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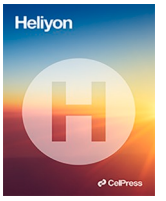

Research article

Prevention or ex-post forcing? The impact of dual environmental regulation on corporate environmental behavior

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ABSTRACT

Corporate reactions to environmental regulation are the hottest topics in research on corporate environmental behavior. However, a few studies incorporate other environmental behavior into the same framework. By constructing a comprehensive indicator system of dual environmental regulation, this paper uses a comparative analysis to discuss Chinese A-listed corporations' environmental behavior from 2009 to 2017, which were influenced by dual environmental regulation. The study's results show that formal environmental regulation (FER) has a significant U-shaped effect on pre-emptive environmental behavior (PEB) but an insignificant impact on ex-post environmental behavior (NEB). After categorizing the various forms of FER, this study finds that market-incentive environmental regulation has a significant inverted U-shaped effect on NEB but an insignificant impact on PEB, voluntary-participation regulation have a significant U-shaped effect on PEB and an inverted U-shaped effect on their NEB, and command-control regulation has significant influence on neither PEB nor NEB. In addition, informal environmental regulation (IER) has a significantly positive and negative effect on PEB and NEB. This study shows that corporate perceptions of policies can have a positive impact on the interaction between the FER and PEB but a negative impact on the interaction between the IER and PEB, and no impact on the interaction between FER or IER and NEB. Moreover, the impact of FER and IER on corporate environmental behavior (CEB) varies depending on factors like ownership, industry characteristics, the market environment, and regional development. Therefore, governments should understand the choices related to corporate environmental behavior under the dual environmental regulation—formal and informal—and prioritize the synergistic impact of these dual environmental regulation, highlighting their enforceability, and take into account the heterogeneity of their targets and the market to stimulate PEB and decrease NEB to help enterprises align their short-term economic objectives with their long-term social goals.

1. Introduction

Corporate strategies for managing the interface between business and the environment have evolved against the backdrop of regulatory pressures and stakeholder activism. A degraded environment poses a threat to human and other species' survival,

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undermines a country's fundamental competitiveness, and affects enterprises. Consequently, environmental protection has gained increasing attention in emerging nations like China. Meanwhile, the importance of environmental regulation in reducing corporations' emissions and addressing market failures related to environmental issues is widely recognized [1]. Over the last ten years, China's government has established a comprehensive legal framework through the enactment of legislation like the Environmental Protection Law of China and the Air Pollution Prevention Law. The establishment of a comprehensive environmental legal framework signifies a fundamental change in the country's approach to overcoming resource and environmental constraints, paving the way for socio-economic progress. The State's increased environmental regulation has increased the risk of environmental liability for polluters, but while China efforts to address ecological crises are intended to achieve sustainable national development and build a community with a shared future for humankind, whether environmental regulation are actually implemented remains unclear.

Corporations, which are the driving force of economic growth and the reason for the country's implementing an ecological-civilization strategy [2], have significantly contributed to environmental pollution and degradation. As a result, they have drawn increasing scrutiny for their role in environmental issues like climate change and the depletion of natural resources, so they are a key factor in coordinating economic development with protecting the environment. Corporations have been pressed to implement a green-innovation transformation and to upgrade their environmental practices. However, the significant financial burden associated with investing in measures that will protect the environment poses a challenge for them, potentially dampening their motivation to engage in environmental protection initiatives. Therefore, the actions they take are often reactive, shaped primarily by the government's regulatory policies in the area of environmental preservation [3]. As a result, the concept of corporate environmental behavior (CEB) has garnered the interest of diverse stakeholders, policymakers, and society at large. CEB refers to a range of actions and strategies that corporations implement in response to governmental and public pressure to protect the environment [4,5]. Sarkar [6] posits that CEB serves as a proactive response to concerns related to corporate social responsibility. CEB also aims to meet consumer expectations for environmental protection by engaging in self-regulation and self-improvement, thus achieving a win-win for both the environment and the economy. The U.S. Environmental Protection Agency defines CEB as a reactive response by companies that seek to adhere to environmental laws and regulations and enhance their environmental performance. To a certain degree, encouraging businesses to adopt environmentally responsible practices is a viable strategy for addressing prevailing ecological challenges, but objectively assessing and evaluating the ability of the policy measures and environmental regulations to elicit favorable responses from enterprises and promote CEB has become a concern.

To regulate firms' production processes, China's government has adopted formal environmental regulation (FER), which consist of three parts: command-control regulation (CCR), market-incentive regulation (MIR), and voluntary-participation regulation (VPR). CCRs are imposed through formal laws [7,8] and are the historically prevailing method for managing industrial pollution in China. MIRs have progressed slowly: While they effectively addressed environmental issues in their initial stages, they also presented numerous limitations, as environmental protection in China has relied heavily on top-down government mandates with minimal compliance by the public. However, MIRs like tax incentives and environmental subsidies have been adopted [9,10], and market forces increasingly influence Chinese companies to adopt more environmental friendly responsible strategy [11]. Simultaneously, non-governmental organizations' (NGOs') engagement and public participation has increased [12,13] and evolved into a substantial driving force in heightening environmental consciousness throughout society and positive reforms in CEB [14].

As environmental degradation persists and public awareness of the need for environmental protection increases, governments and scholars acknowledge that informal environmental regulation (IER) can be a significant factor (alongside FER) in determining CEB. IERs not only enhance corporations' financial capabilities and social standing but also offset the revenue loss that can result from the positive externalities that all but force corporations to prioritize energy conservation and reduce emissions. Public participation can have a profound influence on enterprises' operational outcomes and motivate them to adopt sustainable environmental practices. Media reports on enterprises' pollution and environmental management practices play a pivotal role in this process, as they bring transparency and accountability to corporate actions [15]. As a result, public participation has imposed a significant financial burden on enterprises in terms of implementing environmental conservation measures as a matter of necessity and reputation management. Social trust in the regions around corporations also has a positive correlation with corporations' environmental practices. Higher levels of trust in the communities toward local enterprises are linked to a greater likelihood of these businesses' adopting CEB to promote sustainability and a healthier environment in the area [16,17]. Similarly, managers tend to be more engaged in corporate environmental efforts in regions that are characterized by strong social trust, and CEB often result in significant advantages for local businesses, which encourages them to undertake additional societal responsibilities. Meanwhile, consumers' green preferences is compelling firms to curate their product selections and pursue technological advancements that increase their sustainability to meet the market's evolving needs [18,19].

However, previous studies discuss only the effect of various types of environmental regulations on specific CEB and often use a single quantitative indicator to measure environmental regulations; few articles incorporate multiple environmental behaviors into the same framework. Therefore, under the stimulus of FER and IER, understanding how corporations react to dual environmental regulation is an issue worthy of investigation.

This article includes both corporate pre-emptive environmental behavior (PEB) and ex-post environmental behavior (NEB) in the same framework for discussion, while considering the conflict between enterprises' short-term economic goals and their long-term social goals. The paper also constructs CEB OLS models by using data from China's A-listed corporations from 2009 to 2017 and focuses on the logic chosen to determine the environmental behavior under various environmental regulation. The article attempts to answer three questions: (1) How do FERs and IERs affect CEB? (2) Do FERs and IERs have differential impacts on PEB and NEB? (3) How do corporate perceptions of policy moderate the relationships of FER and IER with CEB?

This study contributes to the related literature in several ways. First, it places PEB and NEB into a framework to discuss the conflicts

of corporate interests and possible options. It also focuses on the logic of corporations' reactions to FER and IER, rather than environmental performance, to provide a new perspective for the study of CEB and clarify the mechanism between environmental regulation and CEB. In addition, the study reveals that corporate perceptions of policy have a positive moderating influence on the link between FER and PEB and a negative moderating influence on the link between IER and PEB. Finally, the study separately analyzes the effects of FER and IER on both PEB and NEB across the heterogeneity of ownership, industry characteristics, the market environment, and regional development. The empirical results have particular significance for local governments that seek to adjust their environmental policies.

Our research also contributes to the literature for policymakers who seek to offer firm-level evidence from China to the ongoing discourse on the economic implications of environmental regulation. Government departments can use these findings to minimize NEB. Corporations' sustainable practices can help firms in developing and developed countries' to reduce the negative effects of industry. The study can also provide theoretical and empirical evidence for the advancement of environmental regulation policies, the promotion of corporate green transformation, and enhancing policy. Most importantly, the paper suggests the importance of corporate perceptions of policy as a moderator. The study is also helpful for policymakers who seek to identify the most efficient strategies for regulating CEB and gaining a more comprehensive understanding of corporate reactions to regulatory approaches.

The rest of the study proceeds as follows. Section 2 explains the theoretical analysis and empirical discussion used to develop hypotheses. Then section 3 discusses the data collection process, measurements of variables, and research methods. Section 4 provides the empirical results, Section 5 discusses the main results, and Section 6 presents our conclusions and policy implications.

2. Literature review and hypothesis

2.1. Formal environmental regulation (FER) and corporate environmental behavior

FER refers to the measures that governments undertake to protect and heal the environment. These measures require developing laws or norms that restrict the behavior of individuals and corporations. Examples of such regulations include establishing pollutant-emission standard, conducting environmental protection inspections [20], and implementing environmental taxes [4]. Based on new institutional theory [21], many researchers suggest that government regulations is a driving factor of CEB [22–25]. Gray and Deliy [26] and Helland [27] examine the effect of government intervention on CEB in the pulp industry and steel industry and confirm the positive relationship between governmental regulation and enterprises' compliance. Using samples of Standard & Poor's 500 companies, Khanna [28] indicates that governmental regulation drives companies to develop internal environmental policies and implement environmental standards. The evidence Agnolucci and Arvanitopoulos [29] provide shows that governments can reduce corporate emissions by means of reducing energy consumption, encouraging fuel substitutions, and market competition, all of which can offset the increase in emissions that is associated with higher levels of capital investment. Costantini et al. [30] conclude that, when the policy mix is characterized by a balanced blend of demand-driven and technology-driven approaches, the positive impact on ecological innovation increases. According to utilitarian theory, environmental regulation will provide economic incentives for protecting the environment, so firms that have a utilitarian ethic would shift to green development [31]. In sum, research suggests that FER has a positive impact on CEB.

In addition, the solo impact and the combined impact of environmental regulation on CEB differ [13]. Some studies show that MIR's impact on enterprises' environmental strategies is far greater than that of CCR, while CCR's impact on enterprises' technological progress is far greater than that of MIR. For example, Cheng et al. [32]point out that CCR can help reduce emissions but also that CCR's impact on technological progress is insignificant. MIRs are conducive to technological progress, but their impact on reducing emissions is relatively weak. As time goes by, the public in developed countries is playing a more positive role in environmental protection countries and has become a critical factor in affecting CEB [33–35]. Stucki et al. [36] argue that subsidies and voluntary agreements are, to a degree, positively correlated with green product innovation, and Kathuria [37] concludes that local news coverage of pollution influences corporate emissions. In addition, sustained publicity about the polluting activities of industrial estates and their mix of small, medium, and large industries appear to result in a significant decrease in their production of pollution.

Based on this analysis, FERs effectively enforce corporations' compliance with environmental standards and take into account factors that include environmental preservation, economic progress, and social stabilization. Studies also show that corporate environmental management is dominated by short-term characteristics, while firms' production decisions are usually related to the pursuit of long term benefits. CCRs play a more important roles than MIRs do in guiding firm behaviors related to short-term benefits in China; however, MIRs have more potential to promote firms' long-term behavior shifts toward green production decisions, while CCRs do not directly affect these decisions.

In sum, then, CCRs play their role by means of administrative command and have short-term effects. In contrast, MIRs play their role in guiding firm behavior based on market mechanisms and pursue long-term benefits. As a result, during the early phase of FER, firms are inclined to adopt lower-input NEB, rather than higher-input PEB because of the costs associated with corporate pollution control and institutional compliance [38]. A rise in the expenses that are associated with corporations' pollution control has followed the implementation of FER. As a result, corporations are compelled to adopt PEB and integrate its outcomes into their production processes to circumvent the financial costs of environmental regulation [39,40]. However, NEB's effects are typically observed in the short term, whereas PEB's effects are more commonly seen in the long term. This dynamic often results in a U-shaped or an inverted U-shaped relationship between FER's effects on PEB or NEB in terms of both time and intensity. Based on this discussion, Hypotheses 1a and 1b are proposed:

Hypothesis 1a. FER has a U-shaped correlation with PEB.

Hypothesis 1b. FER has an inverted U-shaped correlation with NEB.

2.2. Informal environmental regulation (IER) and corporate environmental behavior

IER refers to behavioral norms that are consciously or unconsciously formed and widely accepted in social interactions [41,42]. FER's effect on mitigating pollution has highlighted the importance of IER in achieving environmental objectives [37]. By increasing the costs associated with corporations' pollution, IER exerts additional pressure on firms to rectify their violations and embrace more environmentally friendly behaviors, so some articles conclude that CEB is related to the level of IER. Synnestvedt [43] endorses this finding, commenting that the focus of providing environmental information to stakeholders as a policy instrument should be on quality, rather than quantity. Dasgupta et al. [44] demonstrate the positive impact of IER imposed through public scrutiny and/or trade, whereas Altham and Guerin [45] opine that a "seamless web" framework of regulation is emerging that recognizes firms' role in formulating policy. Kathuria [37] suggests that lobbying efforts through the media may be effective in influencing CEB. Focusing on China, Zhang et al. [46] show that IER in the form of pressure from supply chains, customers, and communities play a positive role in inducing firms to engage in effective environmental management policies.

As such, IERs not only have a significant impact on corporate governance but also enhance public initiatives in corporate environmental engagement [47,48]. When the level of IER is low, the public's inclination to participate in environmental governance decreases, and corporations may have a sense of complacency or good fortune. Corporations can face penalties for their polluting behavior either through mandatory corrective measures during rigorous inspections or through public reporting and monitoring [49], and as the prevalence of IER rises, the public's inclination toward environmental governance and demand for environmental regulation also increases [46]. Consequently, local governments are intensifying their efforts in environmental investigation, supervision, and punishment of polluting corporations. These measures will compel corporations to augment their green investments and integrate green principles into their production management, thereby fostering environmentally sustainable innovation behavior [50]. At the same time, corporations have the opportunity to cultivate positive relationships with the media [51], consumers [48], and investors [52], thereby enhancing their economic and social values. Therefore, we propose our second hypotheses.

Hypothesis 2a. IER increases corporate PEB.

Hypothesis 2b. IER decreases corporate NEB

2.3. Moderating effects of corporate perceptions of policy (PP)

A policy's ability to attain its intended objectives is contingent on its acceptance by its target. When a corporation is faced with the decision to implement a certain behavior, it undergoes a process that involves gathering and analyzing information, making a decision, and other related activities. Thus, the complexity and diversity of the decision-making process for corporations is similar to that of individuals' decision-making about their behavior. Given the same level of institutional pressure, what factors contribute to the varying levels of corporations' willingness to implement PEB and mitigate NEB? Factors like market pressure, dependence on the government [53], resources [54], and the intensity of enforcement [55] are identified as having moderating roles in the relationship between institutional pressure and CEB. This study focuses on the moderating effect of corporate perceptions of policy on the relationship between environmental regulation and CEB.

Based on the theory of social cognition, corporations develop an understanding of environmental regulation policies through the process of perceiving, comprehending, and interpreting them that influences their environmental behavior. In other words, the impact of environmental regulation on CEB follows a complex evolutionary process known as "policy formulation–policy perception–policy implementation" [56]. Given an environmental regulation policy, corporations and entrepreneurs [57–59], whose cognitive structures may differ [60], will exhibit varying strategic and environmental responses to the policy [61]. Research cites corporate supervisors as the key people who implement the government's environmental regulations [62–64], while employees increase their engagement in environmental behaviors when they perceive more corporate PEB [61,65,66].

Awareness of a policy has a positive influence on a corporation's willingness to use resources to comply with it and then to integrate it into the overall corporate strategy. In so doing, the corporation engages in fulfilling social responsibilities like preventing and controlling pollution and strives to strike a balance between its own profits and the public welfare. A corporation demonstrates its commitment to reducing its negative environmental impact through its mission statement, which aims to establish a positive corporate image that can provide a competitive edge while achieving sustainable development and aligning with the evolving needs of society [67,68]. On the other hand, when firms prioritize profit generation, they may fail to acknowledge or prioritize a policy or the environmental consequences of their behavior. As a result, NEB is likely to increase, while PEB is likely to decrease. Therefore, we propose our third hypotheses.

Hypothesis 3a. PP moderate the positive impact of FER and IER on PEB.

Hypothesis 3b. PP moderate the negative impact of FER and IER on NEB.

The research model for the study is shown in Fig. 1.

3. Data, variables, and methods

3.1. Sample selection and data collection

In 2018, the Chinese government decided to change sewage charges to environmental taxes. It's an important transition in MIR, which might have the potential impact on CEB. So we use the panel data from 30 provinces in China (excluding Tibet, Hong Kong, Macao, and Taiwan) and data from A-listed corporations from 2009 to 2017 as our initial sample [69]. We take several steps to guarantee the rationality and comparability of our samples: We exclude firms that belong to finance industries because of their special information-disclosure standards; we exclude firms with abnormal operating conditions (e.g., ST, *ST, PT, and the samples with missing major financial variables); we complete a small number of the missing values using the mean interpolation method to ensure an adequate sample size; and we logarithmize continuous numerical variables to overcome the overly significant heteroskedasticity in the estimation. We also winsorize all continuous variables at the 1 % and 99 % levels to avoid abnormal values.

We collected most of the data from A-listed corporations' annual reports and several databases. The initial CEB data was collected from the Chinese Research Data Services database (CNRDS). The data on IER and FER was collected from China Environmental Yearbook, China Environmental Statistics Yearbook, China Statistics Yearbook, and China Population and Employment Statistics Yearbook. The data on corporate perceptions of policy was obtained from the reputable third-party rating agency Hexun.com, and the data for the control variables was collected from the China Stock Market Accounting Research Database (CSMAR).

3.2. Variables

3.2.1. Dependent variable: corporate environmental behavior (CEB)

The literature focuses on examining individual environmental behaviors separately, without integrating within a comprehensive analytical framework other environmental behaviors, such as green innovation and eco-innovation behavior and behaviors related to pollution control, investment, environmental commitment, clean management, disclosure of environmental information, fulfillment of environmental responsibilities, product quality, internal governance, or employees' pro-environmental behaviors [70]. Because of the multidimensionality of the CEB measure, which is due to the diversity of such behaviors in corporations, this study categorizes environmental behavior into two categories based on their motives [71]: PEB and NEB.

PEB refer to the proactive actions implemented by corporations to mitigate the potential for adverse environmental effects and environmental regulation, so the company proactively designs or adapts its business operations, manufacturing procedures, and products by anticipating the trends in environmental regulations and societal advancements. These initiatives include development of environmentally friendly products, measures to reduce waste, efforts toward a circular economy, energy conservation, green offices, environmental certification, environmental recognition, and other behaviors. Such behaviors are undertaken voluntarily by the corporation, indicating its robust environmental culture and pro-environmental values.

NEB refer to corporations' reactive actions influenced by external regulations and stakeholder pressure. Adopting a passive stance in their response to environmental regulations and pressure from stakeholders by engaging in defensive lobbying, investing in evading pollution control, and just paying penalties for environmental violations and discharge of pollutants are typical NEB. Engaging in NEB indicates that an organization and the individuals within it lack a sense of environmental responsibility.

3.2.2. Independent variables: FER and IER

FER are usually subdivided into three types of regulations: command-control regulation (CCR), market-incentive regulation (MIR), and voluntary-participation regulation (VPR) [72,73].

CCRs are the most widely used environmental regulations in China. They refer to the environmental laws, regulations, and policies that government departments or environmental protection agencies establish, and acceding to them is mandatory. CCRs address environmental issues in a directly, relying primarily on administrative legislation and orders for implementation. We measure the aspects of CCR from the perspective of the government's tools: the number of employees in environmental agencies, the number of environmental laws and regulations in the region, and the number of environmental penalty cases. The number of employees in environmental agencies measures the level of environmental management [74], whereas the number of environmental laws and regulations in the region measures the level of legislation, and the number of environmental penalty cases measures the intensity of the local government's law enforcement [75].

MIRs are designed by administrative agencies based on the principle of "the polluter pays" to reduce pollutants through market

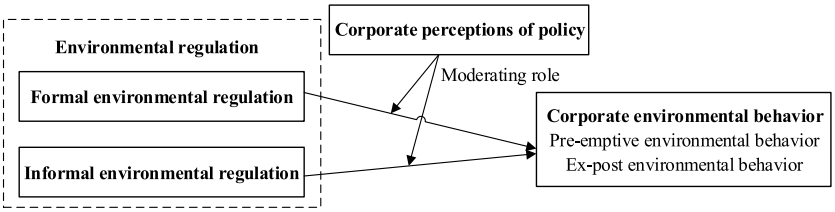

Fig. 1. Research model.

mechanisms. MIRs give enterprises greater autonomy in making decisions than CCRs do. In 2018, China's government changed sewage charges to environmental taxes. Considering data continuity and stability, so we use sewage charges to measure MIR [75].

VPRs refer to the public's expressing its environmental interests by participating voluntarily in environmental regulation activities. Studies show that citizens' posting letters and making visits to local bureaus to complain about environmental pollution [76] play a role in promoting cooperation and mutual assistance between public and private rights [77]. Therefore, we use the number of denouncement of environmental problems, along with the number of environmental proposals made by regional National People's Congresses and Chinese People's Political Consultative Conferences (CPPCCs), to measure VPR [78].

IERs, which stem from social pressure, express the public's environmental consciousness [79], that is, the public's awareness of the need for environmental protection. In general, regions that have higher incomes, higher educational standards, higher proportions of younger people, and greater population density tend to be more adversely affected by environmental pollution, so people who live in these regions tend to have more concern for environmental issues and to participate in environmental protection measures. We measure IER in each province using income level (disposable income of residents per capita), education level (average years of education), population density (total number in relation to area in square kilometers), and age structure (the proportion of the population that is under age 15) [35,80].

3.2.3. Moderating variable: corporate perceptions of policy

Xiong and Wang [81] contend that groups that have higher environmental awareness are more willing to protect the environment. Therefore, companies' willingness to embrace environmental regulations is significantly influenced by their environmental awareness, such that those that have a deeper perception of the importance of environmental protection are more likely to acknowledge, support, and implement FER. Companies' environmental awareness also affects their concern for environmental protection, thus indirectly reflecting their perceptions of and attitudes toward environmental regulation. Although PP and environmental awareness are not identical, environmental awareness can be used, to an extent, to measure PP. Therefore, we created a dummy variable to represent companies' environmental awareness scores, obtained from the rating agency *Hexun*. The dummy variable is assigned a value of 1 when the corporate environmental awareness score exceeds the mean value, and 0 otherwise.

3.2.4. Control variables

Many external and internal factors influence CEB [5,70,81,82]. To control for factors that are likely to confound the relationship between environmental regulation and CEB, a vector of firm- and province-level control variables is included [5,83–86]. At the firm level, we control for firm size (*Size*) as the logarithm of total assets, financial leverage (*Lev*) as total debt divided by total assets, firm age (*Age*) as the logarithm of firm age plus 1, firm profitability (*ROA*), liquidity (*Invrec*) as the proportion of inventory and accounts receivable to total assets, firm growth (*Growth*) as the growth rate of revenue, the shareholding ratio of the largest shareholder (*Top*), the proportion of executive shareholding (*Mgt*), the proportion of independent directors to total directors (*Pindepen*), and the nature of ownership (*Ownership*), which equals 1 if the firm is state-owned, and 0 otherwise. At the province level, we control for the province's law enforcement environment (*Law*) [87] and the province's investment in treating industrial pollution (*Polinvest*) [88]. We also control for industry (*IND*) and time (*YEAR*) effects with standard errors clustered at the firm level [84].

The descriptive statistical results of the main regression variables are presented in Table 1.

Table 1
Descriptive statistics.

Variable	Obs	Mean	Std.	Min	Max
PEB	5,079	0.237	0.142	0.000	0.639
NEB	5,079	0.046	0.106	0.000	0.332
FER	13,683	9.462	0.769	5.362	10.531
MIR	19,212	10.982	0.994	0.000	12.466
CCR	13,692	8.055	0.861	4.540	9.398
VPR	16,421	9.309	1.397	4.064	11.138
IER	18,062	8.952	0.429	7.151	9.838
Top	19,233	0.348	0.150	0.085	0.749
Pindepen	19,233	0.373	0.053	0.333	0.571
Mgt	19,233	0.113	0.190	0.000	0.675
Growth	19,233	0.212	0.450	−0.342	3.157
Size	19,233	21.337	1.465	17.665	25.341
Lev	19,233	0.442	0.214	0.007	1.000
Age	19,233	2.179	0.736	0.693	3.219
ROA	19,233	0.045	0.190	−1.000	20.788
Invrec	19,233	0.269	0.174	0.005	0.766
Ownership	19,233	0.413	0.492	0.000	1.000
Polinvest	19,233	12.275	0.937	9.270	14.058
Law	19,233	0.282	0.362	−0.914	1.602

3.3. Model and measurements

3.3.1. Model

We used ordinary least squares (OLS) regressions with two-way fixed effects to test empirically whether the IER and FER lead to differences in how corporations engage in CEB. OLS, which is widely used in econometrics, has the advantage of requiring the fewest conditions [84,89], so it is suitable for this study's regression analysis. Formula(1), the benchmark model, is used to test Hypotheses 1 and 2. Formula (1) uses the squared FER to test for a nonlinear relationship between FER and CEB. To eliminate the dimension of each variable and overcome heteroscedasticity to some extent, formula (1) is expressed in logarithmic form,

$$\ln CEB_{it} = \beta_0 + \beta_1 \ln FER_{it} + \beta_2 \ln FER_{it}^2 + \beta_3 \ln IER_{it} + \gamma CONTROL_{it} + YEAR + IND + \varepsilon_{it} \tag{1}$$

where CEB_{it} is the environmental behavior of firm i in year t; FER_{it} and IER_{it} are the FER and IER of the province in which firm i is located in year t, respectively; $CONTROL_{it}$ is a control variable; $YEAR$ and IND are the year dummy and industry dummy, respectively; and ε_{it} is the random error term. The robust standard error is also adopted to eliminate the potential of bias caused by heteroscedasticity.

Furthermore, according to the study of Wang et al. and Cao et al. [90,91], this study investigates the moderating effect of PP on the correlations of IER and FER with CEB. The centralized interaction terms are used to avoid the primary masking effect of a single variable. Formula (2) and formula (3) are used to test hypothesis 3,

$$\begin{aligned} \ln CEB_{it} = {} & \beta_0 + \beta_1 \ln FER_{it} + \beta_2 \ln FER_{it}^2 + \beta_3 \ln IER_{it} + \beta_4 * PP_{it} \\ & + \beta_5 \ln FER_{it} * PP_{it} + \gamma CONTROL_{it} + YEAR + IND + \varepsilon_{it} \end{aligned} \tag{2}$$

$$\begin{aligned} \ln CEB_{it} = {} & \beta_0 + \beta_1 \ln FER_{it} + \beta_2 \ln FER_{it}^2 + \beta_3 \ln IER_{it} + \beta_4 * PP_{it} \\ & + \beta_5 \ln FER_{it} * PP_{it} + \beta_6 \ln IER_{it} * PP_{it} + \gamma CONTROL_{it} + YEAR + IND + \varepsilon_{it} \end{aligned} \tag{3}$$

where PP_{it} is firm i's perception of policy in year t.

3.3.2. Measurements

Based on determining the indicator system, this study calculates the comprehensive levels of FER, CCR, VPR, IER, PEB, and NEB. Since the variables' scales differ, the initial data is standardized using the polar deviation method to eliminate the effect of the scale before data analysis. The standardization calculation method is as formula(4),

$$X_{ij}^{'} = \begin{cases} \dfrac{X_{ij} - \min X_{ij}}{\max X_{ij} - \min X_{ij}} * 0.99 + 0.01; \textit{Positive indicator} \\ \dfrac{\max X_{ij} - X_{ij}}{\max X_{ij} - \min X_{ij}} * 0.99 + 0.01; \textit{Negative indicator} \end{cases} \tag{4}$$

where X_{ij} is the initial data of the i indicator for j province, city, or enterprise; $X_{ij}^{'}$ is the standard data of the i indicator for j province, city, or enterprise; max X_{ij} is the maximum value for indicator i in j province, city, or enterprise; and min X_{ij} is the minimum value for indicator i in j province, city, or enterprise.

Then we employ the entropy method to determine optimal weights by quantifying the contribution of uncertain factors within the system [92,93]. We use the entropy-weight method to calculate the index weights to eliminate subjectivity and provide a scientific representation of the level of variation for each evaluation index [94]. First, we calculate the weight of indicator i in j province, city, or enterprise as formula(5),

$$Y_{ij} = X_{ij}^{'} \Big/ \sum_{j=1}^{m} X_{ij}^{'} \tag{5}$$

where Y_{ij} is the share of indicator i in j province, city, or enterprise in the sum of all provinces, cities, or enterprises in that year. Then we calculate the entropy value e_i of the indicator as formula(6),

$$e_i = -K \sum_{j=1}^{m} Y_{ij} \times \ln Y_{ij} \tag{6}$$

where $K = 1/\ln m$ and m represent the sample's capacity. Next, the coefficient of variation for this indicator is calculated by $d_i (d_i = 1 - \theta_i)$, such that the higher value of the coefficient of variation, the greater the influence of the indicator in the overall evaluation of its system. Based on this analysis, the weight w_i of the indicator is determined as $w_i = d_i / \sum_{i=1}^{n} d_i$. Finally, we calculate the composite score for each system in each province, city, or enterprise in that year as formula(7),

$$U_N = \sum_{i=1}^{n} w_i \times X_{ij}^{'} \tag{7}$$

where U_N is the combined evaluation value of the subsystems, such that U_1, U_2, U_3, and U_4 represent FER, IER, PEB, and NEB, respectively. The weights assigned to these indicators are presented in Table 2.

4. Empirical analysis and results

4.1. Benchmark regression

Table 3 reports the impact of FER and IER on CEB in formula(1). The table reports the results when PEB is used as the dependent variable and when NEB is used as the dependent variable. When PEB is the dependent variable, the coefficient estimates of FER are negative and significant at the 1 % level, and the coefficient estimates of the quadratic term of FER are positive. Therefore, the relationship between FER and PEB is U-shaped. The inflection point is $FER = 7.955$, and the sample's mean is 9.462, which exceeds the inflection points of the U-curve. These results indicate that China is at the stage of promotion after the "inflection point" and that the influence of FER on PEB should be increased.

One reason for this result may be that it takes time for policies to work. In the initial stages of FER, corporations may face excessive pressure in terms of environmental governance, which weakens the incentive to use resources [95]. Then, to expedite their achievement of the environmental regulations' objectives, companies are compelled to allocate additional resources toward end-of-pipe pollutant treatment, which entails adopting NEB after an event has occurred while simultaneously reducing investment in PEB. As time passes and the stringency of environmental regulation increases, companies increasingly invest in PEB for the purpose of sustainability and incorporate the delayed effectiveness of PEB. Although FER does not have a significant effect on NEB, it has the potential to enhance PEB, thus enhancing corporations' ability to address environmental issues proactively. These findings provide support for Hypothesis 1a.

Table 3 also reports the regression results of FER, categorized into MIR, CCR, and VPR. The results show that MIR does not have a significant relationship with PEB. As for MIR's impact on NEB, the coefficient estimates of MIR are positive and significant at the 1 % level, while the coefficient estimates of the quadratic term of MIR are negative, so the relationship between MIR and NEB has an inverted U shape with the inflection point at $FER = 23.141$. The mean value of the sample firms is 10.982, which does not exceed the inflection points of the inverted U-shaped curve, so firms are still increasing their strategic environmental behaviors in response to MIR, and MIR should be enhanced to exceed the inflection point. The results also show that CCR does not have a statistically significant effect on either PEB or NEB, supporting Hypothesis 1b.

Finally, Table 3 shows that the coefficient estimates of the relationship between VPR and PEB are negative and significant at the 1 % level, and the coefficient estimates of the quadratic term of VPR are positive. The coefficient estimates of the relationship between VPR and NEB are positive and significant at the 5 % level, and the coefficient estimates of the quadratic term of VPR are negative. These results show that the effects of VPR on PEB and NEB have a U-shaped relationship and an inverted U-shaped relationship, respectively,

Table 2
Weighting table based on entropy value.

Variable	Weighting
1. Pre-emptive environmental behavior	
Companies develop products that are good for the environment	0.091
Measures to reduce the three kinds of waste	0.057
Circular economy	0.142
Energy conservation	0.073
Green office	0.122
Environmental certification	0.142
Environmental recognition	0.177
Other behaviors	0.196
2. Ex-post environmental behavior	
Environmental penalties imposed on corporations	0.671
Pollutant discharge behavior	0.329
3. Formal environmental regulation	
(1) Market-incentive regulation	
Sewage charges	0.111
(2) Command-control regulation	
Number of employees in environmental agencies	0.191
Number of environmental laws and regulations, local regulations, and environmental standards promulgated in each region	0.218
Number of environmental penalty cases	0.211
(3) Voluntary-participation regulation	
Number of environmental proposals from regional NPCs and CPPCCs	0.111
Number of denouncement of environmental problems	0.159
4. Informal environmental regulation	
Population density	0.135
Income	0.315
Education	0.299
Age Structure	0.251

Table 3
Heterogeneous effects of IER and FER on CEB.

Variable	PEB				NEB			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Total	MIR	CCR	VPR	Total	MIR	CCR	VPR
FER	−0.131***	−0.002	−0.006	−0.065***	0.033	0.020***	0.039	0.023**
	(-3.49)	(-0.30)	(-0.17)	(-4.44)	(0.97)	(4.19)	(1.38)	(2.34)
FER^2	0.008***	0.000	0.001	0.004***	−0.002	−0.001***	−0.003	−0.001**
	(3.83)	(0.30)	(0.52)	(5.18)	(-1.11)	(-3.28)	(-1.48)	(-2.48)
IER	0.024***	0.023***	0.019***	0.014**	−0.040***	−0.039***	−0.038***	−0.038***
	(3.65)	(3.96)	(2.98)	(2.27)	(-8.21)	(-9.38)	(-8.05)	(-8.75)
Size	0.025***	0.030***	0.025***	0.027***	0.011***	0.010***	0.011***	0.011***
	(12.46)	(17.07)	(12.43)	(14.68)	(7.50)	(8.00)	(7.44)	(7.95)
Lev	0.015	0.007	0.013	0.012	0.021	0.028**	0.023*	0.026**
	(0.94)	(0.51)	(0.82)	(0.76)	(1.56)	(2.40)	(1.67)	(2.05)
Age	0.002	0.000	0.002	0.001	−0.005	−0.007***	−0.005	−0.006**
	(0.38)	(0.08)	(0.48)	(0.16)	(-1.64)	(-2.73)	(-1.64)	(-2.23)
ROA	−0.026	−0.038	−0.027	−0.036	−0.239***	−0.213***	−0.238***	−0.240***
	(-0.60)	(-0.98)	(-0.62)	(-0.88)	(-5.69)	(-6.08)	(-5.69)	(-6.29)
Invrec	−0.067***	−0.064***	−0.070***	−0.068***	−0.106***	−0.111***	−0.106***	−0.106***
	(-4.11)	(-4.52)	(-4.24)	(-4.45)	(-9.42)	(-11.36)	(-9.32)	(-9.99)
Growth	−0.013*	−0.011*	−0.013**	−0.009	−0.007*	−0.007*	−0.007*	−0.007*
	(-1.93)	(-1.77)	(-1.97)	(-1.41)	(-1.94)	(-1.90)	(-1.91)	(-1.92)
Top	−0.013	−0.019	−0.015	−0.010	0.015	0.012	0.015	0.008
	(-0.80)	(-1.32)	(-0.96)	(-0.69)	(1.34)	(1.28)	(1.35)	(0.82)
Pindepen	−0.024	−0.035	−0.017	−0.035	−0.082***	−0.074***	−0.082***	−0.079***
	(-0.57)	(-0.99)	(-0.42)	(-0.92)	(-3.32)	(-3.34)	(-3.31)	(-3.33)
Mgt	0.034*	0.038**	0.033*	0.029	0.050***	0.029**	0.050***	0.042***
	(1.73)	(2.19)	(1.69)	(1.58)	(3.33)	(2.23)	(3.35)	(2.99)
Ownership	0.006	0.003	0.007	0.006	0.014***	0.012***	0.015***	0.014***
	(1.07)	(0.60)	(1.18)	(1.14)	(3.69)	(3.74)	(3.78)	(3.85)
Polinvest	0.000	0.009**	0.006**	0.003	0.003	0.000	0.001	0.002
	(0.12)	(2.55)	(2.04)	(1.02)	(1.03)	(0.00)	(0.44)	(0.92)
Law	0.007	0.006	0.009	0.005	−0.012**	−0.011**	−0.013***	−0.010**
	(1.03)	(0.99)	(1.51)	(0.76)	(-2.49)	(-2.33)	(-2.65)	(-2.09)
Cons	−0.016	−0.710***	−0.584***	−0.298***	0.062	0.146***	0.052	0.103
	(-0.09)	(-9.34)	(-4.21)	(-3.14)	(0.39)	(3.02)	(0.42)	(1.51)
IND & YEAR	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	3358	4753	3362	4042	3358	4753	3362	4042
Adj_R^2	0.116	0.138	0.115	0.138	0.256	0.265	0.255	0.254

Note: ***p < 0.01, **p < 0.05, *p < 0.1.Figures in parentheses are robust standard errors. All U-shaped and inverted U-shaped curves passed the *U* test [96].

while the inflection point of the U-shaped and inverted U-shaped curves are $FER = 7.223$ and $FER = 6.658$, respectively. The mean value of the sample is 9.309, which exceeds both inflection points and indicates that VPR in China is at the stage of promoting PEB after the "inflection point," while inhibiting NEB. Therefore, VPR's effects on both PEB and NEB should be enhanced. As a nascent approach

Table 4
The influence of informal environmental regulation intensity.

Variable	PEB			NEB		
	(1)	(2)	(3)	(4)	(5)	(6)
	Weak	Medium	Strong	Weak	Medium	Strong
FER	0.019	0.097	0.072	0.143***	0.050	−0.192**
	(0.32)	(0.35)	(0.46)	(2.77)	(0.30)	(-2.10)
FER^2	−0.002	−0.003	−0.004	−0.010***	−0.004	0.012**
	(-0.55)	(-0.22)	(-0.42)	(-3.06)	(-0.42)	(2.42)
IER	−0.040	0.170***	0.044	0.018	0.002	0.033*
	(-1.59)	(3.97)	(1.09)	(0.82)	(0.06)	(1.96)
Cons	−0.216	−2.545*	−0.922	−0.931***	−0.402	0.435
	(-0.66)	(-1.72)	(-1.24)	(-3.20)	(-0.44)	(1.05)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
IND & YEAR	Yes	Yes	Yes	Yes	Yes	Yes
N	960	1101	1295	960	1101	1295
Adj_R^2	0.115	0.203	0.095	0.321	0.207	0.271

Note: ***p < 0.01, **p < 0.05, *p < 0.1. Figures in parentheses are robust standard errors. All U-shaped and inverted U-shaped curves passed the *U* test. To limit the length of the table, *Controls* represents all control variables.

to environmental control, VPR has limited binding influence on CEB, although its influence is expected to increase gradually because of the growing environmental awareness among business leaders and employees. This increase is likely to result in a rise in PEB and a decrease in NEB. These findings provide support for Hypothesis 1a and Hypothesis 1b.

Table 3 also shows IER's influence on PEB and NEB. The coefficients of IER exhibit significant and positive effects on PEB at the 1 % and 5 % levels, respectively, and significant and negative effects on NEB at the 1 % level. IER's significant positive effect on PEB and significant negative effect on NEB suggest that IER can have a substantial impact on encouraging PEB and discouraging NEB. These findings provide support for Hypothesis 2a and Hypothesis 2b.

However, firms may react to IER based on the threat of increased intensity after poor CEB [37,97,98]. Therefore, this study also explores the influence of IER intensity on the relationships of IER and FER with CEB. Using the triple quantile of the informal system, we categorized the sample into three levels of intensity: weak, medium, and strong. The results are presented in Table 4.

Table 4 shows that the coefficient for the influence of FER on NEB is positive and significant at the 1 % level, while coefficient estimates of the quadratic term of FER are negative if IER is weak. The coefficient for the influence of FER on NEB is negative and significant at the 5 % level, and the coefficient estimate of the quadratic term of FER is positive if IER is strong. This result shows that the effects of FER on NEB exhibit a U-shaped relationship under strong IER and an inverted U-shaped relationship under weak IER, while the inflection points of the U-shaped and inverted U-shaped curves are $FER = 7.426$ and $FER = 7.907$, respectively. The mean values of the sample are 9.091 and 9.461, respectively, which exceed both inflection points. Therefore, the effects of FER on NEB in firms in China under weak and strong IER are situated in the descending stage on the right side of the inverted U-shaped curve and in the ascending stage on the right side of the U-shaped curve, respectively. Meanwhile, the coefficients of IER are significant and positive at the 1 % level and 10 % level, respectively, indicating that IER has a significant positive effect on PEB under medium intensity of IER and a significant positive effect on NEB under strong intensity of IER. Therefore, FER and IER are substitutions to a degree, as the stronger IER is, the less effective the implementation of FER becomes. Moderate IER can enhance the enforcement of FER.

4.2. The endogeneity problem

Endogeneity problems in the relationships of FER and IER with CEB may occur if some unobservable variables affect these variables simultaneously. To solve the endogeneity problem in this study, the ventilation coefficients (VC) [99], the green coverage rate for the built-up areas by province where the enterprises are registered (GC) [100], the average topographic relief by province (TR) [101], lagged one period of FER (Lag1FER), lagged one period of squared FER (Lag1FER^2), and lagged one period of IER (Lag1IER) [102] are used as instrumental variables for FER and IER. All the instrumental variables guarantee the exogeneity and relevance of assumptions about the instrumental variables. The VCs of the province are determined by meteorological conditions, which are exogenous to CEB. The GC and the TC of the provinces are also exogenous because they are predefined geographic information variables that directly affect FER and IER.

We calculate the VCs of each city by multiplying the wind speed and the height of the atmospheric boundary layer. Then we

Table 5
Endogeneity problem - instrumental variable regression.

Variable	First-stage regression			Second-stage regression	
	FER	FER^2	IER	PEB	NEB
FER				−0.109**	−0.021
				(-2.01)	(-0.39)
FER^2				0.007**	0.000
				(2.44)	(0.14)
IER				0.023***	−0.046***
				(2.89)	(-7.94)
VC	−0.183***	−2.949***	0.050***		
	(-6.98)	(-6.28)	(2.93)		
GC	0.584***	11.287***	0.475***		
	(7.23)	(7.85)	(8.47)		
TR	−0.190***	−3.374***	−0.067***		
	(-9.96)	(-9.84)	(-4.12)		
Lag1FER	0.462***	−6.678***	0.107		
	(3.99)	(-3.46)	(1.49)		
Lag1FER^2	0.015**	1.100***	−0.012***		
	(2.45)	(10.65)	(-3.04)		
Lag1IER	−0.137***	−2.721***	0.824***		
	(-5.09)	(-5.74)	(29.35)		
Cons	2.455***	27.650**	−1.534***	−0.085	0.315
	(3.71)	(2.41)	(-3.77)	(-0.34)	(1.28)
Controls	Yes	Yes	Yes	Yes	Yes
IND & YEAR	Yes	Yes	Yes	Yes	Yes
N	2756	2756	2756	2756	2756
Adj_R^2				0.112	0.257

Note: ***p < 0.01, **p < 0.05, *p < 0.1. Figures in parentheses are robust standard errors. All U-shaped and inverted U-shaped curves passed the *U* test. To limit the length of the table, *Controls* represents all control variables.

combine all the cities by province to calculate the province's mean VC. We obtained the data for GC from the "China Urban Construction Statistical Yearbook" and calculated the average TC of the province according to Feng et al. [103].

We used two-stage ordinary least squares (2SLS) to regress the instrumental variables. The results are shown in Table 5. The Lagrange multiplier statistics and the Kleibergen-Paap rk Wald statistics are significant, indicating that the model passed the under-identification and weak identification tests, respectively. The results of the Anderson-Rubin test also reject at the 1 % level the null hypothesis that the sum of the endogenous regression coefficients is zero, which suggests a strong correlation between the instrumental and endogenous variables and that the instrumental variables we selected are appropriate. These results show that the results in Table 5 are robust, that is, that FER has a U-shaped relationship with PEB, while IER is significantly and positively correlated with PEB but significantly and negatively correlated with NEB.

4.3. Robustness tests

We employed three methods to assess the robustness of the results. First, we replaced the independent variable FER with sewage charges as a percent of GDP by province [104] and replaced IER with the number of searches for "environmental pollution" on Baidu [105,106]. Baidu is China's version of Google. The second approach involved using PEB and NEB as proxies for the primary dependent variable, CEB. The third approach substituted the control variables with those same variables lagged by one period to address the potential that reverse causality and endogeneity are in formula(1). The test results of these three methods, shown in Table 6, align with the outcomes of the previous analysis, confirming the robustness of our findings.

4.4. The moderating effect of corporations' perceptions of policy

A corporation's perception of a policy, or PP, which is based on a collection of natural and developmental factors, may affect the responsiveness of its CEB to environmental regulations. We use formula (2) and formula (3) to analyze the moderating effects of PP on the relationships of FER and IER with CEB. The regression results of the moderating models for various levels of CEB are shown in Table 7. Table 7 shows that that the two kinds of environmental regulation, the control variables, and the moderating variables have significant influence on PEB. The coefficients on the interactive term $FER \times PP$ are significant and positive on PEB at the 1 % level but insignificant and negative on NEB, so the positive impact of FER on PEB is strengthened when a corporation's perception of FER is positive. When the interaction term between IER and PP is included, the coefficients on $IER \times PP$ is significant and negative on PEB at the 5 % level but insignificant and positive on NEB, so when a corporation has a positive perception of IER, the negative impact of IER on PEB becomes more pronounced, thereby attenuating the linear association between the two variables. These findings support Hypothesis 3a, which proposed that PP plays a positive role as a moderator in the association between FER and PEB and between FER and PEB, but they do not support Hypothesis 3b, which proposed that PP is a positive moderator between IER and PEB and a negative moderator between FER and NEB.

4.5. Additional test

Considering that firms vary in terms of ownership, industry characteristics, market environments, and regional development, the motivations for and strategies employed in CEB may differ. Tables 8 and 9 report the results of exploring the impact of these factors on the relationships we address.

4.5.1. Heterogeneity of ownership

The study's sample is divided into two subsamples: state-owned enterprises (SOEs) and non-state-owned enterprises (NSOEs). SOEs

Table 6
The robustness results.

Variable	PEB				NEB			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FER	−1.192***	−0.275***	−0.315**	−0.142***	0.630***	0.151***	0.075	0.033
	(-4.94)	(-5.17)	(-2.35)	(-3.42)	(3.51)	(3.53)	(0.93)	(0.88)
FER^2	5.817***	0.015***	0.020***	0.009***	−5.050***	−0.007***	−0.005	−0.002
	(3.29)	(5.22)	(2.62)	(3.70)	(-3.90)	(-3.22)	(-1.07)	(-0.92)
IER	0.004	0.063***	0.060***	0.024***	−0.032***	−0.058***	−0.097***	−0.043***
	(0.60)	(5.48)	(2.83)	(3.31)	(-6.99)	(-6.32)	(-8.37)	(-8.19)
Cons	−0.564***	0.585**	0.038	0.051	0.181***	−0.518***	0.182	0.129
	(-7.70)	(2.54)	(0.06)	(0.26)	(3.43)	(-2.70)	(0.48)	(0.72)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
IND & YEAR	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	4753	2919	3358	3089	4753	2919	3358	3089
Adj_R^2	0.143	0.128	0.159	0.122	0.267	0.236	0.257	0.257

Note: ***p < 0.01, **p < 0.05, *p < 0.1. Figures in parentheses are robust standard errors. All U-shaped and inverted U-shaped curves passed the *U* test. To limit the length of the table, *Controls* represents all control variables.

Table 7
Results of moderation.

Variable	PEB			NEB		
	(1)	(2)	(3)	(4)	(5)	(6)
FER	−0.133***	−0.116***	−0.118***	0.033	0.028	0.029
	(-3.52)	(-2.90)	(-3.00)	(0.98)	(0.83)	(0.83)
FER^2	0.008***	0.007***	0.007***	−0.002	−0.002	−0.002
	(3.86)	(2.90)	(3.04)	(-1.12)	(-0.85)	(-0.87)
IER	0.023***	0.022***	0.038***	−0.040***	−0.039***	−0.042***
	(3.62)	(3.38)	(3.44)	(-8.21)	(-8.10)	(-5.62)
PP	−0.028***	−0.022***	−0.022***	0.003	0.001	0.001
	(-3.77)	(-2.84)	(-2.81)	(0.52)	(0.21)	(0.20)
FER × PP		0.021***	0.018**		−0.005	−0.005
		(2.95)	(2.55)		(-1.03)	(-0.91)
IER × PP			−0.028**			0.005
			(-1.98)			(0.47)
Cons	−0.533***	−0.527***	−0.521***	−0.218***	−0.219***	−0.220***
	(-8.38)	(-8.30)	(-8.20)	(-4.93)	(-4.97)	(-4.99)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
IND & YEAR	Yes	Yes	Yes	Yes	Yes	Yes
N	3358	3358	3358	3358	3358	3358
Adj_R^2	0.120	0.122	0.123	0.255	0.255	0.255

Note: ***p < 0.01, **p < 0.05, *p < 0.1. Figures in parentheses are robust standard errors. All U-shaped and inverted U-shaped curves passed the *U* test. To limit the length of the table, *Controls* represents all control variables.

Table 8
Influence of the nature of the control and the industry.

Variable	PEB				NEB			
	Ownership		Industry Characteristics		Ownership		Industry Characteristics	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	SOEs	NSOEs	Polluting	Non-polluting	SOEs	NSOEs	Polluting	Non-polluting
FER	−0.070	−0.209***	−0.114*	−0.224***	−0.012	0.063	−0.048	0.023
	(-1.35)	(-3.70)	(-1.89)	(-4.19)	(-0.26)	(1.35)	(-0.80)	(0.83)
FER^2	0.004	0.014***	0.008**	0.013***	0.000	−0.003	0.003	−0.001
	(1.39)	(4.33)	(2.17)	(4.35)	(0.01)	(-1.09)	(0.82)	(-0.77)
IER	0.025***	0.016	0.019	0.018**	−0.056***	−0.009	−0.059***	−0.006**
	(3.11)	(1.39)	(1.58)	(2.28)	(-8.83)	(-1.03)	(-4.39)	(-2.02)
Cons	−0.416*	0.722***	−0.163	0.492*	0.391*	−0.319	0.573**	−0.039
	(-1.70)	(2.84)	(-0.60)	(1.93)	(1.80)	(-1.62)	(2.19)	(-0.31)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
IND & YEAR	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2090	1268	955	2403	2090	1268	955	2403
Adj_R^2	0.122	0.126	0.114	0.121	0.298	0.201	0.316	0.075

Note: ***p < 0.01, **p < 0.05, *p < 0.1. Figures in parentheses are robust standard errors. All U-shaped and inverted U-shaped curves passed the *U* test. To limit the length of the table, *Controls* represents all control variables.

are enterprises that are owned by the state at the central, provincial, prefectural, and municipal levels, while NSOEs are privately owned and foreign-funded enterprises. The results in Table 8 show that FER has no significant effect on SOEs' PEB or NEB, although IER has significant positive effect on PEB and a significant negative effect on NEB.

These findings indicate, that as IER strengthens, SOEs will be subject to stricter supervision in areas like environmental governance because of heightened external supervision. Since 2011, national-level documents have been issued to integrate the development of ecological civilization into the evaluations of the government officials and senior executives who oversee SOEs to ensure that they prioritize environmental protection when making decisions regarding production and operations, thereby minimizing NEB.

NSOEs exhibit a U-shaped relationship between FER and PEB. The inflection point of the U-shaped curve is $FER = 7.590$, and the mean value of the sample firms is 9.569, which exceeds the inflection point. Meanwhile, IER has no significant impact on PEB or NEB for these firms. One explanation for this result could be that NSOEs demonstrate more responsive CEB and a higher level of sensitivity to environmental regulations than SOEs do [107]. Compared to SOEs, NSOEs face greater challenges in accessing financing, so they operate with larger margins to offset the costs associated with complying with FER, including the costs of adjusting their export activities [108]. NSOEs also encounter heightened market competition, so they are inclined to seize market share when they can. However, unofficial forces like IER may not be as effective in NSOEs as they are in SOEs because NSOEs tend to focus more on economic interests and market competition and may be inclined to ignore the impact of IER. In addition, NSOEs' limited scale and resources can pose challenges in absorbing the extra costs associated with environmental protection measures, thereby limiting their ability to

Table 9
Influence of market environment and regional development.

Variable	PEB					NEB				
	Market Environment		Regional Development			Market Environment		Regional Development		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Govern-ment-driven	Market-driven	Eastern	Central	Western	Govern-ment-driven	Market-driven	Eastern	Central	Western
FER	−0.079*	−0.069	−0.248***	0.162	−0.183	0.119***	−0.113	0.020	1.250***	0.507***
	(-1.75)	(-0.47)	(-3.45)	(0.29)	(-1.46)	(3.04)	(-1.37)	(0.38)	(2.61)	(4.41)
FER^2	0.005*	0.005	0.015***	−0.010	0.011	−0.008***	0.007	−0.001	−0.069***	−0.032***
	(1.76)	(0.65)	(3.75)	(-0.35)	(1.47)	(-3.57)	(1.50)	(-0.24)	(-2.70)	(-4.48)
IER	0.015	0.011	0.036***	−0.007	−0.062*	−0.032***	−0.020**	−0.026***	0.094	0.034
	(1.15)	(0.90)	(2.68)	(-0.05)	(-1.70)	(-3.39)	(-2.15)	(-2.95)	(0.80)	(1.06)
Cons	−0.164	−0.155	0.394	−1.081	0.677	−0.477**	0.706*	0.056	−7.156***	−2.039***
	(-0.75)	(-0.23)	(1.21)	(-0.36)	(1.07)	(-2.53)	(1.83)	(0.24)	(-2.71)	(-3.63)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
IIND & YEAR	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1809	1549	2390	588	379	1809	1549	2390	588	379
Adj_R^2	0.122	0.115	0.127	0.136	0.156	0.275	0.278	0.217	0.306	0.387

Note: ***p < 0.01, **p < 0.05, *p < 0.1. Figures in parentheses are robust standard errors. All U-shaped and inverted U-shaped curves passed the *U* test. To limit the length of the table, *Controls* represents all control variables.

respond to IER.

In contrast, SOEs lack motivation to engage in PEB because of their reliance on financial support from the Treasury and their limited exposure to market competition. SOEs also exhibit a significantly stronger political affiliation with the government than NSOEs do; this close association can decrease the effectiveness of FER. In addition, SOEs do not tend to prioritize profit maximization as their primary objective because they are expected to fulfill certain social responsibilities [109]. As a result, SOEs exhibit less responsiveness to and tolerance of FER than NSOEs do.

4.5.2. Heterogeneity of industry characteristics

Because differences in corporations' industrial characteristics lead to differences in their responses to environmental regulations [8], we categorize industries into two groups: polluting and non-polluting. According to "Guidelines for Environmental Information Disclosure of Listed Companies," issued by the Ministry of Environmental Protection of China in 2010. and the standard classification industries issued by the China Securities Regulatory Commission in 2012, twelve industries—mining, textile, paper and paper products, petroleum, chemical, chemical fiber, black (nonferrous) metal smelting and processing, rubber and plastic, pharmaceutical, and fur products—are classified as polluting industries, and the remaining industries are classified as non-polluting industries. The regression results are presented in Table 8.

The polluting industries show a U-shaped relationship between FER and PEB, with the inflection point of the U-shaped curve at $FER = 6.741$, and the mean value of the sample firms at 9.457, which exceeds the inflection point. IER has a significant and negative effect on NEB and an insignificant and positive effect on PEB. The non-polluting industries have a U-shaped relationship between FER and PEB. The inflection point of the U-shaped curve is $FER = 8.771$, and the mean value of the sample firms is 9.464, which exceeds the inflection point. IER has a significant and positive relationship with PEB and a significant and negative relationship with NEB. These results indicate that FER promotes PEB in both the polluting and non-polluting industries and that IER inhibits non-polluting and polluting industries' NEB and promotes PEB in the non-polluting industries.

4.5.3. Heterogeneity of market environments

Differences in market environments also lead to differences in CEB. In regions where government intervention is prominent, the government assumes a more influential role in the allocation of resources. To acquire additional resources, corporations that operate in the region are motivated to adopt PEB and minimize NEB. This paper uses the *FanGang Index* as a substitute measure for the market environment to investigate the differential effect of IER and FER on CEB across various market environments. Based on the median of the *FanGang Index*, the sample is characterized into two subsamples: government-driven regions and market-driven regions. The findings are presented in Table 9.

Table 9 shows that, in government-driven regions, FERs have a U-shaped and an inverted U-shaped impact on PEB and NEB, respectively. The inflection points of the U-shaped curve and inverted U-shaped curve are $FER = 8.364$ and $FER = 7.564$, respectively, and the mean value of the sample is 9.340, which exceeds the inflection points of the two curves. These findings indicate that the impact of FER on PEB in government-driven regions follows an upward trend on the right side of a U-shaped curve, while the impact of NEB follows a downward trend on the right side of an inverted U-shaped curve.

Meanwhile, IERs have a significant negative effect on NEB in both government-driven and market-driven regions, suggesting that IER can compel companies to decrease their NEB by intensifying environmental monitoring and imposing penalties through government agencies, media, or the public.

4.5.4. Heterogeneity of regional development

We categorized the sample into three regions—central, western, and eastern—based on their levels of economic development. The eastern region exhibits the highest level of development, the western region the lowest, and the central region in between. The findings are presented in Table 9. Based on the coefficients of IER, IER and PEB have a significant positive relationship and IER and NEB have a significant negative relationship in the eastern regions. In the western regions, IER and PEB have a significant negative relationship. We also find that FER has a U-shaped relationship with PEB in the eastern regions, and an inverted U-shaped relationship with NEB in the central and western regions. The inflection point of the U-shaped curve in the eastern regions is $FER = 8.377$, but the mean value of FER in the sample is 9.628, which exceeds the U-shaped curve's inflection point.

The inflection points of the inverted U-shaped curve in the central and western regions are $FER = 8.976$ and $FER = 7.807$, respectively, and the mean values of the FER that the sample firms face are 9.309 and 8.789, respectively, both of which exceed the inverted U-shaped curve's inflection points. In the central and western regions, the government presents a significant burden in terms of environmental protection, while the industrial sector operates at a relatively lower level. Under the pressure of the eastern regions "Get rich first" strategy and the ongoing process of industrial transfer from the east, the local governments in the central and western regions are increasingly focused on finding ways to accelerate and enhance economic output. Consequently, local governments in these regions have minimal concern about PEB because these behaviors are time-consuming and often carry high risk, taking away from the economic output most firms in these regions pursue [110]. Because of local corporations' backward approaches to development and their limited environmental awareness, they tend to prioritize the consistent profits from existing product markets [70,111]. Many corporations contemplate evading supervisory in an effort to avoid penalties, but as time passes and environmental regulations become part of the landscape, corporations are likely to decrease their NEB.

5. Discussion

This study uses a comparative analysis to examine the relationship of CEB with IER and FER, an area that has not been well studied. Our research shows that FER and IER have varying influences on CEB. The paper also addresses the behavioral choice scenario and selection logic.

We use a comparative analysis to delve into the logic of corporations' choices related to CEB, as influenced by FER and IER. The central question we address concerns how FER and IER alter the choices corporations make in terms of their CEB. Using an OLS model with two-way fixed effects that accounts for what affects CEB, we gain several useful insights. We also discuss the behavioral choice scenario and corporations' selection logic to help ensure full comprehension of these complex relationships' nuances.

Although studies emphasize that increasing FER is effective in regulating CEB [30,32,70,112], this research finds that FERs have a significant U-shaped effect on PEB but an insignificant impact on NEB. This conclusion aligns with the observations by Yu et al. [113] and Liu et al. [114]. Using a categorization of FER into MIR, VPR, and CCR, we found that MIRs have a significant inverted U-shaped effect on NEB but an insignificant impact on PEB, that VPRs have a significant U-shaped effect on PEB and an inverted U-shaped effect on NEB (which is consistent with Pargal and Wheeler [35]), and that CCRs influence neither PEB nor NEB, which is consistent with Liu et al. and Cai et al. [11,115].

Our findings highlight the importance of considering the nature of policy and the timing of its implementation. The policies' effects often exhibit a certain lag, and corporations' considerations during the initial stages of policy implementation can differ from their considerations during the later stages. Initially, enterprises might prioritize economic gains, ignoring the need for CEB. However, they may embrace PEB over time to achieve sustainable development, although, when regulations or enforcement are inadequate, enterprises may lack sufficient pressure to modify their CEB. Technological and economic constraints can hinder CEB further.

The role of IER receives considerable attention in academia. The present study finds that IERs have a significant and positive effect on PEB and a significant and negative effect on NEB, a finding that is also reflected in the research results of Zhang et al. and Hartman et al. [46,116]. The present study also reveals that IERs exert substantial impacts on SOEs' PEB and NEB in the form of a significant and positive effect on PEB but a negative effect on NEB. In contrast, the impact of IER on NSOEs is relatively insignificant, as it affects neither PEB nor NEB. IERs also have a significant positive influence on PEB in non-polluting industries and a significant negative effect on NEB in both polluting and non-polluting industries. IERs also exert varying impacts depending on the market and regional environments, as they have a negligible effect on PEB across market environments and a negative influence on NEB. IERs significantly promote PEB and significantly hinder NEB in the eastern regions and significantly hinder PEB in the western regions. In the central regions, although the impact is less pronounced, IERs positively affect NEB.

These findings suggest that the effectiveness of IER in promoting CEB among enterprises varies significantly across regions and market conditions, perhaps because governments in the central and western regions face significant challenges related to environmental protection and relatively low economic development. Under the pressure of the "get rich first" strategy in the eastern region and the ongoing process of industrial relocation from the east, local governments in the central and western regions prioritize strategies that aim to achieve more, faster, better, and more economically in their efforts to stimulate economic growth. Consequently, these governments tend to be focused on boosting the overall economy, so enterprises in these regions tend to favor existing products that offer stable returns.

However, some studies show that FER and IER can have unintended or even perverse consequences for CEB [11,115]. Reasons for such effects include that the transformation of CEB is not always the regulations' objective; that too many regulations reduce the impact of individual policies or lead to unintended negative consequences; coordination issues and conflicting objectives among various levels of government, sectors, and agencies; and powerful firms' ability, as significant employers and political players, to undermine enforcement efforts [117]. According to Cai et al. and Xang et al. [115,118], the stringent requirements of environmental

regulations can also elevate the cost of corporate pollution control and hinder a company's capacity to absorb and adopt new technologies that would reduce illegal environmental behavior. We expect to delve into these reasons in future research.

The definition and discussion of PEB and NEB in this paper constitute a noteworthy contribution, as we argue for the value of examining these two types of environmental behaviors within the same analytical framework. The findings of this study reveal that enterprises often adopt distinct approaches to CEB in the forms of PEB and NEB, highlighting the need for a nuanced categorization of CEB. Furthermore, a company's transformation from pursuing NEB to pursuing PEB signifies a shift in its prioritization—or at least a balancing—of long-term social interests over short-term economic gains. This shift helps to explain how enterprises navigate their environmental responsibilities and align them with their strategic objectives.

Our results indicate that FER and IER neither uniformly promote PEB nor uniformly hinder NEB across the regions of the country. This outcome reflects the challenges Chinese companies face from multiple stakeholders, including the government, the public, and shareholders, to embrace green and sustainable practices. Although companies exhibit a desire to assume responsibility for environmental sustainability, their operational status often prevents them from prioritizing long-term social benefits over short-term economic gains, presenting a significant challenge for Chinese environmental management departments.

This study shows that corporate perceptions of policies can have a positive impact on the interaction between the FER and PEB but a negative impact on the interaction between the IER and PEB and no impact on the interaction between FER/IER and NEB. As key players in policy implementation, enterprises carry both economic and social responsibilities, but their perception of policies is a direct reflection of their compliance, so it is central to ensuring that enterprises adhere to environmental policies, enhance their effectiveness, and achieve sustainable development.

An important aspect of this paper is its addressing the rationale behind corporations' choices in how to respond to regulations by engaging in CEB. The government cannot focus on superficial observations but must comprehend the logic that guides these choices under various kinds of environmental pressure and assess the landscape around these choices in terms of companies' perceptions of policies. Doing so will allow them to formulate targeted policy recommendations, such as taking a gradual approach to aligning companies' short-term economic objectives with their long-term social goals.

Environmental regulations must stimulate PEB and decrease NEB, as investing in PEB increases the likelihood that companies will adhere to environmental laws and decreases the likelihood that they will engage in NEB, but the government should exercise patience and avoid hasty enforcement measures that could be counterproductive. Incremental adjustments to the intensity of FER and enhancement of IER could yield superior regulatory outcomes.

6. Conclusions and implications

This study focuses on the CEB of Chinese A-listed corporations and considers the effects of two types of CEB—PEB and NEB—and how these two types of environmental regulation influence how firms choose to implement CEB. The study establishes a comprehensive index of FER, IER, PEB, and NEB using data across 30 provinces and Chinese A-listed corporations from 2009 to 2017. The study also investigates how firms' type of ownership, industry, market, and region influence their response to FER and IER in terms of implementing CEB. The study also explores the moderating effects of corporations' perceptions of policies on the relationships of FER and IER with CEB. We conducted robustness tests by substituting the independent variables with proxies, changing how the dependent variables are measured, and introducing a one-period lag to the control variables.

The study finds that FERs have a significant U-shaped effect on PEB and that MIRs have a significant inverted U-shaped effect on NEB. VPRs have a significant U-shaped effect on PEB and an inverted U-shaped effect on NEB. Moreover, FERs have a significant U-shaped effect on NSOEs' PEB and enterprises that operate in non-polluting industries and polluting industries that are located in the eastern regions. Conversely, FERs have an inverted U-shaped effect on NEB in regions that are dominated by government influence, particularly in the central and western regions. We also find that IERs have a significantly positive and negative effect on PEB and NEB and a significantly negative effect on SOEs' NEB. IERs have contrasting impacts on PEB and NEB in the eastern regions. Corporations' perceptions of policy play a central role in positively moderating the relationship between FER and PEB. Conversely, corporations' perceptions of policy have a negative moderating effect on the relationship between IER and NEB.

These findings have several implications. First, because of the synergistic impact of FER and IER, when the level of FER is relatively low during a regulation's initial phase, the government must enhance the incentives for corporations to engage in PEB and strengthen the penalties for non-compliance to reduce the occurrence of NEB and foster a shift in corporations' perceptions of green transformation. If governments follow this approach, the effect of FER can break the inflection point of the U-shaped and inverted U-shaped curves, thereby influencing CEB and facilitating corporations' timely realization of its value. On the other hand, IER, which is characterized by its flexibility and social moral norms and values, has the potential to address the short-sightedness of top management and foster greater engagement and participation of both enterprises and individuals by cultivating a stronger moral sentiment and a heightened sense of historical mission in protecting the environment. Not least of corporations' motivations is that green transformation has significant potential for corporations' long-term growth and branding.

Governments should also adopt a range of measures to improve corporations' perceptions of and compliance with environmental regulations, establish diverse channels for the dissemination of environmental regulations, and grant enterprises the opportunity to demonstrate their commitment and dedication to environmental management to encourage PEB and discourage NEB. Governments should also take into account the heterogeneity of regulations' targets and corporations' environments when formulating FER. Various forms of FER and IER should be formulated for different types of enterprises, as, for example, NSOEs have less capacity and fewer resources to withstand environmental regulations than SOEs do. Increasing the supervision and stringency of FER in both non-polluting and polluting industries and providing incentives in the form of financial support to promote PEB can help to mitigate

the adverse impacts of enterprises' production and operational activities. Green research and development (R&D) efforts should also be supported, along with the use of environmentally friendly production inputs. Establishing an effective cost-sharing mechanism can help to mitigate enterprises' NEB and minimize the negative externalities associated with their operations.

Taking into account the heterogeneity of environmental differences can also be useful. Enterprises in the eastern regions, where competition is fierce, may exhibit a higher level of environmental awareness of and demonstrate greater enthusiasm for adopting PEB, while the development of enterprises in the central regions, western regions, and regions that are dominated by the government is less advanced. Local governments in these areas face challenges in implementing green initiatives because of the political pressures to perform economically that they encounter. Governments in these areas should adhere to policy guidance and prioritize the establishment of IER, thus reducing the expenses associated with supervision and internalizing within enterprises the need to attain a green transformation.

Our paper's results suggest directions for future research. First, future work could quantify the magnitude and/or stringency of environmental regulations to allow for more comprehensive analyses of the relationships between environmental regulations and CEB in China, especially as CEB relates to green innovation. Second, future work could subdivide further the dual environmental regulations of FER and IER to facilitate analyses and identification of the mechanisms through which subsets of environmental regulations affect CEB in China. Third, we call for future work to provide a comprehensive analysis of the perceptions of FER and IER and enterprises' behavior related to green innovation.

Data availability statement

Data will be made available on request.

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CRediT authorship contribution statement

Mingjie Lyu: Writing – original draft, Software, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Ying Chen:** Writing – review & editing, Supervision, Software, Resources, Methodology, Data curation. **Song Chen:** Writing – review & editing, Supervision, Resources, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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