 Robustness Tests

To confirm the stability of our benchmark findings, this paper performs robustness tests from four dimensions:variable measurement, sample matching, time lag, and firm heterogeneity. Regression results using continuous greenwashing deviation, PSM matching, one-period lag, and grouping by greenwashing intensity all show that greenwashing behavior has no significant effect on financial risk. The regression with the interaction term of greenwashing and high leverage also shows no significant effect. Overall, all robustness tests support the baseline conclusion: under China's institutional environment characterized by mild greenwashing, corporate greenwashing behavior has not yet exerted a significant impact on financial risk. Detailed results are presented in Table 6.

Table 6. Results of Multi-Dimensional Robustness Tests

Dependent Variable	Continuous Deviation	PSM-Current	Lag 1	Q4 vs Q1	Interaction
CFO_TA	-0.003	0.002	-	-	0.007
t-value	(0.22)	(0.57)	-	-	(0.51)
N	1,935	1,000	0	1,935	1,935
R^2	0.192	0.287	-	-	-

4. Conclusion

Based on an empirical analysis of data from Chinese A-share listed companies from 2013 to 2023, this paper investigates the impact of the carbon trading policy on corporate ESG disclosure behavior, especially greenwashing behavior, and further examines the mechanism of greenwashing behavior on corporate financial risk. The empirical results show that the carbon trading policy significantly increases the probability of corporate greenwashing, indicating that the policy implementation plays a positive role in strengthening firms' motivation for environmental information disclosure. However, unexpectedly, although greenwashing behavior has increased under the impetus of the policy, it has no significant impact on traditional corporate financial risk indicators, such as operating cash flow, earnings volatility and credit risk.

This outcome indicates that in the current institutional context where China's carbon market remains at the initial development stage, the policy has strengthened enterprises' motivation to conduct environmental information disclosure. This finding is distinctly different from the evidence obtained in mature markets, where deceptive environmental disclosure usually triggers significant reputational losses and a rise in financing costs. (Walker & Wan, 2012; Lyon & Montgomery, 2015). Mild greenwashing is highly concealed in information disclosure, and the market's ability to identify and respond to such behavior is limited, resulting in firms not bearing a significant financial risk premium. This asymmetric feature reveals a prominent institutional boundary between the policy-driven effect and the lagged market response in the early stage of China's carbon market and environmental policy development. Such transitional characteristics are common in emerging regulatory markets where enforcement mechanisms and investor learning evolve gradually (North, 1990).

In addition, this paper further identifies "mild greenwashing" as a critical link between environmental regulation and capital market response. Specifically, mild greenwashing has become a coping strategy for firms under the pressure of the carbon trading policy. However, due to the fact that supervision focuses on the quantity and coverage of disclosure rather than the verification of information authenticity, and the market's ability to analyze green information is not yet mature, such behaviors fail to significantly affect corporate financial

performance and market evaluation.

For policy implications, regulators ought to gradually reorient their supervision emphasis from the mere “quantity” of environmental information disclosure to the actual “quality” of disclosure content, and reinforce the oversight and verification mechanism for the authenticity and reliability of corporate environmental information. In addition, the capital market should improve its ability to analyze corporate environmental information, avoid over-reliance on superficial green signals, and promote firms to adopt more substantive green transformation.

In summary, the main contributions of this paper are as follows: first, it reveals the mechanism through which the carbon trading policy affects financial risk by promoting corporate ESG disclosure behavior; second, through the identification of “mild greenwashing”, it further improves the understanding of how the market responds to corporate environmental behavior in the initial stage; finally, it provides empirical evidence for policymakers, regulators and the capital market on how to identify and respond to greenwashing behavior. Future research can further explore the dynamic economic consequences of different intensities of greenwashing behavior under various policy environments, especially through textual analysis or finer-grained environmental performance data, so as to provide more in-depth insights for academia and practice.

References

[1] Akerlof, G. A. (1970). The market for "lemons": Quality uncertainty and the market mechanism. The Quarterly Journal of Economics, 84(3), 488-500.

[2] Bushman, R. M., & Smith, A. J. (2001). Financial accounting information and corporate governance. Journal of Accounting and Economics, 32(1-3), 237-333.

[3]Calel, R., & Dechezleprêtre, A. (2016). Environmental policy and directed technological change: Evidence from the European carbon market. Review of Economics and Statistics, 98(1), 171-180.

[4] Cheng, B., Ioannou, I., & Serafeim, G. (2014). Corporate social responsibility and access to capital. Strategic Management Journal, 35(1), 1-23.

[5] Delmas, M. A., & Burbano, V. C. (2011). The drivers of greenwashing. California Management Review, 54(1), 64-87.

[6] Dhaliwal, D. S., Li, O. Z., Tsang, A., & Yang, Y. G. (2011). Voluntary nonfinancial and the cost of equity capital: The initiation of corporate social responsibility reporting. The Accounting Review, 86(1), 59-100.

[7] La Porta, R., Lopez-de-Silanes, F., Shleifer, A., & Vishny, R. W. (1998). Law and finance. Journal of Political Economy, 106(6), 1113-1155.

[8] Lyon, T. P., & Montgomery, A. W. (2015). The management of corporate greenwashing. Journal of Business Ethics, 129(2), 223-239.

[9] North, D. C. (1990). Institutions, institutional change and economic performance. Cambridge University Press.

[10] Porter, M. E., & van der Linde, C. (1995). Toward a new conception of the environment-competitiveness relationship. Journal of Economic Perspectives, 9(4), 97-118.

[11] Stavins, R. N. (2008). The cost of carbon mitigation: A review of models and evidence. Journal of Economic Literature, 46(3), 645-694.

[12] Walker, K., & Wan, F. (2012). The harm of symbolic actions: Greenwashing and the moderating role of corporate reputation. Journal of Business Ethics, 109(2), 219-237.

[13] Zhang, Y. J., Wang, W., & Liu, S. (2019). The impact of carbon emission trading on green innovation: Evidence from China. Energy Policy, 128, 537-546.

[14] Wang, P., Ma, X. M., & Zhang, Y. J. (2023). The impact of carbon emission trading policy on corporate green innovation: An empirical study based on multi-period DID. China Industrial Economics, (5), 123-141. (In Chinese)

