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THE SILENT WATCHDOG: HOW PUBLIC ENVIRONMENTAL CONCERN DETERS CORPORATE GREENWASHING OVER TIME

O GUARDIÃO SILENCIOSO: COMO A PREOCUPAÇÃO PÚBLICA COM O MEIO AMBIENTE DISSUADE O GREENWASHING CORPORATIVO AO LONGO DO TEMPO

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Abstract
Public environmental concern plays a silent supervisory role in corporate governance, yet its impact on greenwashing remains underexplored. This study examines the relationship between public environmental concern and corporate greenwashing using panel data of Chinese A-share listed companies from 2011 to 2023. Employing a two-way fixed effects model, we find that public environmental concern significantly inhibits corporate greenwashing, though with a time lag. This lag reflects the time firms need to perceive and respond to public pressure. The inhibitory effect is more pronounced in the eastern region, which is more developed. Heterogeneity analysis reveals that the effect is stronger in non-state-owned enterprises and heavily polluting industries. These findings suggest that public concern operates as a gradual constraining force rather than an immediate deterrent. The results have implications for improving environmental information disclosure regulations and strengthening corporate environmental legal responsibility.

Resumo
A preocupação pública com o meio ambiente desempenha um papel silencioso de supervisão na governança corporativa. mas seu impacto sobre o greenwashing ainda é pouco estudado. Este estudo examina a relação entre a preocupação pública ambiental e o greenwashing corporativo utilizando dados em painel de empresas listadas na China no período de 2011 a 2023. Com um modelo de efeitos fixos bidirecionais. verificamos que a preocupação pública ambiental inibe significativamente o greenwashing. embora com um efeito defasado no tempo. Essa defasagem reflete o tempo necessário para que as empresas percebam e respondam à pressão pública. O efeito inibitório é mais pronunciado na região leste. mais desenvolvida. A análise de heterogeneidade revela que o efeito é mais forte em empresas não estatais e em indústrias de alta poluição. Esses achados sugerem que a preocupação pública atua como uma força gradual de contenção. e não como um impedimento imediato. Os resultados têm implicações para o aprimoramento das normas de divulgação de

Keywords: Fixed Effects Model. Greenwashing. Lagged Effect. Panel Data. Public Environmental Concern.

informações ambientais e para o fortalecimento da responsabilidade jurídica ambiental das empresas.

Palavras-chave: *Dados em Painel. Efeito Defasado. Greenwashing. Modelo de Efeitos Fixos. Preocupação Pública Ambiental.*

1 INTRODUCTION

Against the backdrop of the "dual carbon" goals (peak carbon by 2030 and carbon neutrality by 2060). corporate environmental behavior has increasingly attracted attention from all sectors of society. Greenwashing. the practice of companies selectively disclosing environmental information and exaggerating their green achievements to cultivate an environmentally friendly image without engaging in substantial green transformation. has become a phenomenon that cannot be ignored (Doğan et al.. 2026; Lyon & Montgomery. 2015). Greenwashing not only distorts resource allocation and damages investor confidence but also raises compliance and legal issues related to environmental information disclosure. Companies that obtain green funding or policy benefits through false or misleading environmental information may constitute environmental fraud and face regulatory penalties and litigation risks. Therefore. finding effective mechanisms to curb greenwashing has significant theoretical and practical implications.

In recent years. public environmental concern has emerged as an important external governance force. receiving widespread attention from the academic community. With the increasing prominence of environmental problems and the strengthening of public environmental awareness. the public exerts strong external pressure on companies by searching for environmental information. monitoring corporate environmental performance. and participating in environmental supervision (Zhou & Ding. 2023). This pressure may prompt companies to place greater emphasis on environmental responsibility and reduce opportunistic behavior. From a legal regulatory perspective. increased public environmental awareness helps strengthen the social oversight mechanism for environmental information disclosure. compensating for the shortcomings

of relying solely on government regulation and fostering a multi-stakeholder environmental governance model (Sun & Yin. 2026).

While public environmental awareness is theoretically significant. empirical research on its relationship with corporate greenwashing remains limited. Existing studies largely focus on the impact of formal regulations such as environmental laws and government oversight on corporate environmental behavior (Zhang et al.. 2023). The role of informal institutions. particularly public awareness. is relatively lacking in in-depth research. Furthermore. the few studies on public environmental awareness typically use cross-sectional data. failing to control for unobserved corporate heterogeneity and failing to capture the dynamic evolution of this relationship over time.

This study aims to fill this gap by utilizing a comprehensive panel dataset of Chinese A-share listed companies from 2011 to 2023. containing 40.117 company-year observations. This study employs a fixed-effects model. controlling for heterogeneity by company and year. to empirically examine the impact of public environmental concern on corporate greenwashing behavior. The study finds that public environmental concern significantly inhibits corporate greenwashing behavior. Heterogeneity analysis indicates that this inhibitory effect is more pronounced in non-state-owned enterprises. heavily polluting industries. and the eastern region.

This study contributes to the literature in several ways. First. this study directly examines the relationship between public environmental concern and greenwashing behavior using large-scale panel data. providing more reliable evidence than previous cross-sectional studies. Additionally. from the perspective of collaborative governance through legal and social oversight. this paper reveals the supplementary role of public environmental concern as an informal institution to formal legal regulation. Third. by employing a fixed-effects model that controls for corporate heterogeneity and time trends. this paper provides more reliable causal estimates than previous studies. Furthermore. this paper provides empirical evidence for policymakers to improve environmental information disclosure supervision and strengthen corporate environmental legal responsibility.

The structure of this paper is as follows: Part II reviews the literature and proposes research hypotheses. Part III describes the research design. including data sources. variable definitions. and model specifications. Part Four presents the empirical results.

including descriptive statistics. correlation analysis. main regression results. robustness tests. and heterogeneity analysis. Part Five discusses the research findings and summarizes policy implications and limitations.

2 LITERATURE REVIEW

2.1 Greenwashing: concept. Causes. And consequences

Greenwashing refers to a company's use of symbolic rather than substantive environmental information disclosure to mislead stakeholders' judgments about its environmental performance (Walker & Wan. 2012). The term was first coined by environmentalist Jay Westerveld in 1986. He observed that some hotels encouraged guests to reuse towels under the guise of "environmental protection." while simultaneously engaging in environmentally harmful practices **(de Freitas Netto et al.. 2020)**. Since then. with increasing environmental awareness and growing pressure on companies to fulfill their environmental responsibilities. greenwashing has become increasingly prevalent.

From a legal and regulatory perspective. greenwashing may constitute false advertising or environmental fraud. violating the requirements for information accuracy under the Environmental Protection Act and the Securities Act (Zhang. 2022). In many jurisdictions. greenwashing can lead to regulatory penalties. consumer lawsuits. and reputational damage. For example. in 2020. the Australian Competition and Consumer Commission fined a large energy company for misleading consumers regarding its environmental credentials **(Brooks et al.. 2025)**. In China. the State Administration for Market Regulation has intensified its crackdown on false environmental claims in recent years.

Existing research has explored the causes of greenwashing from multiple perspectives. From a corporate governance perspective. studies have found that institutional investors. board independence. and other internal governance mechanisms can effectively curb greenwashing. From an external regulatory perspective. environmental regulation (T. Zhang. 2023). media regulation (Yue & Li. 2023). and other external forces can also effectively constrain corporate greenwashing.

However. the role of public environmental concern. an important informal institution. has been rarely studied. As an important supplement to formal laws and regulations. public environmental concern may have a unique impact on corporate environmental behavior. Unlike formal regulations that rely on government enforcement. this study proposes that public concern potentially operates through reputation mechanisms. social norms. and informal sanctions. and its impact may reach levels of corporate behavior that are difficult for formal regulations to reach.

2.2 Public environmental concern: concept and governance mechanisms

Public environmental concern refers to the degree of public attention to environmental issues and the intensity of environmental awareness. It encompasses individuals' awareness of environmental issues. their attitudes towards environmental protection. and their willingness to take action to address environmental problems (Dunlap. 2002). Public environmental concern can be measured through surveys. media reports. or (as used in this study) search engine data. which captures actual information-seeking behavior.

2.2.1 Reputation mechanism

As a significant external force in governance. public concern about the environment influences corporate behavior through the following mechanisms. First. there's the reputation mechanism. In regions with high public environmental awareness. a company's environmental performance is more easily noticed and discussed by the public. media. and other stakeholders. Once greenwashing is exposed. companies face severe reputational damage. leading to financial losses such as decreased sales. falling stock prices. and increased capital costs (Xu et al.. 2025). With increased public oversight. the expected costs of greenwashing significantly increase. thus serving as a deterrent.

2.2.2 Oversight mechanism

Second. there's the oversight mechanism. The public can directly monitor corporate environmental behavior through social media. whistleblowing platforms. and other channels. reporting suspected violations to regulatory agencies. This increases the likelihood of greenwashing being detected and punished. The digital age has greatly expanded the scope and effectiveness of public oversight; social media platforms enable the rapid dissemination of information about corporate environmental misconduct (Lyon & Montgomery. 2015). This creates a synergistic effect between social oversight and legal regulation. making it more difficult for companies to conceal their true environmental performance.

2.2.3 Pressure transmission mechanism

Third. there's the pressure transmission mechanism. Public concern indirectly exerts pressure on companies by influencing government policies and regulations. When the public is highly concerned about environmental issues. governments face greater pressure to strengthen environmental regulation and enforcement (Liu et al.. 2023). This may lead to stricter environmental standards. more frequent inspections. and harsher penalties for violations. Therefore. public attention can amplify the impact of formal laws and regulations. forming a multi-layered governance system that can curb corporate greenwashing.

2.2.4 Consumer preference mechanism

Fourth. the consumer preference mechanism. Environmentally conscious consumers may be more inclined to choose products from companies with good environmental records and boycott products from companies involved in greenwashing. This market mechanism directly affects corporate revenue and profits. providing a strong incentive for companies to avoid greenwashing and commit to substantial environmental improvements.

Based on the above theoretical analysis. this study proposes the following hypotheses: Public environmental concern inhibits corporate greenwashing behavior. with the effect operating through a time lag.

2.3 Theoretical framework: institutional theory

Institutional theory provides a powerful perspective for understanding how external pressures shape organizational behavior. According to DiMaggio and Powell (1983). organizations operate within an institutional environment that exerts three types of pressure: coercive pressure. normative pressure. and imitative pressure. These pressures drive organizations toward isomorphism. adopting similar structures. strategies. and practices to gain legitimacy and ensure survival.

Coercive pressure stems from the formal and informal power exerted by strong stakeholders. particularly the state. In the environmental sphere. coercive pressure includes environmental laws and regulations. government inspections. and penalties for violations (Gu & Xie. 2022). Firms facing strong coercive pressure are more likely to comply with environmental disclosure requirements to avoid legal sanctions.

Normative pressure stems from professional norms. social values. and the expectations of stakeholders such as communities. customers. and civil society organizations. Public concern about environmental issues is a typical example of normative pressure. When the public is highly concerned about environmental issues. firms face social expectations of demonstrating environmental responsibility. Failure to meet these expectations can lead to a loss of social legitimacy. reputational damage. and reduced market support (Gatti et al.. 2021)

Imitation pressure stems from uncertainty. prompting organizations to emulate the practices of successful or legitimate peers. In the environmental field. firms may observe and emulate the environmental disclosure practices of industry leaders. especially when the effectiveness of different strategies is unclear.

Regarding greenwashing. institutional theory argues that public concern about environmental issues. as a normative pressure. should incentivize firms to improve the quality and accuracy of their environmental disclosures(Sun & Yin. 2026; Wang et al.. 2025). However. firms' responses may differ depending on how they interpret and address

this pressure. Some firms may make substantial environmental improvements. while others may resort to symbolic responses—including greenwashing to maintain legitimacy without incurring real costs of change (Meyer & Rowan. 1977).

Simple legal oversight (coercive pressure) may have resource and information blind spots. However. public attention (normative pressure). as a distributed social oversight network. can penetrate into corners that the law cannot reach. forcing companies to spontaneously move towards substantive compliance when facing a crisis of social legitimacy. This reduces the overall cost of law enforcement and improves the effectiveness of environmental laws.

3 RESEARCH DESIGN

3.1 Data sources and sample selection

This study uses Chinese A-share listed companies from 2011 to 2023 as the initial sample. The sample period begins in 2011 because public environmental concern data based on the Baidu Search Index is available from that year. The final sample consists of 40.117 firm-year observations after the following screening procedures:

1. **Exclude financial industry companies**: Financial companies have unique financial structures and are subject to different regulations. making them incomparable with non-financial firms.
2. **Exclude ST**. ***ST**. **and PT companies**: These specially treated companies have abnormal financial conditions that may distort the analysis.
3. **Exclude observations with missing core variables**: Observations missing key variables such as greenwashing (gw_dum) or public environmental concern (PEC) are removed.
4. **Winsorize continuous variables**: All continuous variables are winsorized at the 1% and 99% levels to mitigate the influence of outliers.

   Data sources:

Greenwashing data (gw_dum): Constructed as a decoupling index following Hu et al. (2023) and Wang et al. (2024). Green communication (oral) is measured by the frequency of green-related terms in the Management Discussion & Analysis (MD&A)

section of annual reports. obtained from the Wingo platform. Actual environmental performance is measured by environmental penalty records from CSMAR and CNRDS databases. GW_dum equals 1 if a firm has above-median green communication and has received environmental penalties. and 0 otherwise.

Public environmental concern data (PEC): Baidu Search Index. constructed based on the search frequency of environment-related keywords at the provincial level. Keywords include "haze".

Financial and corporate governance data: CSMAR database. the most authoritative data source for Chinese listed companies.

Regional data: China Regional Statistical Yearbooks.

This study adheres to ethical standards and utilizes publicly available secondary data. All data sources have been properly cited. and this study did not involve any human subjects or animals.

3.2 Variable definitions

Table 1

Variable description

Variable	Form	Definition
Greenwashing	gw_dum	Dummy variable. equals 1 if the company engages in greenwashing behavior in year t. 0 otherwise
Public Environmental Concern (Lagged)	L.PEC	Public environmental concern in year t-1. measured at the provincial level based on Baidu Search Index
Institutional Ownership	INST	Proportion of shares held by institutional investors
Tobin's Q	TobinQ	Ratio of market value to replacement cost of assets. reflecting growth opportunities
CEO Duality	Dual	Dummy variable. equals 1 if the chairman and CEO are the same person. 0 otherwise
Revenue Growth Rate	Growth	(Current year revenue - Previous year revenue) / Previous year revenue

Variable	Form	Definition
Total Asset Turnover	ATO	Revenue / Average total assets. reflecting operating efficiency
Return on Equity	ROE	Net profit / Average net assets. reflecting profitability
Audit Opinion	Opinion	Dummy variable. equals 1 if the company receives a standard unqualified audit opinion. 0 otherwise
Firm Fixed Effects	α_i	Control for all time-invariant firm-specific characteristics
Year Fixed Effects	λ_t	Control for common shocks affecting all firms in a given year

3.3 Model specification

To test the impact of public environmental concern on corporate greenwashing. this study employs a two-way fixed effects model with a lagged independent variable:

$$gw\_dum_{it} = \beta_0 + \beta_1 PEC_{i.t-1} + \gamma Controls_{it} + \alpha_i + \lambda_t + \varepsilon_{it} \quad (1)$$

where:

i indexes firms. t indexes years

gw_dum_{it} is the greenwashing dummy for firm i in year t

$PEC_{i.t-1}$ is public environmental concern in the province where firm i is located in year t-1 (lagged by one period)

$Controls_{it}$ is a vector of firm-level control variables

α_i are firm fixed effects. controlling for all time-invariant firm characteristics

λ_t are year fixed effects. controlling for common time trends

ε_{it} is the error term

The use of lagged public environmental concern addresses two methodological concerns. First. it mitigates potential reverse causality. as current greenwashing behavior cannot affect previous-period public concern. Second. it captures the theoretical

proposition that firms need time to perceive. interpret. and respond to public pressure—consistent with annual reporting cycles and corporate decision-making processes.

The inclusion of firm fixed effects is crucial because it controls for unobserved heterogeneity across firms that might be correlated with both public environmental concern and greenwashing. For example. firms in regions with high public environmental concern might also have better management teams or stronger corporate cultures. which could independently affect greenwashing. Firm fixed effects absorb all such time-invariant characteristics. allowing us to identify the effect of changes in public environmental concern within firms over time.

Year fixed effects control for common shocks that affect all firms in a given year. such as changes in national environmental policies. economic cycles. or major environmental events. This ensures that the estimated effect of public environmental concern is not confounded by these aggregate factors.

Under strict exogeneity assumptions. linear probability models with fixed effects provide consistent estimates and allow for direct interpretation of the coefficients. To address the inherent heteroscedasticity of linear probability models and the issue of serial correlation within firms. standard errors are clustered at the firm level (Angrist & Pischke. 2009). All analyses were performed using Stata 18.

3.4 Descriptive statistics

Table 2

Descriptive Statistics

Variable	Obs	Mean	Std Dev	Min	p25	p50	p75	Max
gw_dum	40.117	0.174	0.379	0.000	0.000	0.000	0.000	1.000
PEC	40.117	4.512	1.623	0.000	4.455	4.934	5.320	6.528
INST	40.117	0.430	0.249	0.003	0.219	0.440	0.633	0.912
TobinQ	40.117	1.996	1.262	0.836	1.236	1.586	2.261	8.321
Dual	40.117	0.304	0.460	0.000	0.000	0.000	1.000	1.000

Variable	Obs	Mean	Std Dev	Min	p25	p50	p75	Max
Growth	40.117	0.148	0.366	-0.557	-0.036	0.095	0.251	2.120
ATO	40.117	0.634	0.426	0.075	0.358	0.542	0.785	2.559
ROE	40.117	0.059	0.134	-0.647	0.027	0.071	0.121	0.351
Opinion	40.117	0.973	0.162	0.000	1.000	1.000	1.000	1.000

The mean value of greenwashing (gw_dum) is 0.174. indicating that about 17.4% of firm-year observations involve greenwashing behavior. This baseline rate provides context for interpreting the economic significance of the estimated effects.

The mean value of public environmental concern (PEC) is 4.512. with a standard deviation of 1.623. The substantial variation in PEC across provinces and years provides a good foundation for identifying its effect on greenwashing. The 25th percentile (4.455) and 75th percentile (5.320) indicate that the distribution is relatively concentrated in the middle-to-high range. suggesting that public environmental concern has been generally high during the sample period.

Control variables show patterns consistent with the literature. Institutional ownership averages 43.0%. indicating that institutional investors have become important shareholders. CEO duality is present in 30.4% of observations. The average growth rate is 14.8%. and ROE averages 5.9%. consistent with typical listed company performance.

3.5 Correlation analysis

Table 3

Correlation Matrix

Variable	**gw_dum**	**PEC**	**INST**	**TobinQ**	**Dual**	**Growth**	**ATO**	**ROE**	**Opinion**
gw_dum	1.000								

Variable	gw_dum	PEC	INST	TobinQ	Dual	Growth	ATO	ROE	Opinion
PEC	-0.102***	1.000							
INST	0.080***	-0.063***	1.000						
TobinQ	-0.142***	0.120***	-0.055***	1.000					
Dual	-0.051***	0.039***	-0.188***	0.071***	1.000				
Growth	-0.004	-0.001	0.044***	0.064***	0.023***	1.000			
ATO	0.053***	-0.060***	0.090***	-0.024***	-0.028***	0.147***	1.000		
ROE	-0.000	-0.038***	0.147***	0.049***	0.019***	0.272***	0.210***	1.000	
Opinion	0.004	-0.009*	0.046***	-0.048***	0.014***	0.060***	0.050***	0.252***	1.000

*Note: ***. **. * indicate significance at the 1%. 5%. and 10% levels. respectively*

The correlation coefficient between public environmental concern (PEC) and greenwashing (gw_dum) is -0.102. significant at the 1% level. This negative correlation provides preliminary support for Hypothesis 1. suggesting that higher public environmental concern is associated with lower greenwashing. However. correlation does

not imply causation. and the multivariate regression analysis with fixed effects will provide more reliable evidence.

The correlation coefficients among control variables are all below 0.3. indicating no serious multicollinearity concerns. This is confirmed by variance inflation factor (VIF) tests. which show all VIFs below 2. well below the conventional threshold of 10.

4 EMPIRICAL RESULTS

4.1 Main regression results

Table 4 reports the main regression results of public environmental concern on greenwashing. Column (1) includes only firm fixed effects and year fixed effects without control variables. Column (2) adds the full set of control variables. Standard errors are clustered at the firm level to account for within-firm correlation over time.

Table 4:

Main Regression Results: Public Environmental Concern and Greenwashing

Variable	(1) gw_dum
L.PEC	**-0.0264*****
	(-3.20)
INST	0.1248***
	(4.51)
TobinQ	-0.0087***
	(-3.78)
Dual	-0.0010
	(-0.13)
Growth	0.0063
	(1.08)

Variable	(1) gw_dum
ATO	-0.0238*
	(-1.71)
ROE	0.0393*
	(1.91)
Opinion	-0.0178
	(-1.25)
Firm FE	YES
Year FE	YES
Observations	34.163
Within R^2	0.0025
Variable	(1) gw_dum
L.PEC	**-0.0264*****

*Note: t-values in parentheses; *** p<0.01. ** p<0.05. * p<0.1*

Table 4 reports the main results of a two-way fixed-effects model using lagged public attention. The coefficient for L.PEC is -0.0264. significant at the 1% significance level (t = -3.20). This indicates that higher public attention in year t-1 significantly reduces the probability of greenwashing in year t.

From an economic perspective. for every standard deviation increase in lagged public attention (1.623). the greenwashing rate decreases by 4.3 percentage points. This represents a 25% reduction relative to the sample mean of 17.4%. This is a considerable amount. comparable to the effects recorded by other governance mechanisms (D. Zhang. 2023).

The lag in this effect is theoretically significant. Concurrent public attention (not listed in the table) did not show a significant impact (coefficient = 0.0038. t = 0.54).

suggesting that firms need time to perceive and respond to public pressure. consistent with annual reporting cycles and organizational decision-making processes.

Among the control variables. institutional ownership was positively correlated with "greenwashing" behavior (0.1248. $p < 0.01$). while Tobin's Q was negatively correlated (-0.0087. $p < 0.01$). The significance of other control variables varied.

4.2 Robustness checks

Table 5 reports robustness checks using an alternative PEC measure and excluding 2020. The alternative measure yields a coefficient of -0.0214 ($t = -3.12$). significant at 1%. Excluding 2020 gives -0.0251 ($t = -2.98$). also significant at 1%. These results confirm that the main finding is not sensitive to measurement choices or pandemic-related disruptions.

Table 5

Robustness Check

Variable	**Alternative Measure of PEC**	**Excluding 2020**
L.PEC_alt	-0.0214***	-0.0251***
	(-3.12)	(-2.98)
Controls	YES	YES
Firm FE	YES	YES
Year FE	YES	YES
Observations	34.163	31.245
Within R^2	0.0024	0.0026

"The negative effect of lagged public concern remains robust across alternative specifications. including different measurement approaches and excluding the COVID-19 pandemic year."

4.3 Heterogeneity analysis

To test Hypothesis 2. this study conducts heterogeneity analysis by splitting the sample based on ownership type. industry pollution intensity. and region.

Table 6

Heterogeneity Analysis

Variable	Eastern Region
L.PEC	**-0.0312****
	(-2.45)
Controls	YES
Firm FE	YES
Year FE	YES
Observations	5.892
Within R^2	0.0031

*Note: t-values in parentheses; ***. **. * indicate significance at the 1%. 5%. and 10% levels. respectively*

The inhibitory effect of lagged public concern is particularly pronounced in eastern regions (coefficient = -0.0312. $p < 0.05$). where institutional development and media penetration are higher. This suggests that the effectiveness of public pressure depends on the broader institutional context**.**

5 DISCUSSION AND CONCLUSION

5.1 Discussion of main findings

This study found that public attention to the environment significantly inhibited corporate "greenwashing" behavior. and this inhibitory effect had a time lag. Increased public attention in year t-1 reduced "greenwashing" behavior in year t by 4.3 percentage

points. equivalent to 25% of the average level. Public attention had no significant impact during the same period.

This lag effect has important theoretical implications. Firms do not react immediately to changes in public attention; they need time to perceive. interpret. and respond to changes in the external environment. This is consistent with the annual reporting cycle. organizational decision-making processes. and the time required for public attention to translate into specific pressures from media. regulatory. or market channels.

The results support the institutional theory's emphasis on normative pressure as a governance mechanism (DiMaggio & Powell. 1983). Public attention operates through reputation mechanisms. social norms. and informal sanctions. reaching levels of corporate behavior that formal regulations may struggle to address. The results also indicate that public attention complements formal regulation by constructing a distributed surveillance network that continuously monitors firms.

Heterogeneity analysis reveals that this effect is more pronounced in the eastern region. where institutional development. media penetration. and civil society are more advanced. This suggests that the effectiveness of normative pressure depends on the broader institutional environment.a key boundary condition for informal governance mechanisms.

5.2 Comparison with previous literature

This study expands upon previous research in several ways. First. while previous studies examined formal regulation (D. Zhang. 2023) and media oversight (Yue & Li. 2023). this study focuses on public attention as an informal governance mechanism. Second. the discovery of lag effects helps understand the timing of firms' responses to external pressures—an aspect often overlooked in previous research. Third. regional heterogeneity analysis provides evidence for the boundary conditions of informal governance.

The findings are consistent with studies documenting the role of public attention in corporate governance (Zhou & Ding. 2023) and extend the research to the specific area

of greenwashing. Greenwashing is particularly susceptible to public scrutiny because it involves deceiving environmental performance.

5.3 Theoretical and policy implications

Theoretically. this study enriches institutional theory by demonstrating that normative pressure has a time lag and depends on the institutional environment. Furthermore. it emphasizes the role of external stakeholders (i.e.. the public concerned about this issue) in shaping corporate behavior. thus supplementing traditional internal governance mechanisms and enriching corporate governance theory.

For policymakers. the results suggest that public attention can be leveraged to improve regulatory effectiveness. Strategies to enhance this effect include: creating platforms to facilitate public access to corporate environmental information; establishing mechanisms for public reporting of suspected greenwashing; ensuring timely responses to public complaints by regulatory agencies; and investing in media development and civil society building. especially in underdeveloped regions.

For corporate managers. the results indicate that ignoring public attention has tangible costs. Companies that fail to respond to ongoing public attention will face increasingly stringent scrutiny and reputational risks. Active participation in environmental issues and transparent information disclosure can mitigate these risks.

5.4 Research limitations and future research directions

This study has some limitations. First. although panel data including firm fixed effects controlled for time-invariant heterogeneity. causal identification remains incomplete. Future research could employ instrumental variable methods or quasi-natural experiments. Secondly. public attention metrics based on search data reflect attention rather than sentiment; combining search data with sentiment analysis could provide richer insights. Thirdly. the sample only includes Chinese listed companies; whether the results can be generalized to other institutional contexts requires cross-national comparisons.

Future research should also examine the mechanisms by which public attention translates into corporate actions (media reports. regulatory responses. market responses).

and the interactions between these channels. Furthermore. investigating whether lag effects vary with firm characteristics (size. ownership. industry) could reveal more boundary conditions.

6 CONCLUSION

This study demonstrates that public concern about the environment significantly inhibits corporate greenwashing. and this inhibitory effect has a time lag. The study found that only lagged public concern has a significant impact. while concurrent concern is not significant. revealing how informal social pressure shapes the temporal dynamics of corporate behavior. Firms need time to perceive and respond to changes in public concern; therefore. the lag effect is a suitable model for examining this relationship.

Its economic implications are significant: for every standard deviation increase in lagged public concern. corporate greenwashing behavior decreases by 25% relative to the average. This effect is robust under different model settings and is more pronounced in the more institutionally developed eastern region.

These findings contribute to understanding the governance role of informal institutions and indicate that an informed and environmentally conscious public is an important complement to formal environmental regulations. Policymakers should recognize this synergistic effect and create conditions to translate public concern into effective pressure on firms. ultimately strengthening their environmental responsibility.

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Authors' Contribution

All authors contributed equally to the development of this article.

Data availability

All datasets relevant to this study's findings are fully available within the article.

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