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The impact of the environmental protection tax on ESG greenwashing among heavily polluting enterprises in China

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Abstract Against the backdrop of rapid global sustainable development and green finance, the quality of Environment, Society, and Governance (ESG) information disclosure has increasingly garnered attention from regulators and investors. However, the phenomenon of companies engaging in ESG greenwashing through symbolic disclosure is becoming increasingly common, which impairs capital market resource allocation efficiency and hampers the clear transmission of policy signals. This study takes the implementation of the 2018 Environmental Protection Tax Law as an exogenous shock and utilizes data from Chinese A-share listed companies to empirically test how the introduction of environmental protection tax affects corporate ESG greenwashing behavior using the Difference in Differences (DID) method. The findings indicate that the enforcement of environmental protection tax notably curtails such greenwashing behavior, and this outcome has been consistently confirmed through various robustness checks. Moreover, further mechanism analysis reveals that environmental protection tax indirectly curbs greenwashing behavior by increasing analyst attention, easing corporate financing constraints, and encouraging companies to reduce symbolic disclosure. Further, results from the heterogeneity analysis demonstrate a significantly stronger effect of environmental protection tax governance in the eastern region, high tax burden areas, and enterprises with high ESG scores. This paper explores the economic impacts of environmental protection tax from the perspectives of signal transmission and compliance, enriching the research path of external governance mechanisms for ESG greenwashing behavior. At the same time, using a text similarity index based on natural language processing to quantify the degree of greenwashing provides a new measurement tool for ESG research.

Index Terms Environmental protection tax, ESG greenwashing, Symbolic disclosure, Text similarity, Heavy-polluting enterprises

I. Introduction

With the advancement of global environmental projects, ESG rating scores have become a key indicator for measuring a company's sustainable development. However, in recent years, serious greenwashing disorder has gradually been exposed in the process of ESG information disclosure. Specifically, ESG greenwashing behavior misleads investors in judging a company's true sustainable performance through vague disclosure, selective information presentation, and other means. This not only leads to resource misallocation but also damages the trust foundation of the capital market in green finance. Hassan (2024) [1] pointed out that the lack of unified regulation and mandatory disclosure audits makes it difficult for ESG rating mechanisms to identify the true performance of companies, further exacerbating the systemic skepticism and trust crisis of the market towards ESG investment tools. The greenwashing not only led to investors' misjudgment of the actual ecological performance of companies, but also weakened the credibility of the ESG rating mechanism, and even triggered a systematic crisis of trust in green finance in the capital market. The text similarity study found that the ESG reports of Chinese listed companies are highly homogeneous. Some enterprises have used similar templates to disclose social responsibility content for several consecutive years [2]. Faced with the increasingly rampant ESG greenwashing behavior, traditional mechanisms relying on voluntary disclosure and external reputation supervision by enterprises are no longer effective in curbing false compliance motives.

Therefore, more and more research is focusing on the role of external institutional constraint tools in regulating corporate green behavior. As an essential component of environmental policy, the environmental protection tax is considered an important external policy tool that may affect the motivation for corporate ESG disclosure due to its direct increase in environmental governance costs through the polluter pays mechanism [3]. China formally enacted the Environmental Protection Tax Law in 2018, elevating environmental management from a fee system to a tax framework. The law clearly imposes taxes on pollutant emissions, with the goal of incentivizing enterprises to shift towards substantive green governance through economic means, while also strengthening external market attention to environmental behavior through policy signals. This provides us

with an ideal research background to explore whether environmental protection tax can alleviate companies' symbolic compliance behavior in ESG disclosure, thereby suppressing greenwashing.

Existing research mainly reflects two key viewpoints about environmental protection tax and ESG greenwashing. Some researchers believe that introducing environmental protection tax may temporarily exacerbate corporate greenwashing behavior. Related research indicates that when the environmental protection tax increases the compliance costs of enterprises and the supporting resources and incentive mechanisms are not yet perfect, enterprises may cope with supervision through formal disclosure, repetitive reporting to achieve compliance appearances [4]. Berrone et al. (2017) [5] also found that under the dual effects of regulatory pressure and social expectations, if a company's environmental performance is insufficient, it may gain legitimacy through ESG greenwashing, which can backfire. Research has shown that sample companies have increased their ESG greenwashing levels by 13.16% after implementing environmental protection tax, suggesting that firms prefer symbolic disclosure as a response to cost pressures, especially in large enterprises and provinces with strong regulation [6]. In addition, environmental protection tax may also drive companies to engage in green mergers and acquisitions to enhance ESG ratings, but most of the related mergers and acquisitions are cross regional acquisitions, related to weak governance areas, and more reflected in pollution transfer and formal compliance [7]. However, supporters argue that the environmental protection tax not only strengthens the cost and institutional pressure of environmental governance but also enhances the authenticity of corporate ESG information disclosure, thereby curbing greenwashing behavior. Early research has shown that government environmental regulatory systems have a good effect on incentivizing companies to comply with green regulations through punishment mechanisms, especially in regions with stronger regulation and higher information disclosure requirements, which can reduce symbolic disclosure [8]. At the same time, after receiving environmental subsidies or facing environmental tax pressure, enterprises have a stronger motivation to improve environmental performance and reduce greenwashing, especially in state-owned enterprises [9]. Recent research confirms that environmental protection tax not only improves ESG outcomes by enhancing green innovation and strengthening governance structures, but also reduces corporate strategic compliance behavior through external supervision mechanisms such as increasing analyst attention [10]. Furthermore, environmental protection tax can also encourage enterprises to engage in significant environmental investment initiatives and to reduce their motivation for false disclosure to a certain extent [11].

Based on the above analysis, the existing research conclusions on whether environmental protection tax can effectively govern ESG greenwashing behavior are still inconsistent, presenting distinct theoretical contradictions and practical complexities. It is urgent to conduct more targeted empirical research in a specific institutional context. This study employs the 2018 Environmental Protection Tax Law as a control in a quasi-natural experiment to discern the influence of the tax on firms' greenwashing practices. Then, we construct a difference DID model with data from heavily polluting enterprises in China. Specifically, we analyze corporate social responsibility reports using TF-IDF to measure text similarity and derive the Greenwash score [2], [12]. The result indicates that the environmental protection tax can significantly curb ESG greenwashing. Post robustness assessments including the parallel trend, placebo, and propensity score matching tests, the study's findings retain their stability. Further, this paper finds that environmental protection tax can suppress ESG greenwashing by enhancing analyst attention, alleviating financing constraints, and encouraging companies to reduce symbolic disclosure. Moreover, by incorporating regional and firm-specific characteristics, we investigate the differential impact of the environmental tax on greenwashing in varied contexts. Results indicate that the environmental protection tax substantially strengthens its suppression of ESG greenwashing in the eastern region, in jurisdictions with higher tax burdens, and among firms with stronger ESG performance.

This study offers notable contributions beyond current research. In terms of theoretical contributions, this paper starts from the link between environmental protection tax and corporate greenwashing behavior in ESG, responds to the current academic differences on this issue, and broadens the research outlook on the economic consequences of environmental protection tax and ESG compliance governance. Limited research exists on how the environmental protection tax influences corporate ESG outcomes or disclosure practices [6], [10], but there is no unified conclusion yet on whether it can effectively curb greenwashing behavior. Some literature suggests that environmental protection tax can effectively suppress symbolic compliance tendencies by increasing environmental governance costs and strengthening external regulatory signals [9], [11]; Another part of the research suggests that policy pressure may induce firms to engage in formal disclosure behavior in the context of insufficient resource support, which in turn exacerbates greenwashing [4], [5]. On this basis, this article further combines legitimacy theory and signal transmission theory to systematically identify the multi-path mechanism of environmental protection tax to suppress greenwashing. Not only did it provide a micro-level response to the aforementioned divergent views, but it also achieved an organic combination of two literature systems of environmental protection tax research and ESG greenwashing governance.

In terms of methodological contributions, this paper innovatively uses the text similarity index of listed companies' social responsibility reports to quantify the degree of ESG greenwashing of enterprises, and constructs a symbolic disclosure recognition framework based on natural language processing to compensate for the subjectivity and limitations of traditional ESG greenwashing measurement methods [2], [12]. Previous studies have relied heavily on third-party rating agencies to infer greenwashing behavior based on differences in ESG scores or abnormal patterns between corporate ESG performance and cash flows [13], [14], but these methods are often influenced by factors such as bias from rating agencies and data scarcity. In

contrast, this article calculates the textual similarity of social responsibility reports between different periods to capture whether companies have a tendency towards template-based and empty generalization in information disclosure, which more directly reflects symbolic compliance behavior. This method not only improves the objectivity and operability of greenwashing recognition but also provides a text-mining-based ESG research paradigm for subsequent research, which has strong expansion value.

The subsequent parts of the article are organized as follows. Section 2 introduces the policy background and proposes research hypotheses. Specifically, Section 3 offers an in-depth overview of the selection of samples and related variables and the design of empirical models. Then, Section 4 presents the initial regression findings and performs robustness checks to validate the results. Further, Section 5 delves into the underlying mechanisms and investigates the discrepancies in the effects of environmental protection tax in various settings. Finally, Section 6 wraps up with conclusions and practical policy implications.

II. Background and hypothesis development

II. A. Background and hypothesis development

Amid the worsening environmental pollution crisis, China formally introduced the Environmental Protection Tax Law on January 1, 2018. This move signifies a complete shift from the previous pollution fee framework to a more structured, legally mandated tax system. The tax is based on the polluter-pays principle and targets air and water contaminants, solid waste, and noise pollution, aiming to foster corporate greening and advance ecological civilization via economic incentives. Unlike the old pollution fee system, the tax boasts a more robust legal backing, a clearer and more straightforward collection process, and a reduced level of interference from local authorities, which helps to build a more standardized and institutionalized environmental governance system [3]. The tax not only directly raises operational expenses for polluting enterprises, but also indirectly strengthens the motivation of enterprises' environmental protection compliance by transmitting the system signal of environmental treatment priority to the market.

On the theoretical basis, the legitimacy theory points out that to maintain their social operation qualification, enterprises often obtain institutional identity by disclosing environmental information. Therefore, as a national regulatory tool, the environmental protection tax will stimulate enterprises to cope with the pressure of legitimacy by improving ESG performance [15]. At the same time, signaling theory believes that enterprises can convey their compliance willingness and long-term sustainable development ability to investors and regulators through public disclosure of environmental performance, green investment, ESG rating, and other ways. The introduction of the environmental protection tax has made this signaling mechanism crucial, as companies now risk serious reputational damage and regulatory penalties for failing to disclose or providing misleading information. [16].

As a regulatory mechanism for environmental matters, the environmental protection tax is designed to integrate pollution expenses into the price mechanism and foster enterprises' transition to sustainable practices [17]. Early studies pointed out that environmental protection tax can significantly lower pollution output through the polluter pays principle [18], and could generate a dual benefit for economic development [19], [20]. China's Environmental Protection Tax Law (2018) replaced pollution fees with taxation, strengthened the legal binding force, and significantly increased the pollution cost of enterprises [21]. The research revealed a substantial rise in corporate environmental investment due to the combined effects of both penalty and reward mechanisms in environmental taxation [21], [22]. Furthermore, the environmental protection tax has significantly improved the ESG performance and green innovation investment of enterprises, especially in state-owned and large firms, signifying that the environmental protection tax both discourages inefficient resource use and encourages proactive corporate behavior [3], [23].

II. B. Hypothesis development

II. B. 1) Environmental protection tax and greenwashing

With the intensification of global environmental issues, companies are increasingly emphasizing the disclosure of ESG information to enhance their social responsibility image and market competitiveness [24], [25]. Existing literature suggests that the transparency and authenticity of ESG information disclosure have a significant impact on a company's environmental performance and social responsibility [24]. However, the issue of greenwashing in ESG information disclosure is becoming increasingly prominent. If a company performs poorly in terms of actual environment, society, and governance, it may use false or exaggerated ESG information disclosure to cover up its shortcomings and thereby engage in greenwashing behavior [26], [27]. Greenwashing behavior refers to companies using false or exaggerated ESG information disclosure to conceal their actual environmental performance to gain the trust of investors and consumers [28]. Research has shown that greenwashing not only misleads market participants but also exacerbates information asymmetry, affecting the long-term sustainable development of enterprises [29]. Furthermore, some companies have adopted symbolic environmental measures rather than substantive environmental improvement actions to obtain higher ESG ratings [28]-[30]. This behavior not only damages the reputation of the

company, but also weakens the credibility of ESG ratings [31]. Therefore, how to curb corporate greenwashing behavior and enhance the authenticity of ESG performance has become a focus of attention for academia and policymakers.

Environmental protection tax, as an environmental regulation tool, has triggered a large number of studies on its economic and environmental impact since its official implementation in China in 2018. A series of empirical studies shows that it can significantly inhibit corporate behavior by increasing environmental governance costs and compliance pressure. For one thing, environmental protection tax boosts firms' adherence expenses, encouraging a rise in environmental investments and a reduction in pollutants emitted [32]. This cost pressure not only forces companies to take practical environmental improvement measures but also reduces their motivation to improve their ESG ratings through greenwashing [8]. For another thing, environmental protection tax urges them to enhance focus on environmental compliance performance through legitimacy pressure, thus reducing the motivation for symbolic disclosure [33]. In this context, in order to maintain its public image and social identity, enterprises tend to improve the authenticity and differentiated content of ESG information disclosure to avoid regulatory risks and reputation losses.

Furthermore, when stringent rules are applied, high-emission companies tend to pursue eco-friendly initiatives, as elevated taxes and strict legal restrictions raise the costs of illegal practices [34]. Conversely, eco-friendly companies gain tax benefits, reducing the motivation for corporate greenwashing [35]. This focused strategy encourages businesses to embrace greener methods, supporting sustainable growth, improving productivity, and thus easing tax strain [34], [36]. Following this analysis, hypothesis 1 is proposed:

H1: Environmental protection tax can effectively curb ESG greenwashing.

II. B. 2) Environmental protection tax, analyst attention, and ESG greenwashing

In recent years, research examining how external oversight influences corporate actions has been increasing. Analysts are regarded as information intermediaries performing important monitoring functions in the financial market, which has gradually attracted academic attention [37], [38]. On the one hand, the implementation of environmental protection tax has increased the cost pressure of enterprises in environmental governance. Some enterprises may alleviate the concerns of the outside world about their real environmental risks by exaggerating the disclosure of positive environmental performance, thus leading to the greenwashing of corporate information disclosure [39]. At this time, analysts will strengthen the review of the performance of enterprises' environmental responsibilities and the authenticity of green investment [40], restrict the behavior of senior executives by providing investment suggestions and profit forecasts, and curb the behavior of enterprises to obtain market recognition through "floating green" [41], [42]. In addition, analysts incorporated corporate environmental performance into the value assessment framework, helped the market identify and correct information bias, and promoted the disclosure of corporate real environmental performance through in-depth interpretation of corporate social responsibility reports [29].

On the other hand, environmental protection tax, as a strongly binding external environmental policy tool, reflects the government's high attention to ecological governance issues and transmits a obvious policy signal to the market and enterprises based on the signal transmission theory and legitimacy theory, thus significantly increasing the attention of external regulators to the environmental behavior and information disclosure of enterprises [43], [44]. When facing this external institutional pressure, to maintain its legitimacy and social identity, enterprises will choose to respond to policy signals by enhancing the quality and authenticity of ESG information disclosure [45]. Specifically, when enterprises face additional costs and reputation risks caused by environmental protection tax, analysts strengthen the governance function of information intermediary by tracking and analyzing the policy effect and enterprise response, and passing external regulatory information to the capital market [46]. In order to maintain market reputation and gain investors' trust, enterprises tend to disclose information truthfully and transparently [2], [47]. Therefore, introducing the environmental protection tax will heighten analysts' focus, and inhibit the false disclosure of information by enterprises. Following this analysis, hypothesis 2 is proposed:

H2: Environmental protection tax can effectively curb ESG greenwashing by enhancing analyst attention.

II. B. 3) Environmental protection tax, financing constraints, and ESG greenwashing

Financing constraint is an important problem faced by enterprises under the condition of asymmetric information or imperfect capital market, especially in long-term return projects such as environmental protection investment and information disclosure. Part of the reason for ESG greenwashing is to save real compliance costs, and enterprises choose to disclose compliance in a low-cost and symbolic way to win recognition from the capital market.

Previous studies have shown that environmental protection tax, as a cost-effective policy tool, may increase the financing pressure of enterprises in the short term while increasing the environmental governance cost of enterprises, especially in the high pollution and high expenditure industries. This resource tension makes some enterprises more inclined to transfer the pressure through green floating [47]. However, some studies have found that the environmental protection tax can force enterprises to improve their financing structure and reduce the cost of capital by stimulating enterprises to improve environmental performance and disclosure quality under certain mechanisms, thus reducing the symbolic disclosure motivation [48]. Specifically, green finance and green tax incentive policies have been proven to effectively alleviate the financing constraints of

enterprises, and significantly improve the performance and disclosure quality of ESG, to reduce the green drift behavior. The research points out that the expansion of green finance not only improves the level of green innovation of enterprises but also reduces the motivation of green drift by improving the financing environment [49]. In addition, creditors in the capital market can also form constraints on enterprises through the financing constraint mechanism. A study found that when enterprises have the behavior of selective disclosure of environmental information, creditors usually punish them by raising financing costs and other means, thus forcing enterprises to improve the level of real environmental information disclosure [50].

Therefore, driven by the environmental protection tax policy, the cost of environmental compliance faced by enterprises has risen synchronously with the supervision of the external capital market, forming a back-up mechanism, which helps to enhance the willingness of real disclosure and ease the motivation of green drift caused by financing constraints, thus supporting the theoretical logic of environmental protection tax curbs greenwashing by easing financing constraints. Following this analysis, hypothesis 3 is proposed:

H3: Environmental protection tax can effectively curb ESG greenwashing by alleviating financing constraints.

II. B. 4) Environmental protection tax, environmental disclosure and, ESG greenwashing

The prevailing view holds that the higher the quality of environmental information disclosure, the lower the degree of ESG greenwashing. However, this study finds that the implementation of the environmental protection tax increases pollution costs and strengthens regulatory pressure on heavily polluting enterprises. Under these conditions, firms reduce symbolic environmental disclosures that were previously used as instruments of greenwashing and legitimacy signaling. Although this reduction leads to a lower measured quality of environmental information disclosure, it reflects diminished greenwashing behavior and enhanced authenticity of ESG performance.

On the one hand, when facing the dual pressure of compliance costs and resource constraints caused by environmental protection tax, enterprises tend to take the initiative to reduce the strategic disclosure behavior to avoid excessive attention or expectation from the outside world and turn to a more cautious, concise and substantive disclosure method [47]. Such disclosure compression substantially reduces redundant information, thus weakening the symbolic expression of talk more and do less. On the other hand, the existing literature points out that the complex, inconsistent, and difficult to compare information disclosure structure is a hotbed for the breeding of greenwashing. Some enterprises create information overload through vague discourse and content stacking, which misleads the market to judge their real environmental performance [51]. After the implementation of the environmental protection tax policy, some enterprises chose to reduce the amount of disclosure and avoid excessive packaging in an environment of limited resources and legal pressure [52].

Therefore, the environmental protection tax can inhibit corporate greenwashing motives by reducing symbolic disclosure content. This mechanism path provides a new theoretical perspective for understanding the non-linear impact of policy tools on enterprises' compliance behavior. Following this analysis, hypothesis 4 is proposed:

H4: Environmental protection tax can effectively curb ESG greenwashing by encouraging companies to reduce symbolic disclosure.

III. Research design

III. A. Sample and data selection

Due to the official implementation of the environmental protection tax in 2018, this study examines A-share firms listed on the Shanghai and Shenzhen exchanges between 2013 and 2022 for ten consecutive years, and removes them according to the following steps: excluding financial enterprises; Exclude ST and PT enterprises; After removing samples with abnormal or missing data, 6810 observations were obtained. To mitigate extreme value effects, all continuous variables are standardized and winsorized at the 1% and 99% percentiles. ESG greenwashing data sourced from WinGo Database, all other variables in this article are obtained from the China Stock Market & Accounting Research Database.

III. B. Model design and variable selection

To examine the impact of the environmental protection tax on ESG greenwashing by heavily polluting enterprises, we define high-polluting enterprises as the experimental group and other enterprises as the control group, and construct the DID model:

$$Greenwash_{it} = \alpha_0 + \alpha_1 Tax_{it} + \lambda X_{it} + \mu_i + \omega_t + \varepsilon_{it} \quad (1)$$

where i and t refer to the company and year. The dependent variable Greenwashit represents the degree of ESG greenwashing of company i in year t. The essential meaning of ESG greenwashing is the inconsistency between a company's ESG information disclosure and ESG investment, manifested as inconsistency between words and actions. For companies without substantial ESG investment, they tend to use vague symbolic disclosures, such as qualitative descriptions, program statements, or simply copying previous year's statements. For companies that invest more in ESG, they are more willing to disclose quantitative data on their ESG performance to the outside world, which is more manifested as substantive disclosure, such as quantitative

descriptions, case studies, and factual statements. Therefore, we believe that the higher the textual similarity of corporate ESG information disclosure, the more symbolic disclosure the company has, and the less substantive disclosure it has, indicating a more severe ESG greenwashing. Specifically, we conduct text analysis on the social responsibility reports of listed companies, use the TF-IDF method to calculate text similarity, and obtain the Greenwash value. The higher the value, the more severe the degree of greenwashing in the company's ESG report.

The independent variable Tax_{it} represents the interaction term between spatial dummy variables and temporal dummy variables (Treat × Post). When an enterprise belongs to 15 industries such as thermal power, steel, coal, metallurgy, chemical, petrochemical, papermaking, textile, leather, and mining, it is defined as a high-polluting enterprise. At this time, Treat = 1, otherwise Treat = 0. When the sample time is in 2018 or later, Post=1, otherwise Post=0. Therefore, Tax_{it} is assigned a value of 1 if high-polluting enterprises implement environmental tax policies in year t, and 0 otherwise.

X_{it} represents the control variables in this article. In order to control for the impact of other factors on corporate ESG information disclosure, we introduce a collection of firm-level control variables. Specifically, these variables consist of company size (Size), company age (Age), debt-to-equity ratio (Lev), return on equity (ROE), revenue growth rate (Growth), board size (Board), dual employment (Dual), largest shareholder shareholding ratio (Top1), Tobin's Q (Tobin Q), and management shareholding ratio (Mshare). In addition, to mitigate the impact of potential omitted variables on the main regression results of this study, we further implement fixed effects of year (μ_i) and individual company (ω_t). As shown in Table 1:

Table 1: Control variable definitions

Variable name	Variable symbol	Variable measure
Company size	Size	The natural logarithm of annual total assets
Company age	Age	The natural logarithm of years since a company has been listed
Debt-to-equity ratio	Lev	The ratio of total liabilities to total assets
Return on equity	ROE	The ratio of net profit to total equity
Revenue growth rate	Growth	The ratio of revenue growth to the previous year's revenue
Board size	Board	The natural logarithm of the number of board members
Dual employment	Dual	1 if the chairman and general manager are the same person, and 0 otherwise.
Largest shareholder shareholding ratio	Top 1	The ratio of the largest shareholder to the total number of shares
Tobin's Q	Tobin Q	The natural logarithm of years since a company has been listed
Management shareholding ratio	Mshare	The ratio of directors, supervisors, and senior executives to the total number of shares

IV. Empirical analysis

IV. A. Descriptive statistics

From the descriptive statistics findings in Table 2, it can be seen that the minimum value of Greenwash is 0.016 and the maximum value is 0.679. The distribution results show that there are great differences in ESG greenwashing among the sample enterprises and the quality of ESG information disclosure among China's A-share listed companies can still be enhanced. The mean value of Tax is 0.148, indicating that about 15% of the samples in this paper are affected by the environmental protection tax. In addition, the distribution properties of other control variables are close to the statistical results in the literature, which shows that the data quality of this paper is high.

Table 2: Descriptive statistics

VarName	Obs	Mean	SD	Min	Median	Max
Greenwash	6810	0.231	0.052	0.016	0.229	0.679
Tax	6810	0.148	0.355	0.000	0.000	1.000
Size	6810	23.215	1.395	19.639	23.102	26.430
Age	6810	2.990	0.312	0.000	3.045	3.611
Lev	6810	0.468	0.195	0.046	0.475	0.925
Growth	6810	0.144	0.328	-0.653	0.097	3.808
ROE	6810	0.080	0.116	-0.962	0.082	0.414
Board	6810	2.166	0.204	1.609	2.197	2.708
Dual	6810	0.204	0.403	0.000	0.000	1.000
Top1	6810	0.366	0.157	0.081	0.354	0.757
TobinQ	6810	1.861	1.285	0.802	1.430	16.647
Mshare	6810	6.890	14.373	0.000	0.027	69.750

IV. B. Baseline regression results

This study analyzes the effects of the environmental tax on ESG greenwashing using Chinese A-share listed company panel data from 2013 to 2022. Table 3 presents the findings, with column (1) indicating that the coefficient on Tax is negative and statistically significant without controlling for the fixed effects of individual firms and years. According to column (2), the coefficient of Tax is -008 after adding control variables, which is still significant at the 1% level. The above regression results preliminarily indicate that the first hypothesis of this article is valid, that is, the implementation of the environmental protection tax will significantly reduce the degree of greenwashing among high-polluting enterprises, and also demonstrate that environmental regulatory policies are an effective means to improve the information environment of the capital market.

Table 3: Baseline regression

	(1)	(2)
Variables	Greenwash	Greenwash
Tax	-0.008***	-0.008***
	(0.002)	(0.002)
Size		0.010***
		(0.002)
Age		0.029**
		(0.013)
Lev		-0.006
		(0.006)
ROE		-0.011**
		(0.005)
Growth		0.001
		(0.001)
Board		-0.006
		(0.005)
Dual		0.003
		(0.002)
Top1		0.008
		(0.010)
TobinQ		0.002***
		(0.001)
Mshare		0.001***
		(0.000)
Constant	0.232***	-0.078
	(0.000)	(0.057)
Company	YES	YES
Year	YES	YES
Observations	6,810	6,810
R-squared	0.747	0.751

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

IV. C. Robustness test

IV. C. 1) Parallel trend test

This paper conducts a parallel trend test on the effects of environmental protection tax from 2013 to 2022, with 2018 being the year of policy implementation. Specifically, the years before the policy are defined as pre 5 to pre 1 (to avoid multicollinearity, pre 1 is omitted as the base year), the policy year is defined as current, and the years after the policy are defined as post 1 to post 4. As shown in Figure 1, the test results show that the estimated coefficients for each period before the policy are not significant, indicating that ESG greenwashing of the treatment and control group prior to the environmental protection tax implementation meets the parallel trend hypothesis. After the implementation of the policy, the coefficients for the current year and subsequent years of the policy are significantly negative, indicating that environmental protection tax significantly reduced corporate ESG greenwashing behavior. The 2021 figure shows a negative coefficient with insignificant impact, potentially linked to fleeting behavioral shifts or COVID-19-related data fluctuations in corporate sectors. The above results

verify that the double difference model satisfies the parallel trend hypothesis, and the inhibitory effect of environmental protection tax on ESG greenwashing is persistent.

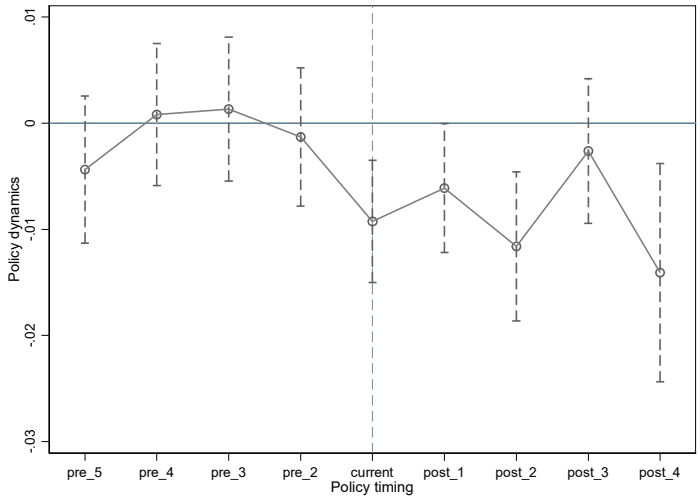

Figure 1: Parallel trend test

IV. C. 2) Placebo test

To mitigate the impact of unobserved variables on the empirical findings, a placebo test is implemented. To begin with, the study divides each firm into two groups: a treatment and a control set, purely by chance. Subsequently, it picks a random year as the focal point for implementing the environmental tax intervention within the treatment group. Finally, employing Eq. (1) for conducting DID analysis, the process is iterated 500 times. In Figure 2, we can observe the coefficient distributions from the regression analysis, revealing that they cluster near zero and adhere to a normal distribution pattern, which aligns with the anticipated outcomes of the placebo experiment.

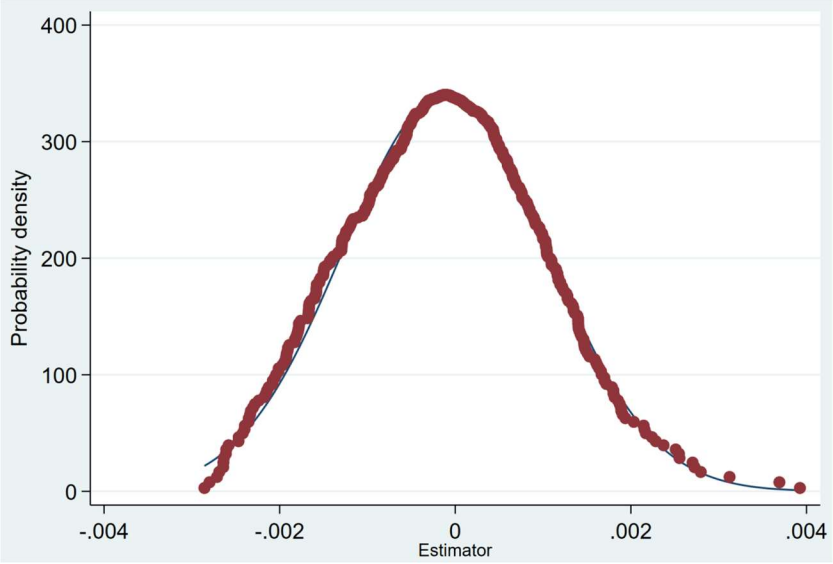

Figure 2: Placebo test

IV. C. 3) Propensity score matching

Under the quasi-natural experimental framework of environmental protection tax, there are often systematic differences in endogenous characteristics between heavily polluting enterprises and non-heavily polluting enterprises. These differences not only affect whether the enterprises are classified as heavily polluting, but also may affect their ESG information disclosure behavior. This study utilizes Propensity Score Matching (PSM) as the primary analytical approach to address potential sample selection biases. Specifically, the matching process incorporates several key firm characteristics, including company size

(Size), company age (Age), debt-to-equity ratio (Lev), return on equity (ROE), revenue growth rate (Growth), board size (Board), dual employment (Dual), largest shareholder shareholding ratio (Top1), Tobin's Q (Tobin Q), and management shareholding ratio (Mshare) as covariates, and uses the nearest neighbor matching method for the treatment group. Figure 3 displays the matching results. The samples' financial features remain largely consistent after matching. Subsequently, regression analysis is performed on the sample confirming the hypothesis, with the corresponding findings depicted in Table 4. Column (2) indicates that the coefficient on Tax is still significantly negative, confirming the robustness of the baseline regression results.

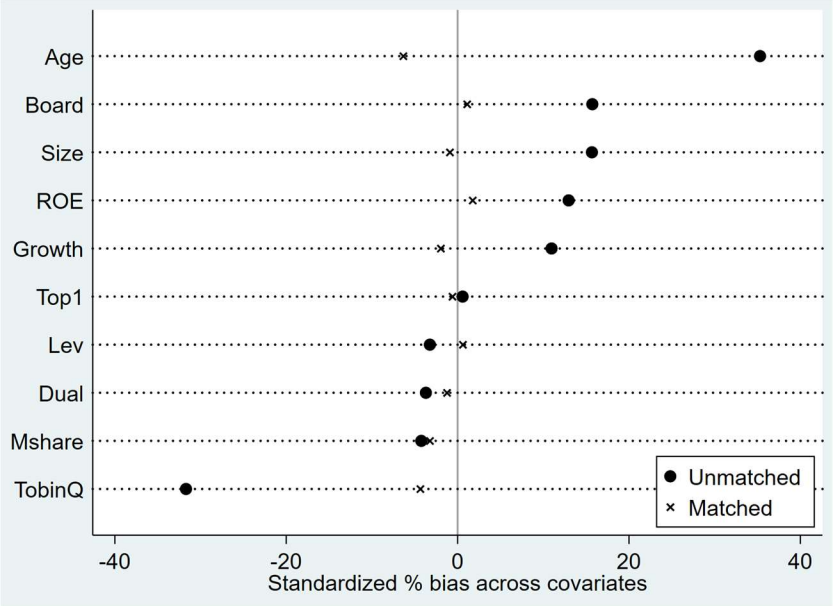

Figure 3: PSM method result

Table 4: PSM-DID and lagged explanatory variable

	(1)	(2)	(3)	(4)
Variables	Greenwash	Greenwash	Greenwash	Greenwash
Tax	-0.008***	-0.010***	-0.008***	-0.006**
	(0.002)	(0.003)	(0.002)	(0.002)
Controls	YES	YES	YES	YES
Constant	-0.078	-0.030	-0.143*	-0.236**
	(0.057)	(0.098)	(0.082)	(0.109)
Company	YES	YES	YES	YES
Year	YES	YES	YES	YES
Observations	6,810	3,602	5,148	4,243
R-squared	0.751	0.798	0.759	0.767

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

IV. C. 4) Lagged explanatory variable

Addressing the issue of mutual influence among variables, we lag the explanatory variable by one period and two periods respectively, and the regression outcomes appear in Table 4. From columns (3) and (4), it can be seen that the coefficient of Tax is significantly negative at the 1% level and the 5% level respectively. This demonstrates that the lagged one and two periods of environmental protection tax continue to exert a notable dampening effect on companies' ESG greenwashing practices, reinforcing the robustness of the baseline regression findings.

IV. C. 5) Eliminating policy interference

First, three policy dummy variables are generated to eliminate the interference from other existing policies for the same period.

Firstly, after the new environmental law took effect on January 1, 2015, the cost of corporate environmental violations has significantly increased at the legal level. At the same time, the legal requirements for information disclosure and public supervision have also been gradually clarified. In order to cope with stricter regulations, enterprises tend to increase the frequency

and depth of environmental compliance reports or cover up the actual pollution level through formal compliance disclosure, thus generating ESG greenwashing motivation. In particular, heavy polluting enterprises face stricter compliance requirements and higher legal risks after the implementation of the new environmental protection law. Therefore, a policy dummy variable (Law) is created, set to 1 if the firm operates in a high-pollution industry during that year, and 0 if not.

Secondly, since 2010, the state has successively implemented low-carbon city pilot projects in some cities. Under the pressure and incentives of the local government, enterprises in the pilot area may actively or passively improve the social responsibility report, making its text appear more unified template content, thus improving the text similarity between annual reports and forming the ESG greenwashing of formal disclosure. Therefore, a policy dummy variable (Carbon) is crafted, taking the value of 1 for companies situated within low-carbon city areas during the specified year and 0 for all others.

Thirdly, after the central government issued the Green Financial Reform and Innovation policy, enterprises in the pilot areas can enjoy green credit, green bond, and special financing tools to reduce the financing cost of environmental protection projects and enhance the willingness of green investment. Further, enterprises are more motivated to truly present environmental performance, thus reducing the green space and the text similarity of the social responsibility report. Therefore, a policy dummy variable (GFRI) is created, set to 1 for firms partaking in the GFRI policy trial during the year, and 0 for those not involved.

Then, the three policy dummy variables are included as control variables in the regression model and subjected to regression analysis. Moreover, these variables are collectively added as control variables to the baseline regression model for regression analysis. As shown in Table 5, the negative coefficients of all independent variables remain significant, indicating that the impact of environmental protection tax remains strong, unaffected by concurrent policy interventions during the study period.

Table 5: Eliminating policy interference

	(1)	(2)	(3)	(4)
Variables	Greenwash	Greenwash	Greenwash	Greenwash
Tax	-0.009***	-0.008***	-0.008***	-0.010***
	(0.002)	(0.002)	(0.002)	(0.002)
Law	0.005**			0.005*
	(0.002)			(0.002)
Carbon		0.003		0.002
		(0.003)		(0.003)
GFRI			-0.007***	-0.007***
			(0.002)	(0.002)
Controls	YES	YES	YES	YES
Constant	-0.087	-0.082	-0.084	-0.094
	(0.057)	(0.058)	(0.057)	(0.058)
Company	YES	YES	YES	YES
Year	YES	YES	YES	YES
Observations	6,810	6,810	6,810	6,810
R-squared	0.751	0.751	0.751	0.752

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

V. Further discussion

V. A. Mechanism analysis

According to the second part of this article, it may be deduced that the environmental protection tax can alleviate ESG green-washing by raising analyst attention, relieving financing constraints, and encouraging companies to reduce symbolic disclosure in the theoretical aspects. Next, this section will explore how these mechanisms work in practice through empirical analysis. Specifically, the following model is constructed for mechanism analysis [53]:

$$Attention_{it}/SA_{it}/Eidq_{it}=\beta_0+\beta_1 Tax_{it}+\lambda' X_{it}+\mu_i+\omega_t+\varepsilon_{it} \quad (2)$$

$$Greenwash_{it}=\alpha_0'+\alpha_1' Tax_{it}+\gamma Attention_{it}/SA_{it}/Eidq_{it}+\lambda X_{it}+\mu_i+\omega_t+\varepsilon_{it} \quad (3)$$

Firstly, Attention refers to analyst attention. Specifically, it is measured by the natural logarithm of the number of companies that are tracked by analysts (or teams) within a year. As shown in column (2) of Table 6, the coefficient of Tax is significantly positive, indicating that the implementation of environmental protection tax can significantly raise analyst attention to enterprises. It can be seen from column (3) that the coefficients of Tax and Attention are significant after adding Attention to model (1), and the absolute value of tax coefficient is lower than that of model (1), which indicates that analyst attention plays a partial mediation effect between environmental protection tax and ESG greenwashing.

Table 6: Analysis of analyst attention mechanism

	(1)	(2)	(3)
Variables	Greenwash	Attention	Greenwash
Tax	-0.008*** (0.002)	0.257*** (0.049)	-0.007*** (0.002)
Attention			-0.001*** (0.001)
Controls	YES	YES	YES
Constant	-0.078 (0.057)	-17.874*** (1.379)	-0.105* (0.058)
Company	YES	YES	YES
Year	YES	YES	YES
Observations	6,810	6,810	6,810
R-squared	0.751	0.813	0.751

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

Secondly, we select the Size-Age (SA) index to measure financing constraints [54]. Specifically, the greater the value, the stronger the financing constraints. As shown in column (2) of Table 7, the coefficient of Tax is significantly negative, indicating that the implementation of environmental protection tax contributes to easing the financing constraints of enterprises. It can be seen from column (3) that, Tax and SA are significant after adding SA to model (1), and the absolute value of tax coefficient is lower than that of model (1), which indicates that the mechanism analysis is passed, and the financing constraint plays a part of the mediation effect.

Table 7: Analysis of financing constraints mechanism

	(1)	(2)	(3)
Variables	Greenwash	SA	Greenwash
Tax	-0.008*** (0.002)	-0.008*** (0.003)	-0.007*** (0.002)
SA			0.103*** (0.011)
Controls	YES	YES	YES
Constant	-0.078 (0.057)	-5.637*** (0.129)	0.503*** (0.091)
Company	YES	YES	YES
Year	YES	YES	YES
Observations	6,810	6,810	6,810
R-squared	0.751	0.984	0.757

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

Thirdly, we select the quality of environmental information disclosure (Eidq) to measure environmental disclosure. Specifically, we score a total of 25 indicators across five dimensions including environmental management, environmental certification, environmental performance, and governance, etc, and then take the natural logarithm of the sum plus one. As shown in column (2) of Table 8, the coefficient of Tax is significantly negative, indicating that the implementation of environmental protection tax has significantly reduced the quality of environmental information disclosure of enterprises, which actually reflects a decrease in greenwashing behavior. It can be seen from column (3) that the coefficients of Tax and Eidq are significant after adding Eidq to model (1), and the absolute value of tax coefficient is lower than that of model (1), which shows that the mechanism analysis is passed, and the quality of environmental information disclosure plays a part of the intermediary effect.

V. B. Heterogeneity analysis

V. B. 1) Region heterogeneity

To explore the differences in the impact of environmental protection tax on companies' ESG greenwashing behavior among enterprises in different regions, we conduct group regression analysis. Specifically, we divide the sample into three regional groups according to the classification criteria of the National Bureau of Statistics. Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan are the eastern regions. Shanxi, Jilin, Heilongjiang, Anhui,

Jiangxi, Henan, Hubei, and Hunan are the central regions. Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Xizang, Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang are the western regions.

Table 8: Analysis of environmental disclosure mechanism

	(1)	(2)	(3)
Variables	Greenwash	Eidq	Greenwash
Tax	-0.008***	-0.066***	-0.007***
	(0.002)	(0.019)	(0.002)
Eidq			0.015***
			(0.001)
Controls	YES	YES	YES
Constant	-0.078	2.536***	-0.115**
	(0.057)	(0.626)	(0.057)
Company	YES	YES	YES
Year	YES	YES	YES
Observations	6,810	6,810	6,810
R-squared	0.751	0.774	0.757

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

The regression results are shown in Table 9. As shown in column (1), the environmental protection tax has a significant inhibitory effect on ESG greenwashing in the eastern region, while columns (2) and (3) show no significant changes in the central and western regions. The reason may be that the environmental monitoring and law enforcement capabilities in the eastern region are stronger, which can effectively supervise and punish the illegal discharge behavior of heavy polluting enterprises and improve their awareness and level of compliance with environmental regulations, and thereby curb the ESG greenwashing behavior. On the contrary, the lower environmental law enforcement intensity and insufficient willingness of enterprises to disclose environmental information in the central and western regions weaken the actual binding force of the environmental protection tax.

Table 9: Heterogeneity analysis (1)

	(1)	(2)	(3)
	East	Middle	West
Variables	Greenwash	Greenwash	Greenwash
Tax	-0.010***	-0.005	0.002
	(0.002)	(0.004)	(0.004)
Controls	YES	YES	YES
Constant	-0.020	-0.238	-0.092
	(0.064)	(0.164)	(0.209)
Company	YES	YES	YES
Year	YES	YES	YES
Observations	4,899	1,070	825
R-squared	0.755	0.735	0.773

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

V. B. 2) Tax burden heterogeneity

The collection standard of environmental protection tax is determined by the provincial people's government, which can independently formulate suitable tax rates within the statutory range based on local environmental conditions and the level of economic development. Therefore, the binding force of the environmental protection tax on corporate behavior may vary significantly at different tax burden levels. To further investigate whether there is heterogeneity in the inhibitory effect of environmental protection tax on ESG greenwashing, we conduct group regression. Specifically, according to the regulations on pollutant emission tax rates in various regions, we classify six provinces with high levels of environmental protection tax rates, including Beijing, Tianjin, Hebei, Shanghai, Jiangsu, and Henan, as the high tax burden group, and the remaining provinces as the low tax burden group.

The regression results are shown in Table 10. According to (1) and (2), in the high tax burden group, the coefficient of Tax is -0.015 at the 1% significance level, indicating that environmental protection tax significantly suppresses corporate ESG greenwashing behavior. In another group, the impact of environmental protection tax on ESG greenwashing is relatively weak. This may be due to the rising environmental costs in high tax areas, which puts greater external environmental regulatory pressure on companies. They are not only more proactive in actual pollution control, but also more inclined to enhance the authenticity of ESG information disclosure to avoid policy risks and reputation damage caused by false advertising. On the contrary, in areas with lower tax rates, the cost pressure generated by environmental protection tax is relatively small, and they have not effectively changed the motivation of ESG greenwashing, resulting in relatively limited policy effects.

Table 10: Heterogeneity analysis (2)

	(1)	(2)	(3)	(4)
	High tax	Low tax	High ESG	Low ESG
Variables	Greenwash	Greenwash	Greenwash	Greenwash
Tax	-0.015***	-0.003	-0.012***	-0.002
	(0.003)	(0.002)	(0.003)	(0.003)
Controls	YES	YES	YES	YES
Constant	0.075	-0.176**	0.119	-0.047
	(0.086)	(0.079)	(0.083)	(0.111)
Company	YES	YES	YES	YES
Year	YES	YES	YES	YES
Observations	2,601	4,209	3,493	3,317
R-squared	0.765	0.744	0.784	0.796

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

V. B. 3) ESG performance heterogeneity

The performance of enterprise ESG is the comprehensive embodiment of its sustainable development ability. Enterprises with different ESG levels have different responses to the environmental protection tax. Enterprises with high ESG performance usually have a mature environmental governance mechanism, high transparency of information disclosure, and long-term strategic orientation. Their behavior decisions are more easily guided by external policy signals and tend to respond to policy requirements through substantive environmental investment. However, enterprises with low ESG performance may have relatively lagging policy feedback on environmental protection tax due to weak awareness of environmental responsibility, lack of internal compliance mechanisms, or insufficient governance ability, and may even adopt opportunistic behavior to avoid policy costs. In order to clarify the heterogeneity of policy effects in enterprises with different ESG performance, we conduct group regression. Specifically, we divide the comprehensive ESG scores of all sample enterprises by medians. Those with scores higher than the median are classified as the high ESG group, and those with scores lower than or equal to the median are classified as the low ESG group. (The ESG scores are from the Huazheng)

The regression results are shown in Table 10. According to (3) and (4), in the high ESG group, the coefficient of Tax is -0.012, with a significance level of 1%, indicating that the environmental protection tax significantly inhibits ESG greenwashing of high ESG enterprises. In another group, the impact of tax constraints on the motivation of greening is weak. This may be because high ESG enterprises have relatively perfect endogenous driving forces in information disclosure and governance mechanisms. When faced with the exogenous policy impact of environmental protection tax, they are more able to adjust their disclosure strategies in time and reduce the greenwashing behavior to avoid potential regulatory and reputation costs; On the contrary, low ESG enterprises have a weak governance foundation and an insufficient response to tax signals. Therefore, it is difficult to avoid risks through disclosure improvement and thereby the inhibitory effect of tax constraints is not significant.

VI. Conclusions and discussion

The paper uses China's 2018 Environmental Protection Tax Law enactment as a quasi-natural experiment and employs a difference-in-differences (DID) model to identify the effect of the environmental protection tax on corporate ESG greenwashing behavior. Specifically, we conduct text analysis on the social responsibility reports of Chinese A-share listed companies, using the TF-IDF method to calculate cross-period text similarity and construct the Greenwash value as a quantitative indicator of the degree of corporate ESG greenwashing. The empirical findings indicate a notable reduction in corporate ESG greenwashing due to the introduction of environmental protection tax, indicating that environmental protection tax not only has environmental governance functions, but also strengthens the credibility of ESG disclosure through institutional pressure. In terms of robustness, we verified the reliability of the main conclusion through various methods such as parallel trend testing,

placebo testing, and propensity score matching, and the results all supported the significant effect of the environmental protection tax in controlling greenwashing.

Further mechanism analysis shows that environmental protection tax can indirectly affect companies' ESG disclosure behavior through three paths: first, by increasing analyst attention and thereby strengthening external monitoring; second, by alleviating firms' financing constraints, reducing their incentives for symbolic compliance; and third, by prompting some firms to reduce symbolic disclosure, indirectly enhancing the substance of ESG reporting. In addition, heterogeneity analysis reveals stronger policy impacts in the eastern region, high tax burden areas, and enterprises with high ESG scores. Overall, this paper provides micro-level evidence on how environmental policy can influence corporate disclosure behavior through information channels and offers valuable implications for improving ESG regulatory frameworks and optimizing the design of environmental protection tax instruments.

The findings from the study hold significant policy-relevant implications. Firstly, strengthen coordination between environmental tax enforcement and ESG disclosure regulations. The baseline regression results confirm that the introduction of the environmental protection tax lead to a notable reduction in corporate ESG greenwashing. Therefore, policymakers should better integrate environmental protection tax enforcement with broader ESG regulatory frameworks, such as ESG ratings, environmental credit evaluations, and green finance eligibility, to create a feedback loop between fiscal policy and market discipline.

Secondly, enhance the monitoring capacity of capital market intermediaries to amplify analyst oversight. Mechanism analysis shows that increased analyst attention is an important channel through which environmental protection tax reduces ESG greenwashing. It is suggested that regulatory agencies encourage financial intermediaries such as securities analysts and rating agencies to increase their interpretation and supervision of ESG information, advocate for an independent ESG review and rating framework, and thus form a more binding external information supervision mechanism.

Thirdly, improve green finance support mechanisms to alleviate financing pressure during corporate green transitions. The easing of financing constraints is another key pathway through which environmental protection tax reduces greenwashing. It is recommended that policymakers continue expanding green credit, green bonds, and ESG-linked financing tools, ensuring that firms facing tax burdens can still access resources for genuine environmental improvements, rather than resorting to symbolic disclosures for reputational purposes.

Fourthly, refine ESG disclosure standards to prioritize quality over quantity. This study also finds that, under certain conditions, a reduction in low-quality or redundant disclosure may itself serve as a mechanism for reducing greenwashing. Therefore, ESG reporting regulations should move beyond general templates and vague statements, and instead encourage firms to disclose concise, verifiable, and performance-based environmental indicators. This would enhance the readability, substance, and trustworthiness of ESG reports.

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