

<https://doi.org/10.70731/se581n72>

The Influence of Environmental Regulations on the Phenomenon of Greenwashing

Shuaihua Zhang ^{a,*}

^a Faculty of Economics and Management, Inner Mongolia Normal University, Hohhot, 010000, China

KEYWORDS

*Environmental Regulatory,
Greenwashing,
Green Innovation*

ABSTRACT

Implementing environmental regulations plays a pivotal role in addressing pollution and attaining sustainable development. However, the role of environmental regulations in mitigating greenwashing remains insufficiently explored. Based on Chinese listed companies from 2010 to 2021, this paper investigates the effect of environmental regulation on the greenwashing of heavily polluting enterprises and the internal mechanism of such regulation. The research findings indicate that the execution of environmental regulatory policies can curb corporate greenwashing, with differences in individual enterprises and the level of local environmental governance. Further, we also reveal that environmental regulation can further strengthen the disincentives to corporate greenwashing by promoting corporate green innovation and local market-oriented. This paper further presents theoretical and empirical evidence to support effective government management of corporate greenwashing and promoting green economy development.

1. Introduction

Over the past few decades, the issue of severe environmental pollution has increasingly emerged as a prominent research topic, garnering heightened attention from governments and enterprises[1]. Governments have implemented a range of environmental governance measures, focusing on safeguarding the ecological environment and fostering advancements in sustainable innovation. As a result, companies are now required to disclose environmental information in preparation for their transition towards sustainability.

However, the development of the green economy in some countries is still at an early stage, with problems such as inconsistent standards for disclosure of green projects and low costs of non-compliance. In this context, some enterprises, especially heavily polluting enterprises, in order to attract investors, financing needs, reputation needs, through the packaging of polluting projects, disguise their own environmental performance, speculative exaggeration of the actual, these behaviours are called greenwashing [2]. The enterprises avoid discussing aspects of poor environmental performance, selectively disclose favorable information, or employ language that masks their en-

* Corresponding author. E-mail address: 1332241763zhang@gmail.com

environmental performance and potentially exaggerates the reality. Greenwashing weakens incentives for businesses to engage in environmentally friendly behaviours, reduce the efficiency of green capital allocation and hinder the development of a sustainable economy[3]. China is currently facing such a problem. China's rapid development has come at the cost of significant resource consumption and environmental pollution issues. Over the past 20 years or so, China's air quality has been in severe decline, suffering from the worst haze in its history, which has made the Chinese Government and the public realize the seriousness of environmental problems nature[4]. With the prominence of environmental issues and the public voice being propagated, the Chinese Government has continued to strengthen environmental management and increase policy sanctions for the green transformation of enterprises. However, the environmental information disclosed by certain enterprises in China is characterized by evasiveness, excessive formality, and a greater emphasis on qualitative disclosure rather than substantive disclosure.[5]. In order to enhance corporate environmental performance transparency and the facilitation of Government and public monitoring, the Chinese Government has implemented a range of environmental regulatory measures to enhance corporate disclosure of environmental information. Environmental regulation is one of the tools available to governments.

The implementation of environmental regulations is often used to achieve emission reduction targets, especially in developing economies facing significant environmental challenges[6]. Currently, research on environmental regulation on firms' behavioural decisions focuses on corporate green innovation and corporate environmental investment. Feng [7] finds that corporate green innovation is in line with the growing trend of market environment regulation. Sun et al. (2024)[8] find that emissions trading in China incentivizes green innovation among heavy polluters in pilot regions. Guo et al.(2024)[9] find that the enforcement of stringent environmental regulations on enterprises positively influences investments in environmental protection, which is more significant for heavily polluting enterprises in the central and western parts of the country. Using Ambient Air Quality Standards (2012) as a quasi-natural experiment, Wang et al.(2023)[10] find that regulatory measures for environmental protection improve the level of environmental investment in firms whose executives have public office experience. However, some scholars

have a different view. According to the "weak" version of Porter's hypothesis, stringent environmental regulations would increase production costs, suggesting that firms would have to meet environmental regulations at the cost of lost productivity[11]. Zhang et al. (2023)[12] found that overly strong environmental regulations brought immense environmental pressure to enterprises, which the enthusiasm for enterprises' environmental protection investment not only failed to improve but also resulted in a reduction in production scale.

Taking China for example, the Chinese Government implemented the new Environmental Protection Law (EPL) in 2015, aiming to enhance the quality of green economic development, which raised the quality standards for corporate environmental information disclosure and established a mechanism for subsidizing and penalizing corporate environmental behavior. The new EPL is a typical environmental regulatory policy and clearly states that key emission units should truthfully disclose to the public the names of their primary pollutants, the means of emission, the concentration and total amount of emission, the situation of exceeding the emission standards, and the construction and operation of pollution prevention and control facilities, and accept social supervision. The provisions of China's EPL regarding corporate environmental information disclosure possess the essential characteristic of being obligatory. The legislation mandates companies to implement appropriate pollution treatment facilities in order to effectively manage the pollutants generated and ensure that emissions comply with regulatory standards. In the face of such stringent regulation, firms may be able to reduce through green innovations. However, green innovation requires long-term capital investment, including technology research and development, equipment upgrading, and production line renovation, which has a long cycle and high uncertainty of return[13], which will increase the financial constraints of enterprises and operation sharing. In addition, the new EPL also mandates companies to disclose environmental information in order to facilitate regulatory oversight and public scrutiny of their environmental conduct, with a particular emphasis on stringent requirements for heavily polluting firms[14].

In short, the firm faces a conflict between adhering to the new EPL regulations and pursuing its objective of maximizing profits, which means that the firm may be in breach of this environmental regulation. Furthermore, because of disclosure requirements, enter-

prises can adopt a strategy in which they exaggerate their green performance and establish positive communication about the environmental problems they generate but do not take actual steps to address them[15]. It allows enterprises to construct a fantastic green image at a low cost. The research questions are formulated based on the preceding discussion. Does the environmental regulation promote or inhibit corporate greenwashing behaviors? What is the mechanism through which environmental regulation influences greenwashing behavior? If the above issues are addressed, there are lessons for other developing countries in environmental governance.

To address the research questions, We take the new EPL implementation as a quasi-natural experiment and construct a difference-in-difference (DID) model to test the causal relationship between environmental regulation and greenwashing of enterprises. Further, we address endogeneity through propensity score matching(PSM), placebo, and other methods. The empirical results show that Environmental regulation can significantly curb greenwashing, which is consistent with the robustness test. Moreover, we conduct tests to examine potential pathways of action as well as provinces and firms' heterogeneity.

This paper has three potential marginal contributions. First, previous studies may not be able to fully elucidate the influence of environmental policies on firms' transition towards sustainability because they do not take into account the differences between firms' so-called green performance and practice. However, the primary focus of this paper is to examine the environmental impacts of regulatory measures and policies, specifically on the quality of corporate disclosure regarding environmental information, enriching the research on theories related to environmental regulation. Secondly, a comprehensive analysis of the impact of the differences between the internal and external environments of enterprises on the utility of environmental regulation provides a realistic basis for giving full play to the utility of this policy. Lastly, this paper incorporates corporate greenwashing into the framework of empirical analyses, revealing the "black box" between environmental regulation and corporate green performance through empirical research.

The subsequent sections of this paper are structured as follows: Section 2 proposes our research hypotheses. In Section 3, we introduce our empirical strategy and data. Section 4 provides empirical re-

sults and related analysis. Finally, Section 5 summarizes the conclusions.

2. Theoretical Analysis and Hypotheses

2.1. Direct Impact Effects

On the one hand, the widespread existence of greenwashing by enterprises is due to the fact that China's environmental information disclosure system is not yet sound, the lack of government regulation and third-party supervision of the provision of environmental information by enterprises, and the lack of transparency and openness of environmental protection information by some enterprises, which makes it difficult to assess the environmental performance of enterprises[16,17]. On the other hand, the absence of robust regulatory frameworks and comprehensive monitoring mechanisms facilitates enterprises' evasion of their obligations, thus providing the possibility of greenwashing. Based on the fact that the Chinese Government and other stakeholders are more favorable to environmentally friendly enterprises, enterprises, especially heavily polluting enterprises[18], have sufficient incentives to greenwashing in order to maximize their profits and build up a good image, which makes it particularly necessary to strengthen the guidance of the macro system and the constraints of external rules. Based on the perspectives of legitimacy theory[19], stakeholder theory[20], and institutional theory[21], we explore the inhibitory effect of environmental regulation on corporate greenwashing.

Implementing environmental regulatory policies can improve the quality of corporate environmental information disclosure and increase the transparency of the quality of corporate environmental information. Environmental regulatory policies are mandatory and exert pressure on corporate polluting behavior by setting strict environmental standards and regulations. From the viewpoint of the legitimacy theory, this means of environmental protection governance is highly binding and punitive, aiming at prompting enterprises to adopt environmental protection measures and reduce environmental pollution through coercive means[22]. In a strict environmental regulatory environment, enterprises, due to mandatory environmental regulation, will consider more about the environmental and social impacts of their production in the course of their operations and make positive environmental information disclosure to enhance public information and prove their legitimacy. The improved

quality of corporate environmental information disclosure has led to an escalation in the cost associated with concealing firms' environmental performance. Gradually, this mounting cost outweighs the benefits of greenwashing, resulting in a diminishing impact on the firm's earnings[23]. From a stakeholder theory perspective, environmental regulatory policies promote positive environmental information disclosure by enterprises. This helps stakeholders, such as consumers, residents, and investors, to fully understand the proper attitude of enterprises toward environmental protection[24]. It also exposes enterprises' attempts to falsely appear environmentally friendly, further increasing the cost of such actions and reducing incentives for them. Moreover, Environmental regulation can improve the regulatory environment. Improved corporate environmental impact assessment standards for wastewater, waste gas, and solid emissions can reduce the likelihood of greenwashing by heavily polluting firms at the source. In regions where environmental regulations are strict and law enforcement is strong, the practice of greenwashing has a reduced impact on business performance and firm value due to the high costs of penalties and legal liabilities.

The new Environmental Protection Law (EPL) has been dubbed "the strictest environmental protection law in history in China because it clearly stipulates, at the legal level, the responsibilities of all levels of Government and polluting enterprises with regard to environmental supervision and pollution prevention. The bill proposes administrative penalties and raises the standard of penalties, increasing the environmental costs of offenses committed by polluting enterprises. In terms of institutional theory, environmental regulatory policies exert coercive pressure on firms. The new EPL emphasizes the crucial role of governmental supervision at all levels in environmental management. It also introduces mechanisms for information disclosure and public participation. The new EPL requires major polluting enterprises to disclose environmental information. The level of environmental information disclosure is positively influenced by the requirement, which has a positive impact on the level of environmental information disclosure, strengthens governmental and public oversight of environmental issues and reduces the likelihood of greenwashing being identified. Once the greenwashing behavior is detected, it not only affects the production of the enterprises but also possesses a signif-

icant adverse impact on the reputation of the firms, which can be said to outweigh the loss [25]. Secondly, the new EPL emphasizes the regulatory responsibilities of local governments in environmental protection. The bill adds or modifies new legal entries on environmental quality standards, a system of incentives for benefits, penalties for pollution, and the inclusion of environmental protection in performance appraisals, granting local governments greater enforcement powers. As the core of enterprise management and the responsibility for environmental protection, local governments play a more important role under the new legal framework[26]. Heavy-polluting enterprises are under greater regulatory pressure from the Government and have less incentive to seek profit through greenwashing. Environmental regulatory policies increase the risks and costs of greenwashing and reduce the incentives for firms to engage in such practices. Based on the above theory, the following research hypothesis is proposed:

Hypothesis 1: Implementation of the environmental regulatory policies can inhibit greenwashing.

2.2. Indirect Impact Effects

The implementation of environmental regulations plays a crucial role in driving firms to actively pursue high-quality green innovation. Based on the technical decomposition of productivity as a theoretical basis, the focus is on the impact of technical advancement and the effect of technical efficiency brought about by environmental regulations. From the perspective of technological advancement, according to the Porter hypothesis, the implementation of moderate environmental regulations can incentivize enterprises to engage in technological innovation, enhance their competitiveness and profitability, and reduce the burden of environmental management costs[27]. A large number of scholars have tested the promotional effects of environmental regulation on R&D investment and technological innovation. Qingyuan Li and Zehua Xiao (2023)[28] introduced the technology coefficient to theoretically explain that environmental regulation encourages innovation in enterprises. With the increasing intensity of environmental regulation, enterprises will be incentivized to reflect their innovative behaviors more in resource-saving and environmentally friendly technological advances, promoting green innovation[29]. In terms of technical efficiency, environmental regulations motivate enterprises to increase production efficiency, improve production pro-

cesses, and reduce production costs by saving production inputs and enhancing the recycling of resources so as to realize improved enterprise performance and achieve a win-win situation in terms of economic efficiency and environmental protection. Green innovation promotes enterprises to utilize resources more efficiently and reduce production costs while at the same time minimizing negative environmental impact and promoting incentives for enterprises to greenwash [30]. In summary, through green innovation, enterprises create social and consumer value, improve product quality, improve environmental quality, enhance their reputation and image, attract more consumers and investors, and reduce the need for greenwashing. We raised our hypotheses as follows.

Hypothesis 2: Environmental regulatory policies affect greenwashing by improving corporate green innovation.

3. Methods and Data

3.1. Variables

3.1.1. Dependent Variable

The dependent variable is corporate greenwashing. Current national scholars have different methods of measuring the firm's greenwashing index of enterprises. Schmuck et al.(2018)[31] Adoption of environmental concern as a measure of corporate greenwashing. Walker and Wang(2012)[32]calculate the degree of corporate greenwashing from the perspective of corporate environmental practices by dividing corporate practices into symbolic and substantive behaviors. Some scholars measure greenwashing by the firm's ESG score, considering Bloomberg ESG score ratings as the degree of firms' environmental disclosure, Huazheng ESG score, Wind ESG score, and Hexun ESG score ratings as their actual environmental performance, and measuring the degree of greenwashing of Chinese firms by the difference between the two [33,34,35]. In this paper, the difference in environmental ratings between Bloomberg and CSI is used to measure the degree of greenwashing of firms[33].

Specifically, the firm's Bloomberg ESG score is considered an environmental disclosure score, while the firm's Huzheng ESG score is considered an actual environmental performance score. $ER\bar{B}_{dis}$ and $ER\bar{B}_{per}$ represent the mean of the en-

vironmental disclosure and performance scores, respectively. σ_{dis} is the standard deviation of the envi-

$$GW_{it} = \left(\frac{ERB_{it} - ER\bar{B}_{dis}}{\sigma_{dis}} \right) - \left(\frac{ERH_{it} - ER\bar{H}_{per}}{\sigma_{per}} \right) \quad (1)$$

ronmental disclosure score, and σ_{per} is the standard deviation of the actual environmental performance score. In Equation 1, the first term represents a standardized measure of the position of an enterprise relative to its peers in the distribution of environmental rating disclosure scores, the second term represents a standardized measure of the position of an enterprise relative to its peers in the distribution of its actual environmental rating performance scores, and the difference between the two terms represents the difference between an enterprise's environmental disclosure scores and its actual environmental performance, the degree of greenwashing, with the higher value of greenwashing indicating that the enterprise's greenwashing behaviors are more serious.

3.1.2. Independent Variables

The new EPL enacted in China in 2015 provides the research data for this factual article. The paper's independent variable is $Treat_i \times Post_t$, which presents the "policy" treatment variable in the DID model(the double difference term). Among them, $Treat$ is the dummy variable of the treatment group and the control group. Referring to Liu et al. [36]. This paper classifies two enterprises according to Environmental information disclosure guidance for listed companies released by the China Ministry of Environmental Protection in 2010. If an enterprise belongs to heavily polluting industries, then $Treat=1$; otherwise, $Treat=0$. $Post$ is the time dummy variable of the new EPL, which takes the of 1 for 2015 and later periods and 0 otherwise.

3.1.3. Intermediary Variables

Green innovation is an intermediary variable in this paper. Innovation output can be a more intuitive and effective reflection of a firm's level of technological innovation[36]. Therefore, this study adopted a natural logarithm of the number of green invention patents granted plus one to represent corporate green innovation[37].

3.1.4. Control Variables

This paper builds upon the research conducted by [38] and includes additional control variables that may impact enterprise value, such as enterprise size(Size), asset-liability ratio(Lev), return on assets(Roa), listing years(Age), management cost ratio(Mshare), corporation value(Tobinq), ownership concentration (top10), growth capacity(Growth) and financial liquidity ratio(Liquid). The variable definitions are listed in Table 1.

3.2. Data

We utilize data sourced from the CSMAR database, a widely recognized repository of information on Chinese manufacturing firms listed in the stock market. We selected the basic information and financial data of listed manufacturing companies in China's

manufacturing industry from 2010 to 2021, and the continuous variables were processed by shrinking the tail at the upper and lower 1% to control the effect of extreme values. Finally, we obtain a sample with 7479 firm-year observations. Table 2 shows the descriptive statistics of the main data included in this study. See a detailed description of the data in Table 2.

3.3. Models for Empirical Analysis

3.3.1. Basic Regression Model

The new EPL, adopted by the Standing Committee of the National People's Congress of China and implemented in 2015, requires enterprises to install testing equipment to refine the quality of environmental disclosure, requires heavy-polluting enterprises to disclose their emissions, and increases penalties for

Table 1 | Variable definitions

Variables	Symbols	Definitions
Greenwashing	GW	Calculated from the definition above
Where heavy polluting enterprises	Treat	Enterprises that are HPE take 1, and non-heavy polluting enterprises are 0
Policy release	Post	The 2015 new Environmental Protection Law shall be taken as 0 before the release and 1 after the release.
Green Innovation	GI	Add 1 to the natural logarithm of the number of green invention patents
Enterprise scale	Size	Natural logarithm of total assets at the end of the year
Liabilities level	Lev	(Total liability/Total assets) × Natural logarithm of 100
Profit margin on total assets	Roa	(Net profit/Total assets at the end of the period) × 100
Listing years	Age	Natural logarithm of years since listing
Equity incentive	Mshare	Number of shares held by management/total shares
Corporation value	TobinQ	(Circulation market value + Net assets attributable to non-tradable shares + Book value of liabilities)/Total assets at the end of the period
Merging of two functions	Dual	Chairman and general manager of the two positions together take 1, otherwise take 0
Current ratio	Liquid	Current assets/current liabilities
Business growth capacity	Growth	Ratio of current year's operating income growth/previous year's total operating income
Shareholding	Top10	Number of shares held by top ten shareholders/total number of shares

Table 2 | Variable definitions

Variables	N	Mean	Std	Min	Max
GW	7479	0.029	1.007	-1.164	6.308
Treat×Post	7479	0.122	0.328	0	1
Size	7479	23.151	1.321	19.447	28.509
Lev	7479	0.473	0.204	0.008	1.436
Roa	7479	0.052	0.069	-0.645	0.969
Age	7479	2.402	0.770	0	3.434
Mshare	7479	0.778	0.159	0	0.897
TobinQ	7479	2.058	1.670	0.688	29.167
Dual	7479	0.213	0.409	0	1
Top10	7479	0.609	0.160	0.133	0.981
Growth	7479	0.175	0.359	-0.489	2.107
Liquid	7479	2.001	1.801	0.204	16.132

environmental damage, so It can be seen as an important policy in environmental regulation. This paper referred to the set up of the following DID models.

Where subscript i and t represent enterprises and time. Among them, α_1 =constatat term, β_1 =coefficient of interactions between $Treat_{it}$ and $Post_{it}$. If the result is significantly positive, it can be proved that the environmental regulation will reduce greenwashing. X_{it} represent the control variables, ϑ_i represents firm fixed effect, τ_t represents time fixed effect.

3.3.2. Mediating Effect

$$GW_{it} = \alpha_1 + \beta_1(Treat_i \times Post_t) + \gamma_1 X_{it} + \vartheta_i + \tau_t + \mu_{it} \quad (2)$$

Based on this paper explores the mediating effect of green innovation; this study, referring to Zhonglin (2014)[39] Equations 3 and 4 are added to Equation 2 to test for mediating effects. We use the stepwise regression method to test the intermediary effect, and GW_{it} represents the mediating variable.

If the coefficients in the above Equation(2)-(4) satisfy the following conditions, we consider GW_{it} (Green Innovation) to have an intermediary effect between environmental regulation and greenwashing. First, β_1 in Equation(2) is significant. Secondly, the β_2

in Equation(3) is significant. Third, the β_3 is significant and $\beta_3 < \beta_1$. If the coefficients of β_3 are significant, it is a partial intermediary. Otherwise, it is a full intermediary.

$$GI_{it} = \alpha_2 + \beta_2(Treat_i \times Post_t) + \gamma_2 X_{it} + \vartheta_i + \tau_t + \mu_{it} \quad (3)$$

$$GW_{it} = \alpha_3 + \beta_3(Treat_i \times Post_t) + \omega GI_{it} + \gamma_3 X_{it} + \vartheta_i + \tau_t + \mu_{it} \quad (4)$$

4. Empirical Results

4.1. Basic Regression Results

The basic regression results presented in Table 3 demonstrate the impact of environmental regulatory policies on greenwashing. The results of regressing proved that the coefficients of $Treat \times Post$ are negative at a 1% level after adding the fixed effects firm, fixed effects time, and control variables, indicating that environmental regulatory policy has a significantly curbed corporate greenwashing.

4.2. Parallel Trend Test

The important premise of the DID method is treatment groups and control groups obtain a common trend assumption. It is said that without the implementation of the new EPL, the enterprise value of heavily polluting and non-heavily polluting firms would

not have changed significantly over time. Learn from relevant studies' research methods [40,41], we run the regression following Equation(5). Using 2010 as the base year, the interaction terms of the dummy variables with the dummy variables of the experimental group before and after the enactment of the new EPL and in the current year were set separately and regressed again. The remaining variables are consistent with Equation (2).

As can be seen from Fig.1, the coefficients from 2011 to 2014 are not significant and become significant from 2015 to 2021. From 2011 to 2014, prior to the implementation of the new EPL, these coefficients were not significant, indicating that the parallel trend assumption was met.

4.3. Robustness Test

4.3.1. Placebo Test

The practice was drawn on Liu et al.(2023)[40] to

$$GW_{it} = \alpha_4 + \beta_4 \sum_{i=-5}^6 (Treat_i \times Post_t) + \gamma_4 X_{it} + \vartheta_i + \tau_t + \mu_{it} \quad (5)$$

conduct a placebo test by randomly assigning treatment enterprise Industry. The process was repeated 500 times to obtain the estimated coefficients of the DID, as well as the corresponding p-values. The results are shown in Fig.2; the coefficients are concentrated around 0, follow a normal distribution, and most of the regressions are not significant. The basic regression results of this study have successfully passed the placebo test.

4.3.2. Fictitious Policy Time

This study refers to the Wang(2023)[41] practice of establishing a placebo test which changes the time of the policy. Assuming that the new EPL is brought forward to 2014 and deferred to 2016, the former advances the policy to 0 until 2014 and 1 in 2014 and beyond; the latter defers the policy to 0 until 2016 and 1 in 2016 and beyond. The result of regression is shown in Table 5, Column(1), and Column(2). As can be seen from Table 5, the coefficients of TreatxPost2014 and TreatxPost2016 are not significant. It can be argued that greenwashing is suppressed by the new EPL rather than another time effect. Consequently, the regression results in this paper are proved to be robust.

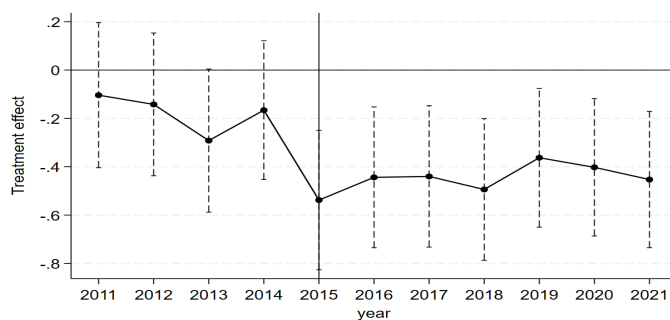


Figure 1 | Parallel trend test

Table 3 | Baseline regression

	GW		
	(1)	(2)	(3)
TreatxPost	-0.219*** (0.049)	-0.246*** (0.067)	-0.241*** (0.068)
Size		-0.108*** (0.022)	-0.109*** (0.023)
Lev		-0.192** (0.084)	-0.144 (0.089)
Roa		-0.055 (0.138)	-0.078 (0.145)
Age		-0.011 (0.044)	-0.013 (0.044)
Mshare		0.195 (0.148)	0.204 (0.149)
TobinQ		0.001 (0.006)	0.001 (0.006)
Dual		0.064*** (0.024)	0.062*** (0.023)
Top10		0.540*** (0.106)	0.491*** (0.111)
Growth			0.623 (1.891)
Liquid			0.004 (0.003)
_Cons	0.048*** (0.086)	3.537*** (0.423)	2.782*** (0.516)
Firm fixed	YES	YES	YES
Year fixed	YES	YES	YES
N	7479	7479	7479
R ²	0.1889	0.3163	0.3241

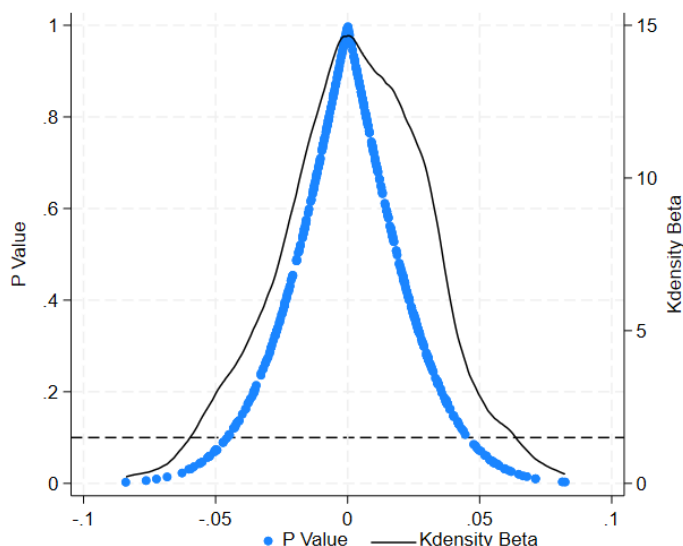


Figure 2 | Results of the placebo test

4.3.3. Propensity Score Matching Test

We employ the Propensity Score Matching test methodology to satisfy the assumption required by the DID model. This method can solve the endogeneity problem and isolate the policy effect. Referring to the relevant study[42], all the control variables are chosen, and Treat (Treat is 1 if the firm is a high-polluting firm and Treat is 0 if the firm is a nonhigh polluting firm) are selected as matching variables. Logit regression is based on 1:1 nearest neighbor non-release and 0.05 caliper range to perform PSM. The results show that the t-value of ATT is 3.19, and the P-value for control variables after matching is not significant. Therefore, after matching, there was no significant difference between the experimental and control groups. Consequently, the matching results fulfill the requirements. Columns(3) of Table 4 show the regression results of the PSM-DID approach. The coefficient of $Treat_{it} \times Post_{it}$ is negative at the 1% level. It can be argued that the new EPL can significantly curb greenwashing.

4.3.4. Exclusion of Green Credit Policy

During the study period, the Green Credit Guidelines enacted in 2012 may have influenced the greenwashing of firms, which reduces the reliability of the paper's conclusions. In order to avoid the interference of related policies, a dummy variable(GP) for the 2012 Green Credit Guidelines in China is added to the baseline regression to test the effect of the Environmental Regulation policy on the greenwashing of enterprises after excluding the effect of green credit

policies. The results are shown in Table 4 column(4). The coefficients of $Treat \times Post$ are significantly negative, which indicates greenwashing is suppressed by the new EPL.

4.3.5. Replacing the Independent Variables

We refer to Pan et al.(2019)[42] to change the classification of heavily polluting industries. The regression results of transformed independent variables, as demonstrated in Table 4 column(5), continue to prove the significant inhibitory effect of environmental regulation policy on greenwashing.

4.4. Mechanism Analysis

This section examines the mediating effect of technological innovation. Environmental regulations increase the risk and cost of corporate "greenwashing," forcing companies to innovate environmentally. Specifically, the new Environmental Protection Law strengthens fines and compensation for environmental pollution, imposes daily penalties on non-compliant companies without an upper limit, and introduces new administrative detention penalties. As a result, corporate managers are not only required to assess the economic costs of "greenwashing" behavior but also to consider the non-economic costs associated with administrative detention, thus increasing the potential costs of "greenwashing." When the costs of managing environmental pollution in production exceed the benefits or even exceed the estimated costs of green innovation, companies will independently invest in green innovation. The cost of pollution management gradually decreases, further reducing the incentive for "greenwashing."

Table 5 reports the results of the green innovation mechanism test. Column (1) indicates that environmental regulation policies effectively suppress "greenwashing" behavior. In Column (2), the estimated coefficient for corporate green innovation is significantly positive at the 1% significance level, suggesting that environmental regulation policies can promote corporate green innovation. In Column (3), both the interaction terms $Treat \times Post$ and GI are negative at the 1% significance level and the Bootstrap test is also significant, indicating that the effect of green innovation on corporate "greenwashing" exists. Under the joint effect of environmental regulations and green innovation, the suppression of "greenwashing" behavior becomes more pronounced.

Table 4 | Robustness tests

	Fictitious Policy Implementation Time		PSM	Exclusion Policy	Replacing the Independent Variables
	(1)	(2)	(3)	(4)	(5)
TreatxPost			-0.250*** (0.084)	-0.272*** (0.069)	
TreatxPost2014	-0.083 (0.056)				
TreatxPost2016		-0.030 (0.048)			
Treat2xPost					
GP				-0.140** (0.068)	
Control	YES	YES	YES	YES	YES
_Cons	2.592*** (0.516)	2.565*** (0.520)	2.621*** (0.773)	2.701*** (0.517)	2.702*** (0.517)
Firm fixed	YES	YES	YES	YES	YES
Year fixed	YES	YES	YES	YES	YES
N	7479	7479	4886	7479	7479
R ²	0.3170	0.3188	0.3708	0.3196	0.3185

Environmental regulations, on the one hand, internalize the externalities of corporate environmental impacts. Companies are required to handle pollutants during their production processes, thereby increasing the cost burden of compliance. This, in turn, helps companies more accurately determine resource allocation and investment decisions, reduces decision-making errors, and ultimately improves the efficiency of resource allocation in the market. On the other hand, as the intensity of environmental regulations increases, companies will face stricter environmental standards, which promotes greater transparency in corporate environmental practices, financial performance, and overall operations, thereby enhancing marketization. As the degree of marketization increases, companies are exposed to stronger market competition and greater investor attention to environmental, social, and governance (ESG) factors. To maintain a good reputation, attract investors, and meet regulatory requirements, companies are motivated to improve the authenticity of environmental

information disclosure, which further reduces "greenwashing" behavior.

From Column (4) of Table 5, it can be observed that the estimated coefficient for MP is significantly positive at the 1% significance level, indicating that environmental regulation policies promote the marketization process in the local area. In Column (5), the regression coefficients for GI and MP are both significantly negative, and the Bootstrap test results are also significant, suggesting that environmental regulation policies can further suppress "greenwashing" behavior by promoting local marketization processes.

4.5. Analysis of Heterogeneity

4.5.1. Property Right Character

There are some differences between state-owned and private enterprises in China. Compared with non-state-owned enterprises, state-owned enterprises have inherent advantages in financing channels and financing costs. Therefore, the paper divides the sample enterprises, state-owned enter-

Table 5 | Mediation effect test

	GW	GI	GW	MP	GW
	(1)	(2)	(3)	(4)	(5)
Treat×Post	-0.241*** (0.068)	0.109*** (0.034)	-0.238*** (0.068)	0.190*** (0.050)	-0.232*** (0.068)
GI			-0.042*** (0.016)		
MP					-0.048*** (0.017)
_Cons	2.711*** (0.517)	-1.145*** (0.291)	2.711*** (0.516)	7.852*** (0.380)	3.091*** (0.534)
Firm fixed	YES	YES	YES	YES	YES
Year fixed	YES	YES	YES	YES	YES
N	7479	7479	7479	7479	7479
R ²	0.3197	0.0295	0.3223	0.0843	0.3585
Bootstrap Z			-8.64***		-9.12***

prises, state-owned state-owned state-owned enterprises (SOEs), and non-SOEs and empirically analyses both samples separately. The results in Table 6 Columns (1) and (2) show that the coefficient of the non-SOE sample is significantly lower than the SOE sample, indicating that environmental regulations have had a more significant dampening effect on the greenwashing of non-state-owned enterprises than state-owned enterprises. The reason is that state-owned enterprises are closely associated with the government, and they are subject to stricter environmental regulations by the government. Their environmental information disclosure is more closely watched by government departments, the media, and the public. These factors make it more risky and costly for state-owned enterprises to be greenwashed, and therefore, they are less likely to be greenwashed.

4.5.2.Financing Constraints

Enterprise financing activities directly affect the daily production and operation of enterprises and have an influence on the development of enterprises. The degree of financing constraints is closely related to the expansion of enterprises, technological innovation, and risk-resistant ability. We, referring to Gong et al.(2023)[43], adopted the SA index to measure firms' financing constraints. The SA specific speed mea-

surement formula: $SA=-0.737\times Size+0.043\times Size^2-0.04\times Age$. The SA index is negative, and we take the absolute value of the SA index, whose larger absolute value indicates that firms face greater financing constraints. Based on the calculated indices, this study divides the sample into two groups according to low financing constraints and high financing constraints and performs group regressions. The results are shown in Table 6, Column(3), and Column (4). In general, The coefficients for both sets of regressions are significantly negative, but the greenwashing for companies with low financing constraints is clearly smaller. The reason is that the green transformation of enterprises requires long-term capital investment, including technological research and development, equipment upgrading, and production line renovation, which involves high risks, long cycles, and high uncertainty of returns, and enterprises will bear greater risks in the green transformation. Therefore, in order to benefit from green policy subsidies and green credit preferences, enterprises with greater financing constraints may still engage in greenwashing behavior, even under increased external regulatory intensity.

Table 6 | Heterogeneity analysis of firms

	Nature of Ownership		Financial Constraints	
	State-owned	Non-state-owned	Low	High
	(1)	(2)	(3)	(4)
TreatxPost	-0.199** (0.080)	-0.427*** (0.160)	-0.314*** (0.113)	-0.217* (0.121)
Control	YES	YES	YES	YES
_Cons	2.057*** (0.878)	2.694*** (0.702)	2.918*** (0.759)	2.228*** (0.954)
Firm fixed	YES	YES	YES	YES
Year fixed	YES	YES	YES	YES
N	3693	3637	3966	3513
R ²	0.1959	0.2999	0.2762	0.3114

4.5.3. Regional Environmental Regulatory Intensity

There are differences in the strength of environmental regulation and policy implementation in different regions, leading to different institutional environments and differences in firms' responses to environmental regulatory policies. Referring to Fan and Mu (2017)[44], we use the ratio of the cost of regional pollution control to the value-added industrial output to characterize regional environmental regulatory intensity. We divided the sample into two groups of samples with high environmental regulation and low environmental regulation, and the regression results are shown in Table 7. The enactment of the new Environmental Protection Law has significantly curtailed greenwashing behavior in areas with strong environmental regulation compared to areas with weaker environmental regulation. It indicates the dependence of the policy effectiveness of environmental regulatory regimes on the strength of local environmental regulation and policy implementation. In the context of effective local government regulation and governance, environmental regulatory policies can better exert the policy effect of suppressing the degree of greenwashing by enterprises; if there are loopholes in local government regulation and limited capacity for environmental treatment, it will hinder the exertion of the effect of environmental regulatory policies.

Table 7 | Heterogeneity analysis of regional environmental regulatory

	Regional Environmental Regulatory Intensity	
	Low	High
	(1)	(2)
TreatxPost	-0.242* (0.144)	-0.265*** (0.088)
Control	YES	YES
_Cons	2.560*** (0.807)	1.788*** (0.935)
Firm fixed	YES	YES
Year fixed	YES	YES
N	3826	3653
R ²	0.2879	0.3454

5. Conclusions and Implications

5.1. Conclusion

Against the backdrop of escalating global environmental challenges and mounting economic uncertainties, conducting a comprehensive analysis of the correlation between environmental regulations and greenwashing assumes paramount significance in addressing ecological issues and promoting sustainable economic growth. This study treats the EPL in

China as a quasi-natural experiment, addresses potential endogeneity by constructing a DID model, and systematically evaluates the impact of environmental regulation on drifting green by using data on Chinese listed firms from 2010-2021. We draw the following findings: First, the EPL policy had a substantial negative effect on greenwashing during the period under examination. We also conducted a series of robustness tests, and all results supported this causal relationship. Secondly, we found that the new EPL further curbs greenwashing by improving corporate green innovation. Finally, we did a heterogeneity test. The results of the heterogeneity analysis indicate that the new EPL had a better negative on greenwashing in State-owned enterprises, firms with high financing constraints, and firms with high environmental regulatory intensity.

5.2. Policy Recommendations

Based on the above findings, we will make the following policy recommendations.

Firstly, the government should construct an orderly strategy of competition and collaboration to narrow the gap between the government and enterprises in terms of environmental protection objectives. Environmental protection departments should strengthen environmental protection supervision and responsibility mechanisms to effectively avoid disorderly competition among regions in implementing environmental policies; cities with strong innovative capacity should be made to have a stronger demonstration and driving role, and on this basis, continue to improve the institutional environment for innovation and entrepreneurship.

Secondly, based on the principle of incentive compatibility, the environmental protection authorities should formulate appropriate guidelines and requirements according to the enterprises' own characteristics and their intrinsic needs so as to reduce the cost of compliance. Some scholars have found through empirical research and testing of Porter's hypothesis that pioneering firms often receive government support and subsidies for environmental technological innovations, while within the Industry, they achieve a latecomer's advantage through learning and imitation.

Thirdly, an in-depth study of the effects of different green innovations under the interaction of heterogeneous environmental regulatory strategies is needed. Synergistic environmental governance optimization and positive green innovation spillovers are promoted

through competition and learning between regions under the guidance of local governments.

Funding

Inner Mongolia Fund Project "Innovation Research on Practice Teaching System of Finance under the New Business Perspective" (NGJGH2022456)

References

1. Ukaogo P O, Ewuzie U, Onwuka C V. Environmental pollution: causes, effects, and the remedies[M]//Microorganisms for sustainable environment and health. Elsevier, 2020: 419-429.
2. de Freitas Netto S V, Sobral M F F, Ribeiro A R B, et al. Concepts and forms of greenwashing: A systematic review[J]. Environmental Sciences Europe, 2020, 32: 1-12.
3. Zhang K, Pan Z, Janardhanan M, et al. Relationship analysis between greenwashing and environmental performance[J]. Environment, Development and Sustainability, 2023, 25(8): 7927-7957.
4. Zhang Y, Chen S, Li Y, et al. Does Environmental Protection Law Bring about Greenwashing? Evidence from Heavy-Polluting Firms in China[J]. Sustainability, 2024, 16(5): 1782.
5. Luo W, Guo X, Zhong S, et al. Environmental information disclosure quality, media attention and debt financing costs: Evidence from Chinese heavy polluting listed companies[J]. Journal of Cleaner Production, 2019, 231: 268-277.
6. Tang M, Li X, Zhang Y, et al. From command-and-control to market-based environmental policies: Optimal transition timing and China's heterogeneous environmental effectiveness[J]. Economic Modelling, 2020, 90: 1-10.
7. Feng Z, Chen W. Environmental regulation, green innovation, and industrial green development: An empirical analysis based on the Spatial Durbin model[J]. Sustainability, 2018, 10(1): 223.
8. Sun C, Tie Y, Yu L. How to achieve both environmental protection and firm performance improvement: Based on China's carbon emissions trading (CET) policy[J]. Energy Economics, 2024, 130: 107282.
9. Guo B, Hu P, Lin J. The effect of digital infrastructure development on enterprise green transformation[J]. International Review of Financial Analysis, 2024, 92: 103085.
10. Wang S, Zhang R, Wan L, et al. Has central government environmental protection intervention improved air quality in China?[J]. Ecological Economics, 2023, 206: 107750.
11. Porter M E, Linde C. Toward a new conception of the environment-competitiveness relationship[J]. Journal of Economic Perspectives, 1995, 9(4): 97-118.
12. Zhang Y, Wang J, Chen J, et al. Does environmental regulation policy help improve business performance of

- manufacturing enterprises? evidence from China[J]. *Environment, Development and Sustainability*, 2023, 25(5): 4335-4364.
13. Zhang X, Zhang M, Zhang H, et al. A review on energy, environment and economic assessment in remanufacturing based on life cycle assessment method[J]. *Journal of Cleaner Production*, 2020, 255: 120160.
 14. Wang Y, Zhang W. Green credit policy, market concentration and green innovation: Empirical evidence from local governments' regulatory practice in China[J]. *Journal of Cleaner Production*, 2024, 434: 140228.
 15. Nemes N, Scanlan S J, Smith P, et al. An integrated framework to assess greenwashing[J]. *Sustainability*, 2022, 14(8): 4431.
 16. Wang Q, Liu M, Zhang B. Do state-owned enterprises really have better environmental performance in China? Environmental regulation and corporate environmental strategies[J]. *Resources, Conservation and Recycling*, 2022, 185: 106500.
 17. Liu Z, Kong L, Xu K. The impact of public environmental preferences and government environmental regulations on corporate pollution emissions[J]. *Journal of Environmental Management*, 2024, 351: 119766.
 18. Boubaker S, Liu P Z, Ren Y S, et al. Do anti-corruption campaigns affect corporate environmental responsibility? Evidence from China[J]. *International Review of Financial Analysis*, 2024, 91: 102961.
 19. Deegan C. An overview of legitimacy theory as applied within the social and environmental accounting literature[J]. *Sustainability accounting and accountability*, 2014: 248-272.
 20. Parmar B L, Freeman R E, Harrison J S, et al. Stakeholder theory: The state of the art[J]. *Academy of Management Annals*, 2010, 4(1): 403-445.
 21. Tina Dacin M, Goodstein J, Richard Scott W. Institutional theory and institutional change: Introduction to the special research forum[J]. *Academy of Management Journal*, 2002, 45(1): 45-56.
 22. Tang M, Li X, Zhang Y, et al. From command-and-control to market-based environmental policies: Optimal transition timing and China's heterogeneous environmental effectiveness[J]. *Economic Modelling*, 2020, 90: 1-10.
 23. De Silva Lokuwaduge C S, De Silva K M. ESG risk disclosure and the risk of green washing[J]. *Australasian Accounting, Business and Finance Journal*, 2022, 16(1): 146-159.
 24. Xu W, Li M, Xu S. Unveiling the "Veil" of information disclosure: Sustainability reporting "greenwashing" and "shared value"[J]. *PloS One*, 2023, 18(1): e0279904.
 25. Lin B, Zhang A. Can government environmental regulation promote low-carbon development in heavy polluting industries? Evidence from China's new environmental protection law[J]. *Environmental Impact Assessment Review*, 2023, 99: 106991.
 26. Huang C, Chang X, Wang Y, et al. Do major customers encourage innovative sustainable development? Empirical evidence from corporate green innovation in China[J]. *Business Strategy and the Environment*, 2023, 32(1): 163-184.
 27. Jie G, Jiahui L. Media attention, green technology innovation and industrial enterprises' sustainable development: The moderating effect of environmental regulation[J]. *Economic Analysis and Policy*, 2023, 79: 873-889.
 28. Li Z, Huang Z, Su Y. New media environment, environmental regulation and corporate green technology innovation: Evidence from China[J]. *Energy Economics*, 2023, 119: 106545.
 29. Deng J, Yang J, Liu Z, et al. Environmental protection tax and green innovation of heavily polluting enterprises: A quasi-natural experiment based on the implementation of China's environmental protection tax law[J]. *Plos one*, 2023, 18(6): e0286253.
 30. Zhang D. Can environmental monitoring power transition curb corporate greenwashing behavior?[J]. *Journal of Economic Behavior & Organization*, 2023, 212: 199-218.
 31. Schmuck D, Matthes J, Naderer B. Misleading consumers with green advertising? An affect-reason-involvement account of greenwashing effects in environmental advertising[J]. *Journal of Advertising*, 2018, 47(2): 127-145.
 32. Walker K, Wan F. The harm of symbolic actions and green-washing: Corporate actions and communications on environmental performance and their financial implications[J]. *Journal of business ethics*, 2012, 109: 227-242.
 33. Hu X, Hua R, Liu Q, et al. The green fog: Environmental rating disagreement and corporate greenwashing[J]. *Pacific-Basin Finance Journal*, 2023, 78: 101952.
 34. Yu E P, Van Luu B, Chen C H. Greenwashing in environmental, social and governance disclosures[J]. *Research in International Business and Finance*, 2020, 52: 101192.
 35. Zhang D. Green financial system regulation shock and greenwashing behaviors: Evidence from Chinese firms[J]. *Energy Economics*, 2022, 111: 106064.
 36. Liu Y, Deng Y, Li C, et al. Do disclosure of ESG information policies inhibit the value of heavily polluting Enterprises?—Evidence from China[J]. *Heliyon*, 2023, 9(12).
 37. Kong D, Xiang G, Zhu L. Innovation-driven development and corporate green innovation[J]. *Finance Research Letters*, 2024, 68: 106008.
 38. Lin B, Zhang Q. Green technology innovation under differentiated carbon constraints: The substitution effect of industrial relocation[J]. *Journal of Environmental Management*, 2023, 345: 118764.
 39. Shi R, Gao P, Su X, et al. Synergizing natural resources and sustainable development: A study of industrial structure, and green innovation in Chinese region[J]. *Resources Policy*, 2024, 88: 104451.
 40. Li W, Shi C, Xiao Z, et al. Bridging the green gap: How digital financial inclusion affects corporate ESG greenwashing[J]. *Finance Research Letters*, 2024, 69: 106018.
 41. Xie J, Chen L, Liu Y, et al. Does fintech inhibit corporate greenwashing behavior?—Evidence from China[J]. *Finance Research Letters*, 2023, 55: 104002.

- 42.Janssen C, Swaen V, Du S. Is a specific claim always better? The double-edged effects of claim specificity in green advertising[J]. Journal of business research, 2022, 151: 435-447.
- 43.Wang Y, Zhang W. Green credit policy, market concentration and green innovation: Empirical evidence from local governments' regulatory practice in China[J]. Journal of Cleaner Production, 2024, 434: 140228.
- 44.Ma Y, Sha Y, Wang Z, et al. The effect of the policy mix of green credit and government subsidy on environmental innovation[J]. Energy Economics, 2023, 118: 106512.
- 45.W. Zhonglin, Y. Baojuan, Mediation effect analysis: Methodology and model development,Adv.Psychol.Sci.5(2014) 731–745, SPJ.1042.2014.00731.
- 46.Liu Y, Deng Y, Li C, et al. Do disclosure of ESG information policies inhibit the value of heavily polluting Enterprises?—Evidence from China[J]. Heliyon, 2023, 9(12).
- 47.Wang Y, Wei S, He X, et al. Environmental regulation and entrepreneurial activity: Evidence from the low-carbon city pilot policy in China[J]. Sustainable Cities and Society, 2023, 98: 104829.
- 48.Pan A, Liu X, Qiu J, et al. Can green M&A of heavy polluting enterprises achieve substantial transformation under the pressure of media[J]. China Industrial Economics, 2019, 2(2): 174-92.
- 49.Gong C M, Gong P, Jiang M. Corporate financialization and investment efficiency: Evidence from China[J]. Pacific-Basin Finance Journal, 2023, 79: 102045.
- 50.Fan H M, Mu H Z. Effects of environmental regulations on the employment of urban dual labor—based on the perspective of labor market segmentation[J]. Economic Theory and Business Management, 2017, 2017(2): 34-47.